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An Evaluation of Teaching Methods Based on Cognitive Achievement

Ryan Patrick Siebenmorgen
University of Arkansas, Fayetteville

AN EVALUATION OF TEACHING METHODS BASED ON COGNITIVE ACHIEVEMENT

An Evaluation of Teaching Methods Based on Cognitive Achievement

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Ryan Patrick Siebenmorgen
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Dr. Don Edgar
Thesis Director

Dr. Donald Johnson
Committee Member

Dr. Vinson Carter
Committee Member

Dr. Freddie Scott
Committee Member

ABSTRACT

The purpose of this study was to determine if there were any significant differences ($p < .05$) in cognitive achievement between different instructional techniques on students enrolled in high school agricultural science classes in Northwest Arkansas. Lesson content covered the production, uses, and performance of biodiesel fuels in compression engines. Treatments were different instructional techniques including lecture, demonstration, and a combination of lecture and demonstration. Cognitive achievement was measured on low level cognition and high level cognition. In addition, this study sought to find any correlation between student perceptions of lecture versus demonstration and tinkering self-efficacy on student achievement.

A true experimental pretest-posttest design (#2) was used to conduct this research (Campbell & Stanley, 1996). The population consisted of all students enrolled in high school agricultural science courses in the spring of 2011. A sample population was used consisting of 27 intact classes (N=333). Nine classes were used per treatment. Subjects were taught using any (but only one per subject group) of the three treatments based on random selection. Every subject received a pretest prior to the lesson and then posttest following the treatment. Student perceptions of tinkering self-efficacy and perceptions of demonstration and lecture were collected for every subject.

Data collected for this study revealed no significant difference across instructional techniques on knowledge acquisition ($F(2)=0.68$, $p=.52$). However, when comparing treatments and cognitive achievement, there was a significant difference between the combination technique (2.92, *SD* .55) and the lecture technique (2.00, *SD* .65) on high cognitive achievement. There was not a significant difference on students' cognitive achievement on low level cognition. There was not a significant correlation between student perceptions (preference) of instructional

technique and knowledge acquisition. Nor was there a significant correlation between student perceptions of tinkering self-efficacy and knowledge acquisition. There was a significant correlation between tinkering self-efficacy and student preference of instructional technique.

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I would like to dedicate this thesis to my family: father, Dr. Terry Siebenmorgen, mother, Patty Siebenmorgen, wife, Abbey Siebenmorgen, and brother Justin Siebenmorgen. Without your high standard of achievement and successes you have earned, I never would have had the motivation to attempt or complete this task. Your success has inspired me to constantly reach for higher goals. Abbey, your patience throughout was greatly appreciated. You gave me encouragement that others cannot which gave me the drive to complete in times of content. Justin, you completed your Master Degree with ease: thanks to our competitive spirits, it provided inspiration. You all have been there in times of joy and celebration as well as hard times. Thank you!

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CHAPTER 1

INTRODUCTION

Need for the Study

Learning is a phenomenon experienced daily by most individuals. Learning is a process that can change behavior or knowledge towards situations through experience (Woolfolk, 2010). Therefore, people gain new information each day through the process of increasing experiences within their environment. Because numerous theorists conceptualize that experiences lead to knowledge acquisition, the question remains regarding selecting the best method to aid in this knowledge acquisition in today's classrooms.

"Learning occurs as a result of experiences had by the learner" (Roberts & Harlin, 2007 p. 47). Experiential learning is simply learning by doing (Dewey, 1938). When an individual experiences a reality, that reality becomes knowledge, thus knowledge acquisition or learning occurs. A similar philosophy, or theory, is that of Lev Vygotsky (1978), a psychologist, who believed that learning is a tool in development; through acting, learning will occur.

There are many different learning styles towards which instruction may be directed, therefore, theories on education and learning hold a lot of importance (Tannahill, 2009). The different types of learners include auditory, visual, and kinesthetic or tactile (Cano & Hughes, 2000; Gregorc, 1979; Jensen, 1969; Knapp cited in Lever, 1952; McGregor, Fraze, Baker, Burley, and Byrd, 2004). A conclusion from the previously cited sources may indicate that every student learns differently. This conclusion is supported with research completed by Cano, Garton, and Raven (1992) who found that "students differ in learning styles, personality styles, and in their preferred method of teaching (pg. 51)." Because of this, not all students learn the same and it becomes important to tailor lessons which cater different learning styles (McGregor et al., 2004). McGregor et al., (2004) stated one must take into consideration that each student learns differently and one method of instruction is not sufficient to effectively reach every type of learner.

Learning is considered a cognitive process consisting of levels (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956). A common goal of teachers is to provide students the ability to think at a level beyond recalling and recitation. Bloom's Taxonomy is composed of two orders of cognitive thinking; high and low (Bloom et al., 1956). Bloom et al., (1956) broke the thinking process into six levels; knowledge, comprehension, application, analysis, synthesis, and evaluation. The first three - knowledge, comprehension, and application - are considered to be low order cognition. The next three steps - analysis, synthesis, and evaluation - are higher order cognitive thinking. One step in the cognitive process must be reached before continuing to the following step (Bloom et al, 1956).

Recently, another theory has evolved which includes similar levels of thinking: Webb's Depth of Knowledge (DOK). Webb's DOK involved student understanding, and the more they understand, the higher the level they achieve (Webb, 2009). Each level indicates, not how much the student has learned but how much the student understands (Webb, 2009). Thus, a higher level of cognition has been achieved.

Teachers can promote conditions that foster teacher effectiveness: teacher effectiveness is a major role or influence on students' academic success (USDOE, 2012). Because of this, a teacher may also have an influence on the level to which a student thinks or understands. Academic success is achieved when students can make connections and associations beyond the classroom (Honigsfeld & Dunn, 2010). Therefore, the goal of teaching is to help students develop the ability to reach higher levels of thinking. Consequently, the purpose of an agricultural educator is to provide the agricultural workforce with skilled and successful workers that are agriculturally literate (Roberts, & Ball, 2009). Congruent with this thought is it is essential that the agriculture workforce be provided with workers that can apply their knowledge. Based on research (Estepp & Roberrts, 2011; Honigsfeld & Dunn, 2010; Roberts & Ball, 2009; USDOE, 2012), it is imperative to provide students an avenue by which higher levels of learning can take place. Allowing students educational and constructed experiences provides them the ability to reflect on and generalize their learning, making it more transferable outside of the classroom or learning environment (Estepp & Roberts, 2011).

Students learn most effectively when they are fully engaged (Honigsfeld & Dunn, 2010). Furthermore, "teaching occurs when performance is achieved with assistance" (Tharp & Gallimore, 1991 ¶11). Researchers (Honigsfeld and Dunn, 2010; Tharp and Gallimore, 1991) purport that teachers should strive to fully engage students in a directive learning environment. Because of instructors' key role in students' engagement, instructors should be selecting teaching methods based on learning styles (McGregor et al., 2004). If students cannot focus because of a lack of understanding, students' engagement is lost (Honigsfeld & Dunn, 2010). Therefore, selecting a learning style in which the instruction is directed is necessary for student engagement.

For years, the main method of delivering educational information has been traditional lecture-type instruction (Broadwell, 1980; O'Malley & McCraw, 1999; Waldron & Moore, 1991). However, lecture does not satisfy the call for experiential learning because it lacks the hands-on experience component necessary for the development of hands-on skills (Dewey, 1916: Roberts & Ball, 2009). Passive learning – i.e. learning without doing – is effective, but when passive meets real-world experience, learning becomes much more significant (Dewey 1916). A common method of delivery in agricultural education, to provide experience, is through hands-on demonstrations. Through hands-on demonstrations, a student is able to be actively involved in the lesson. This engages the tactile and kinesthetic senses, which, according to Dewey (1916) encourages active learning. Although visual and auditory learning involves an experience which the brain must process, those styles are considered passive (Dewey, 1916).

There have been multiple studies which compare different teaching methods and their impact on effectuating knowledge (Dyer & Osborne, 1996; Kolb; 1984; Korwin & Jones, 1990; O'Malley & McCraw, 1999; Ott, Mann, & Moores, 1990; Sallee, 2012). A recent study by Sallee (2012) concluded that there is a positive correlation between student test scores and high perceptions in tinkering self-efficacy. Another finding was a positive correlation between perceptions of tinkering self-efficacy and method used (Sallee, 2012). The conclusion was that presentation method had a significant impact of student learning based on the students' perceived ability towards tactile based learning. Moreover, students taught using the problem-solving approach exhibited higher mean scores on achievement tests than those taught using the subject matter approach (Dyer & Osborne, 1996).

Studies show correlations and comparisons of different methods of teaching, but there appears to be a need for further research (Newsome, Wardlow, & Johnson, 2005). Results from a study performed by Newsome, et al., (2005), suggest that the results comparing teaching methods vary from school to school. Thus, further investigation into the phenomenon of how students learn based in differentiated methodologies should be explored.

Statement of the Problem

The impact of teaching methodologies towards cognitive achievement is a concern of education professionals. Furthermore, there is a lack of evidence within the literature that demonstrates strong comparisons of different teaching methods; lecture, demonstration, and a combination of lecture and demonstration. Therefore, this research is guided by a need for comparing teaching methods and their effect on cognitive achievement.

With many different teaching strategies available to instructors, one is left questioning the most effective method. Resulting from a need of teaching method comparisons, the purpose of this study was to determine the most appropriate method of teaching to achieve high levels of cognition. High and low level cognition were variables of study based on three selected teaching methods: lecture only, demonstration only, and lecture and demonstration combined. This study further sought to determine student perceptions of teaching method used as well as the influence of tinkering self-efficacy towards preference of methods of instruction.

Purpose

The purpose of this study was to determine if there was a significant difference ($p \leq .05$) in different methods of instruction; including lecture, demonstration, and a combination of lecture and demonstration. The study also determined differences in cognitive gains (high or low) between the different methods of instruction. It also sought to determine the influence of student perceptions of methods on knowledge acquisition as well as the influence of tinkering self-efficacy on knowledge acquisition.

Limitations

Limitations to this study were recognized as follows. In consideration that the study was conducted in Northwest Arkansas it may be inferred that students in different areas may return different results; therefore, generalizations could not be made. Also, there was not an opportunity for randomization within the groups because the classrooms were already set by the school. Randomization of treatments was able to occur because intact classes were randomly assigned treatments.

Key Terms

Active Learning: Active learning is broadly defined as the act of learning by being engaged in projects, discussions, and activities which stimulate the mind and involves the student on a higher level than simply listening (Bonwell, 2000).

Biodiesel**:** A domestically produced, renewable fuel made from methyl esters of animal oils, vegetable (plant) oils, or a combination of the plant and animal oil (Marshal, Schumacher, and Howel 1995)

B-20: A blend of biodiesel which contains 20% biodiesel and 80% conventional D2 diesel (Marshal et al., 1995).

D2 Diesel: D2 petroleum is conventional low sulfur diesel fuel. This would be similar to the diesel one might purchase at a regular fuel pump (Marsh et al., 1995).

Demonstration: A hands-on approach to instructional technique designed to engaged the body in learning and target the tactile/kinesthetic senses (Korwin & Jones, 1990).

Lecture: "An efficient means of communicating large amounts of information to many people in a short period of time" (Broadwell, 1980 p.xi).

Lecture and demonstration combined: Lecture and demonstration are clearly defined; this is a method of incorporating both styles of teaching into one lecture.

Experiential learning: Experiential learning is a learning theory that is composed of four tenets: learning through real-life contexts (Dewey, 1938), learning by doing (Knapp, cited in Lever, 1952), learning through projects and learning through solving problems (Lancelot, 1944).

Learning style: Learning styles is best defined as a pattern by which one absorbs knowledge and processes information in educational situations (Tannahill, 2009).

Learning: Learning is a process that can change behavior or knowledge towards situations through experience (Woolfolk, 2010).

Passive Learning: Passive learning is listening and not doing; although listening is technically doing something, other senses are not doing anything, the body is not moving and the mind is not stimulated by activity (Bonwell, 2000).

Tinkering: The act of manipulating, disassembling or assembling, constructing, modifying, or repairing devices or components of objects (Baker & Krause, 2007).

Self-Efficacy: Self-efficacy is most easily defined as one's evaluation of their personal ability to successfully complete or execute a given course of action (Bandura, 1977).

CHAPTER 2

THEORETICAL FRAMEWORK

Introduction

For years, educational theorists and philosophers have been trying to identify exactly what learning is and how it occurs. Learning is a process that can change behavior or knowledge towards situations through experience (Woolfolk, 2010). But there are many factors that influence situations or experiences. These factors not only affect how much is learned but also the premise under which learning is occurring. Thus, to help further analyze for understanding, learning may be categorized as active or passive (von Glaserfeld, 1989).

Education Theory

"Surprisingly, educators' use of the term active learning has relied more on intuitive understanding than a common definition" (Bonwell, 1991, pg. 28). As a result, many ascertain that learning is inherently active because the students' listening is considered active involvement. Bonwell (1991) postulated that active learning is broadly defined as the act of learning by being engaged in projects, discussion, and activities which stimulate the mind and involves student senses beyond the auditory sense. This would agree with Woolfolk's (2010) definition of learning, as previously stated, because it suggests that listening is an active experience and any experience leads to learning.

Dewey's theory, however, suggests that an experience must be a physical action which engages your kinesthetic senses and according to von Glaserfeld (1989), knowledge is not gained passively but by doing. Chickering and Gamson (1987) also suggest that, for student learning to occur, the student must be actively involved beyond just listening. Activities that might be included are reading, writing, discussion, or be involved in solving problems (Chickering and Gamson, 1987).

John Dewey, a proponent of experiential learning, proposed the idea that the most effective means of learning about a topic is to experience it (Dewey, 1916). The nature of an experience is trying or acting: when we partake in an experience, an act is occurring (Dewey 1916). According to this philosophy, there is not an action involved in listening (von Glaserfeld, 1989). Dewey (1916) stated that learning is simply a result of the understanding of the consequences to an action taken by the learner. To every action there is a reaction, or consequence, and if the learner understands this connection, learning has taken place (Dewey, 1916). Dewey's theory is known as experiential learning; learning by doing (Dewey 1916; Roberts & Harlin, 2007).

Although listening may be categorized as active learning due to the nature of what is occurring, listening is considered a passive form of learning because the other senses (kinesthetic, tactile, and visual) are not engaged: the body is not moving and the mind is not stimulated by activity (von Glaserfeld, 1989). The only stimulation is derived through the auditory sense. Students are not considered to be engaged when passive learning is taking place (von Glaserfeld, 1989). Even though the student may be engaged in what a teacher is saying, it is not considered a form of active learning (Bonwell, 2000). The act of doing creates active learning which engages the student beyond the auditory sense. Passive learning is just the opposite; listening and not doing (Bonwell, 2000).

To further analyze learning and the effect different styles have on learning, researchers and theorists continue to examine learning. Researchers (Bonwell, 2000; Roberts & Harlin, 2007; von Glaserfeld, 1989) established that there are different ways of learning: broadly said, there is passive learning and active learning. The question still remains, which is better.

The Zone of Proximal Development (ZPD) is a theory which helps break down learning into levels of understanding. The ZPD is a gap between levels of knowledge. One must achieve a proposed level of knowledge before advancing to the next (Vygotsky, 1978). Based on the ZPD, Lev Vygotsky (1978) proposed a theory in which social interaction plays a fundamental role in the development of cognition. Vygotsky believed that knowledge was influenced by one's social community and that greater knowledge was attained with the assistance of a more knowledgeable other (Vygotsky, 1978). Therefore, students may attain knowledge, but the potential to gain more knowledge is dependent on the teacher: the gap of knowledge is referred to as the ZPD. The teacher must understand ZPD to maximize learning at the greatest cognitive level possible, but may not exceed that particular knowledge level (Vygotsky, 1978). To reach higher levels of cognition, one must be influenced by a more knowledgeable other; and through said interaction, a higher level of learning may occur (Vygotsky, 1978). Vygotsky's theory postulates that learning will occur, but it will occur at a higher level if the environment influences that learning.

Jean Piaget offers a social learning theory which is very congruent with Vygotsky's theories. Piaget's theory stated that there are many different levels of knowledge, and one level must be reached before the following may begin (Piaget, 1970). This is very similar to Vygotsky's idea of the ZPD because the thesis point is that a learner may not be stretched beyond a point of knowledge they have not obtained. Piaget's theory also parallels with Dewey's theory of experiential learning. Piaget believed that learning occurs as a result of interactions with the environment surrounding the learner (Piaget, 1970). Although stated somewhat different, this ‘cause-and-effect’ learning outcome is the same as Dewey stating that learning is a result of the experiences had by the learner.

Cognitive Development

The philosophies of Piaget, Dewey, and Vygotsky are all forms of active learning. Active learning that involves physical movement of the person or direct engagement which stimulates the mind beyond listening. However, according to von Glaserfeld (1989) and as previously illustrated, there are two means of learning; active and passive. Therefore, these philosophies guide this research to examine the differences in passive and active learning. One of the main objectives of this research is to obtain data which might help to answer this question. However, there are different levels at which learning occurs and these different levels require higher or lower levels of thinking (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956).

Bloom et al. (1956) developed a hierarchy of thinking which was known as Bloom’s Taxonomy. This consisted of, in order from low to high, (1) knowledge, (2) comprehension, (3) application, (4) analysis, (5) synthesis, and (6) evaluation. Each step builds upon the previous step and learners must reach one level of thinking before they may proceed to higher levels. Our cognitive processes are always working, and we are processing at every level, every day (Ewing & Whittington, 2007). Ewing and Whittington (2007) performed a study that confirms the theory in Bloom’s taxonomy. Data supported the idea that students must incorporate knowledge, comprehension, and application before they can achieve higher levels of cognitive development (Bloom et al., 1956; Ewing & Whittington, 2007). Although information may be processed at a high level, low level cognitive process(es) are still undergoing.

Recently, another theory has developed which closely parallels Bloom’s Taxonomy. It is known as Webb’s Depth of Knowledge (DOK). DOK is a guide by which student understanding can be measured (Webb, 2009). Bloom's Taxonomy places students at higher cognitive levels once the learner has achieved the current level of thinking because it indicates an accomplished understanding at a particular level (Bloom et al., 1956). Webb's DOK is similar to Bloom's Taxonomy; in the process of learning, some level of understanding has taken place, and the greater the understanding, the greater the DOK. Webb tries to categorize this understanding with how deeply a student understands a topic (Webb, 2009). Marconi, Smith, and Lombardi, (2009) report the incorporation of the ZPD into all of the state testing requirements for the state of Nevada for the testing year of 2010. This indicates the use of the DOK as a progressive theory that is being implemented in curriculum.

The main differences in the two theories are semantics and succinctness. To describe progress in cognitive processing, Bloom uses six verbs to represent or classify the level of cognitive achievement a student has met. The system Webb utilizes is also taxonomical. However, there are numerical levels to describe ones achievement. Those levels are then described with descriptive verbs to helps identify the qualities of a given level. "The DOK level describes the kind of thinking involved in the task" (Marconi, et al., 2009 p.3). Higher DOK levels require greater conceptual understanding and thus higher cognitive processing by the students (Marconi et al., 2009; Webb, 2009).

There are four different depths or levels students may achieve through Webb's DOK (Marconi, et al., 2009; Webb, 2009. The first level (one) involves recall and recitation where responses are, or should be automatic (Webb, 2009). The second level (two) "requires students to engage in mental processing and reasoning beyond habitual response" (Marconi et al., 2009 p.3). The second level requires a student to approach a problem and make interpretations from given concepts. Level three begins into higher cognitive processing (Marconi et al., 2009).

Level three requires that students can create conclusions and provide evidence and reasoning to support those conclusions (Marconi et al., 2009; Webb, 2009). Students at level four may complete tasks which demonstrate reasoning, planning, and developing within and beyond a content area (Marconi et al., 2009; Webb, 2009). In concurrence with Bloom's Taxonomy, when a student reaches the next higher level in the DOK, the previous levels are still undergoing and necessary for the achievement of the current level (Webb, 2009).

DOK Level	**Title of Level**
1	Recall and Reproduction
2	Skills and Concepts
3	Short-term Strategic Thinking
4	Extended Thinking

Figure 1: Adaption of Webb's Depth of Knowledge (Webb, 2009)

This research aimed at discovering differences in levels of cognitive development based on different learning styles. To accomplish measurement of cognitive levels, two styles of questions must be asked. To satisfy this research, there are two types of questions; recitation and construction. Recitation questions only require students to recall information (Marzano, 1993). Recitation questions would only satisfy a lower level of the cognitive order according to the theories of both Bloom and Webb. Construction questions require students to make connections based on previous knowledge to create new knowledge (Marzano, 1993).

Learning Styles

Because this study sought to determine how students will learn (better or worse) at different levels of cognitive processing as a result of active or passive learning influenced by teaching methods, cognitive development plays an important role. If students are only able to recall information, but are unable to make connections to real world situations, that knowledge becomes useless. "The focus of learning should not be so much the learning of a certain body of information. It should rather be the learning of information in relation to its' application of major scientific problems" (Curry, Wilson, Flowers, & Farin, 2012 p. 65). The idea presented is not just to give students the knowledge but give them the ability to synthesize, analyze, and evaluate their knowledge in an effort to extend thinking towards situations outside of the classroom. Therefore, it is imperative for researchers to find the impact of cognitive processing when evaluating the differences between active and passive learning.

To achieve higher cognitive gains, educators are posed with a difficult challenge. There are a number of social and environmental issues to take into account when trying to engage students, and learning styles are among the most important (Tannahill 2009). Learning styles include auditory, tactile/kinesthetic, and visual (Honigsfeld & Dunn, 2010). Visual learners are those whom understand what they see and process through a visual memory (Tannahill, 2009). Auditory learners tend to retain information through listening and/or discussing (Tannahill, 2009). It is suggested by Restake (1979) that most high school students are not auditory listeners and only 70 percent of what they hear may be retained. Most high school students are kinesthetic or tactile learners because their auditory skills are not fully developed (Honigsfeld & Dunn, 2010; Restake, 1979). Tactile learners may be prone to falling behind in classrooms where traditional lecture, discussion, or reading assignments are favored (Honigsfeld & Dunn, 2010). Said type of classroom setting would, indeed, favor an auditory learner. Some characteristics of the auditory learner, making them more favorable when recalling something heard, is that they have the tendency and ability to focus on inflection, tone, speed, volume, and pitch of the presenter's voice (Tannahill, 2009). Tactile learners struggle when trying to recall spoken information because they have a need to learn on their feet and involve their bodies to make concrete associations with the content (Roberts & Harlin, 2007; Honigsfeld & Dunn, 2010).

There have been multiple researchers to suggest that learning styles influence one's knowledge acquisition in regard to teaching approach. One example; Roberts (2007) found that presenting students who prefer tactual/kinesthetic methods of delivery perform better when they receive a hands-on approach to teaching. Additionally, reports favored higher scores on achievement tests when kinesthetic students were taught with the problem-solving approach (Dyer & Osborne, 1996). The problem-solving method is a teaching approach which would favor a kinesthetic learner because there is more direct interaction with the content (Dyer & Osborne, 1996). Yet another study compared learning styles with teaching method from Marrison and Frick (1994). Results indicate 'field dependent' learners acquired more knowledge than 'dependent' learners when presented with the multimedia approach (text, still pictures, and graphics) as opposed to lecture. Studies indicate that higher levels of achievement when students receive a preferred method of teaching. The preferred method of teaching correlates to their learning style (Dyer & Osborne, 1996; Marrison & Frick, 1994; Roberts, 2006).

Learning Efficacy

Self-efficacy is most easily defined as one's evaluation of their personal ability to successfully complete or execute a given course of action (Bandura, 1977). Further, it is the experience, competence, and comfort one has in relation to a task (Baker & Krause, 2007). Self-efficacy is a multifaceted entity which maintains many domains (Zimmerman, 2000). Subsequently, to evaluate one's self-efficacy, one must first identify which domain of self-efficacy to evaluate. For example, in a driver's education course, one may measure driving self-efficacy to find a student's perception of how well they think they can drive.

In recognition of the postulate by Zimmerman (2000), the domain of self-efficacy, in this research deals with tinkering. Tinkering can be a very beneficial tool that may be used in education (Rowe, 1978). Tinkering is best described as the act of manipulating, disassembling or assembling, constructing, modifying, or repairing devices or components of objects (Baker & Krause, 2007). With the understanding of the definition of tinkering and the definition of self-efficacy, one may easily make the connection to tinkering self-efficacy: one's self-perception of the ability to engage in tasks involving hands-on procedures.

Research by Baker and Krause (2007) suggest that males tend to have a stronger perception in tinkering self-efficacy; females generally lack experience with procedural mechanics. Sallee (2012) further found that males have the tendency to perceive themselves high in their tinkering self-efficacy. Sallee (2012) also tested for a correlation between method used and tinkering self-efficacy and found that those who perceived themselves high, also preferred the demonstration method of instruction. There is also a strong positive correlation between student posttest scores and tinkering self-efficacy when they are instructed via demonstration (Sallee, 2012). According to the results, those who perceive themselves as tinkerers may learn material better from a hands-on, demonstration-type approach to teaching methods. However, in a similar study, cognitive achievement was not significantly affected by tinkering self-efficacy (Koch, 2010). The research is conflicting because one measured for a correlation, while the other measured for significant differences. Koch (2010) did not test for a correlation. He found no effect; therefore it assumed there was no correlation. However, both findings are noteworthy and provide reason for further testing of the effects of tinkering self-efficacy on knowledge acquisition in different instructional settings.

Instructional Techniques

Education is a very progressive body that strives to improve from year to year. Although relatively new, Webb's theory is already being incorporated into school systems. The education board for the state of Nevada has incorporated Webb's DOK into their state testing (as of 2010) because "it provides a better depth and breadth of learning, and better helps meet the requirements of academic rigor required by No Child Left Behind" (Hanlon, 2009). The National Research Agenda (2007-2010) posed the question, "How does student participation in agricultural education contribute to student achievement and performance?" These mandates show the progressivism, not only in general education, but in agricultural education as well.

When selecting a teaching method, it is important to understand that factors are constantly changing and one must adjust for those changes; those factors are content, learning style, educational theories, and cultural backgrounds (Hosseini et al., 2009). To teach using only one method would not be targeting different factors as labeled by Hosseini et al. (2009). It would also be isolating different learning styles (i.e. lecture isolates auditory learners but does not target visual learning). Rosenshine and Furst (1971) claim that possessing variability is one of the essential characteristics of effective teachers. A good teacher should be able to deliver multiple approaches to instruction. Therefore, recognizing different learning styles is a key role of both instructors and researchers. It is important to recognize previous research indicating student preference to teaching method and the influence it has on learning (Roberts, 2006). Understanding the different learning styles of individual students is critical because the best learning occurs when performance is achieved with assistance (Tharp & Gallimore, 1991; Woolfolk, 2010). Teachers are not merely banks of knowledge, they are a more intelligent other guiding students towards conclusions (Woolfolk, 2010). Knowing the students' learning style is a necessary step in guiding their learning. Teacher effectiveness is a major role and influence on students' academic success because teachers can create school conditions to foster excellence, school leadership, and culture continuous improvement (USDOE, 2012).

The purpose of teaching is to instill a desire to learn in students (Rogers & Freiberg, 1994). Important learning by the student occurs through social interaction with a skillful teacher (Vygotsky, 1978). Learning occurs as a result of an experience had by the learner (Dewey, 1936). The teacher plays a critical role in effectuating student learning by directing the experiences of the learner(s). If Vygotsky's and Dewey's postulates are accepted and the mandate from the National Research Agenda is to be met, research regarding teaching method is extremely important to achieve the highest level of performance. The research should target which teaching method is most appropriate for engaging students to most effectively influence knowledge.

As proposed through the research, there are two main forms in which teaching occurs (actively and passively), but teaching methods are not limited to only two forms. In agricultural education, there are numerous methods including lecture, demonstration, PowerPoint, guided discussion, guided inquiries, small group projects, etc. Each method of teaching, by nature, is either a passive form or an active form (von Glaserfeld, 1989).

Active learning is broadly defined as the act of learning by being engaged in projects, discussions, and activities which stimulate the mind and involves the student on a higher level than simply listening (Bonwell, 2000). The act of doing creates active learning which engages the student beyond the auditory sense. Passive learning is just the opposite; listening and not doing (Bonwell, 2000). Although listening is technically doing something; in the sense of active versus passive learning, listening is considered a passive form of learning because the other senses are not doing anything, the body is not moving and the mind is not stimulated by activity. The only stimulation is derived through the auditory sense. Students are not considered to be engaged when passive learning is taking place (Dewey, 1916; von Glaserfeld, 1989). Although the student may be engaged (interested) in what a teacher may be saying, it is not considered a form of being actively engaged (Bonwell, 2000). For example, a PowerPoint presentation is a visual display of words and pictures, usually accompanied with a lecture. The students, perhaps engaged, are not taking an action in their learning. Even though learning is probably occurring through the auditory and, perhaps, visual senses, the PowerPoint™ presentation was a passive teaching method.

Lecture Method

As evident from the literature, there are many different methods of delivering information. One method of focus is the lecture method; a very commonly used method. Lecture has been implicated for many years and is one of the oldest forms of transmitting information from one to another (Broadwell, 1980; O'Malley, & McCraw, 1999; Waldron & Moore, 1991). History shows (as far back as the 1980's) lecture was the original method of delivery (Broadwell, 1980). Generally, one person had the knowledge and the lecture-method was the preferred way to pass on the information (Broadwell, 1980).

Lecture is a "means of transmitting cognitive or factual data from a teacher to a group of learners (students)" (Broadwell, 1980, pg 3). Lecture is considered the best means of teaching because teachers have a lot to teach and students have a lot to learn and it conveys a lot of information in a short period of time (Bligh, 2000; Brookfield, 1997;). It consists of a teacher standing in front of a group of students disseminating facts while students listen and [perhaps] take notes (O'Malley & McCraw, 1999). Lecture can be considered a more efficient method because less time may be spent explaining descriptive items and more time on difficult concepts (Broadwell, 1980; Vaughan, 2009). For this reason, teachers often prefer this method because an instructor can deliver a lot of information in a short period of time.

In a study by Hosseini, Dastani, Akbari, Baradaran, Hosseini, and Moonaghi (2009), results found that students retain a significant amount of knowledge from a lecture-type lesson; especially those whom prefer the lecture method. Of course the lecture benefits auditory learners because it involves listening (Tannahill, 2009). An important note is the students which perceive lecture positively, also respond well to receiving the lecture. This is important because the perceptions of students may be an indicator as to the method of teaching to be selected.

Demonstration Method

One way active learning is achieved in agricultural education is through experiential learning, as posited by Dewey (1938) and Vygotsky (1978). The purpose of agricultural education is to provide the agricultural workforce with skilled, successful, and agriculturally literate workers (Roberts & Ball, 2009). Experiential learning is a foundation of secondary agricultural education and provides students the opportunity to be more engaged in their learning by giving students concrete experiences, which are essential to learning (Dewey, 1916). If Dewey's experiential learning theory and Vygotsky's social learning theory are accepted, then giving students hands-on demonstrations is a great way to give students the skillsets necessary to acquire knowledge.

Korwin and Jones (1990) performed a study to find the effects of hands-on instruction on cognitive knowledge and retention. The findings resulted in statistically significant gains of knowledge. However, they also proposed a call for further research with hands-on instruction to strengthen the platform that states 'there is a higher ability for students to learn using the hands-on method for teaching' (Korwin & Jones, 1990, p. 3).

Literature indicates a strong difference between learning through activity and learning without activity (Korwin & Jones, 1990). Demonstration is a way by which to actively learn something; and active learning can be defined as a learning technique in which a student does more than just listen to a lecture (McKinney, 2011). It has become a style that helps students to better understand basic concepts (Elmoselhi, Klement, & Savage, 2010). Korwin and Jones further supported this stating, "Organized psychomotor participation enhances learning and is effective in learning for applicable concepts (1990, p. 8)." Not only would it enhance the ability to retain knowledge, it also aids in the process of application.

By getting students more involved in what they learn, students may be better equipped for more difficult concepts in related tasks (Elmoselhi et al., 2010). With regard to learning style, demonstration is more favorable to the tactile and kinesthetic learners because it involves more movement and learning with their hands (Tannahill, 2009). "The best strategy for engaging tactile and kinesthetic learners is to engage their hands and bodies with manipulative instructional resources allowing them to learn on their feet" (Honigsfeld & Dunn, 2010 p. 221). By providing hands-on projects and demonstrations students can better understand basic concepts (Elmoselhi, 2010).

<u>Lecture and Demonstration</u>

Numerous studies (Elmoselhi, et al., 2010; Honigsfeld & Dunn, 2010; Korwin & Jones, 1990; McKinney, 2011) point to greater gains in knowledge through demonstration. There is, however, reciprocal research determining that demonstration or active learning is not the correlative variable for achieving higher cognitive gains (Bligh, 2000; Broadwell, 1980; Curry, et al., 2012; Hosseini, et al., 2009, Yadar, Shaver, & Meckl, 2010). For example, Curry et. al., (2012) performed a study on experiential learning which resulted in no significant difference against the lecture method. Yadar, Shaver, and Meckl, (2010) also found no significant differences between methods when using lecture and case studies. Although case studies differ from demonstration, the essence of active learning is present which posits that there may be little to no significant difference between demonstration and lecture. However, in nearly every study, due to limitations of sample size of the population, it was suggested to conduct further research to strengthen the conclusion. The same was stated for research that found significant differences with the demonstration method.

As progression into the 21st century occurs and development of technology rapidly increases, lecture has become a method that is incorporated with many other methods of teachings (O'Malley & McCraw, 1999). Recalling that education is a very progressive system, as evident by new mandates, especially from the National Research Agenda in 2007-2010, there is a need to research new methods. Based on previous literature, there is also a need to select a variety of teaching methods to successfully educate students. Rosenshine and Furst (1971) postulated that including variety to one's teaching makes him/her more effective. According to their statement, combining lecture and demonstration is a way to be more variable with delivery.

Because there are a number of differences within a population of students, it is necessary to teach towards those different learning styles as they are separated by different factors of learning (Hosseini et al., 2009). Research by O'Malley and McCraw (1999) state that students' engagement in discussion and students partaking in the interaction within a classroom is important; and being able to contribute in class is beneficial to their learning. This indicated that participation in a lecture through discussion is important, as well as interaction through demonstrations.

Summary

It is understood that learning is the result of something occurring to an individual; cause and effect. The theories are in support of 'experience' to be the driving force behind the cause. The research lacks to provide the evidence that would lead teachers in the proper direction to impact the effect the most. Since learning is a cause and effect action, and there are many different causes to the effect, this research intended to find the best method of instruction to influence learning and have the most impact on understanding.

Review of the literature indicates, teaching methods (demonstration and lecture) were adequate to enable students to retain information (Korwin & Jones, 1990). The research was not conclusive as to which method was superior. There is also a gap in the literature which examines the effects of learning when combining methods, especially lecture and demonstration. These two have been compared, but not combined. This study further explored the relationship between methods as well as the combined teaching method on knowledge acquisition.

CHAPTER 3

METHODS

Statement of the Problem

The impact of teaching methodologies towards cognitive achievement is a concern of education professionals. Furthermore, there was a lack of evidence within the literature that concludes strong comparisons of different teaching methods; lecture, demonstration, and a combination of lecture and demonstration. Therefore, this research was guided by a need for comparing teaching methods and their effect on cognitive achievement.

With many different teaching strategies available to instructors, one is left questioning the most effective method. Resulting from a need of teaching method comparisons, the purpose of this study was to determine the most appropriate method of teaching to achieve high levels of cognition. High and low level cognition were variables of study based on three selected teaching methods: lecture only, demonstration only, and lecture and demonstration combined. This study further sought to determine student perceptions of teaching method used as well as the influence of tinkering self-efficacy towards preference of methods of instruction.

Purpose

The purpose of this study was to determine if there was a difference ($p \leq .05$) in methods of instruction; including lecture, demonstration, and a combination of lecture and demonstration. In addition, the study determined if there were differences in cognitive gains (high or low) between the different methods of instruction.

Research Question

Therefore, this study was guided by the basic question pertaining to what is the effectiveness on knowledge acquisition in regard to high and low level cognitive achievement when teaching biofuels using lecture, demonstration, and lecture and demonstration combined among students in Northwest Arkansas enrolled in high school agriculture classes?

Limitations

Limitations to this study are recognized as follows. In consideration that the study was conducted in Northwest Arkansas it may be inferred that students in different areas may return different results; therefore, generalizations may not be made. Also, there was not an opportunity for randomization within the groups because the classrooms were already set by the school. Randomization of treatments, however, did occur. It should be further noted that the selection of the material presented (biofuels) was chosen to allow the differentiated methods to be analyzed without historical knowledge being present in participants: biofuels education does not exist in the education curriculum (Arkansas Frameworks, 2012). But it is recognized that participants might have previous knowledge and therefore limitations to the findings could be present.

Objectives

The following objectives guided this research:

1. Determine the effectiveness of different teaching methods and their effect on knowledge acquisition.
2. Determine high level cognitive development when treated with different instructional techniques.
3. Determine the perceptions of student preference toward instructional techniques.
4. Determine the influence of tinkering self-efficacy within students and how that influences their perceptions of instructional technique.

Hypotheses

This research sought to answer the following hypotheses:

Ho_1: There will be no significant ($p < .05$) difference between instructional techniques on students' level of knowledge acquisition.

Ho_2: There will be no significant ($p < .05$) difference between instructional techniques on students' cognitive achievement.

Ho_3: There will be no significant relationship between student perceptions of instructional technique and knowledge acquisition.

Ho_4: There will be no significant relationship between tinkering self-efficacy and preferred instructional technique.

Ho_5: There will be no significant relationship between tinkering self-efficacy and knowledge acquisition.

Alternative Hypotheses

Ha_1: There will be no significant ($p < .05$) difference between instructional techniques on students' level of knowledge acquisition.

Ha_2: There will be no significant ($p < .05$) difference between instructional techniques on students' cognitive achievement.

Ha_3: There will be no significant relationship between student perceptions of instructional technique and knowledge acquisition.

Ha_4: There will be no significant relationship between tinkering self-efficacy and preferred instructional technique.

Ha_5: There will be no significant relationship between tinkering self-efficacy and knowledge acquisition.

Design

Following the suggested design by Campbell and Stanley (1996), this study is a pre-experimental design. This study incorporates a true experimental pretest-posttest design (#2) (Campbell, & Stanley, 1996). Based on related research in this field and the literature, an alpha level was set *a priori* at .05. Although the researcher recognizes that eliminating completely the possibility of a type I or type II error is not possible with this alpha level, the alpha level helped prevent the avoidance of a type I or type II error.

<u>Three-group Pretest-Posttest Design</u>

$$\begin{array}{ccc} O_1 & X_1 & O_2 \\ O_1 & X_2 & O_2 \\ O_1 & X_3 & O_2 \end{array}$$

Figure 1: True-experimental, Three-group Pretest-Posttest Design (Campbell, & Stanley, 1996)

Validity

There are seven threats to internal validity: (1) history, (2) maturation, (3) testing, (4) instrumentation, (5) regression, (6) mortality, and (7) selection (Campbell, & Stanley, 1996). Due to the nature of a pretest-posttest design, the most common and most specific threats to internal validity are history, maturation, testing, and instrumentation (Campbell, & Stanley, 1996). The threats of history and maturation were insignificant due to the length of the study. Data was collected in a two day period, thus maturation did not occur. Testing is a threat of the possibility of a pretest presenting knowledge which would influence a subject throughout the treatment and posttest. This threat is not accounted for; however, everyone received the pretest.

Any threat of testing remained consistent and was controlled. The instrument was tested for internal validity and reliability.

There are four threats to external validity: (1) Interaction of testing and treatment, (2) interaction of selection and treatment, (3) reactive arrangements, and (4) multiple-treatment interference (Campbell, & Stanley, 1996). The two threats to external validity, when using the one-group pretest-posttest design are numbers one and two: reactive effects of selection bias and interactive effects of selection bias. The first threat was controlled by administering a pretest and posttest in which questions were rearranged and placed in different orders. The second threat is controlled due to random selecting of intact classes: the classes selected were randomized. True randomization could not occur because the classes were already intact, and selecting students to participate could not occur either for the same reason. The study took randomized samples of the accessible population which minimized the potential for this threat.

Population and Sampling

The target population for this study was all high school agriculture science classes in Northwest Arkansas. The accessible population was all students enrolled in those high school agriculture science classes in the spring semester of 2011. Since not all students could be accessed due to limitations of the researcher, a sample was drawn. The sample included 27 intact classes from various schools throughout Northwest Arkansas. There were five schools contacted which agreed to participate in the study. A total of 27 classes were sampled; there were nine classes per treatment (N=333). The schools were selected randomly upon agreement from the teacher to participate in the study. The researcher obtained permission from the students to allow data to be collected. Subjects included both genders and any age of high school students between the grades of 9-12.

Procedures

Lesson Content

A 50 minute class period was utilized to deliver the lesson. 40 minutes were allowed for the content portion of the instruction and then 10 minutes were allotted for the post-test. The content of the lesson was basic bio-diesel production and performance. The lesson started with an introduction explaining what bio-diesel is and how it is made. The instruction continued about what it is used for and what quality standards are required of the bio-diesel. Then, the researcher informed students of the environmental effects of bio-diesel (emissions), and finally how it performs in engines (horsepower, torque, and fuel consumption,). The lesson plans for all three treatments are attached as appendices (one, two and three).

Variables

The major variable of the study was knowledge acquisition as influenced by the treatment. The three levels of the variable of study were teaching with lecture only (appendix one), teaching with demonstration only (appendix two), and teaching with a combination of lecture and demonstration (appendix three). Classes lasted 50 minutes. The length of time in which instruction occurred was 40 minutes for all classes. There was a pre-test given on the previous day of the treatment which lasted 10 minutes. The following day, the treatment was administered for exactly 40 minutes. Each class received one of the three treatments. Following the treatment, a post-test was administered. The students received the same allotted time of no more than 10 minutes to complete the post-test. The objectives covered in all treatments were identical in content and only varied in method of delivery. Data was collected from 27 classes, nine classes per variable.

The first variable was a lesson via lecture only. The lecture lesson was simply a dissemination of facts; there was not a PowerPoint or discussion of any kind. The second variable tested was a demonstration only. Subjects were gathered around the demonstration device, allowing them to see what was being taught, as it was being taught. Led by the researcher, they collected data and were allowed to adjust the demonstration device so they could understand how the system worked and how to operate it. The third variable was a combination of lecture and demonstration. The instruction began in the class with a brief lecture which included a PowerPoint slide show, and then subjects gathered around the demonstration device as instruction continued. Again, data regarding the system was collected so subjects could visually see and understand similarities or contrasts between the fuels. Material was presented to the subjects as the device was being used in both demonstration and the combination treatments. Following each lesson, the students would be administered a post-test at the same time on the following day.

Instrument

The instrument used was a modification of a previous instrument used for a similar study. The original instrument was developed by Sallee (2010) and had 20- knowledge based questions, eight, 1-5 Lickert-type questions on biodiesel perception, and eight, 1-5 Lickert-type questions on tinkering self-efficacy, and seven questions about demographics.

The newly developed instrument sought to ask knowledge questions that targeted levels of cognitive thinking. The instrument developed consisted of 16 multiple choice questions, eight questions which targeted low level cognition, and eight questions which targeted high level cognition. The perception questions were changed so that the researcher could obtain perspectives of instructional technique preference, so there are ten, 1-5 Lickert-type questions on perceptions of teaching method preference. Five of the perception questions are in regard to perceptions of demonstration, five are about lecture. There are ten, 1-5 Lickert-type questions on tinkering self-efficacy. And finally the same seven questions on demographics. Demographics analyzed were age, gender, classroom performance, (agriculture and non-agriculture) and residence (location and farming background). Permission was received from Sallee to use a modified version of the instrument.

The pretest (appendix four) contained the knowledge questions, tinkering self-efficacy questions, and the demographics sections. The posttest (appendix five) consisted of the same 16 questions rearranged in a different order, and it contained the methodology perception questions.

The instrument was developed from the related literature to meet face validity. It was also thoroughly reviewed by a panel of experts to meet content validity. The panel offered suggested changes and professional insight to question construction.

Field Test

Prior to pilot testing, the researcher conducted a field study. An agricultural mechanics class at the University of Arkansas was selected to field test the lessons. The pretest was administered, content was presented and a posttest was administered following the lesson. Although data was collected, this was merely a trial run to test for any flaws in the lesson content. Another limitation worth noting is that due to lengthy classes and infrequent class meetings, the tests had to be administered in the same day.

Only two lessons were field tested: the lecture lesson and the demonstration lesson. The class of 26 students was split into two groups. The first received the lecture and the second received the demonstration.

Pilot Test

A pilot test was conducted using three different intact classrooms from Siloam Springs, a high school in NWA. There were 60 subjects in total. The treatments were presented as followed by the procedure. After receiving permission, the subjects were given a pretest on the first day. The second day, students received the lesson/instruction and a posttest immediately followed.

Instrument Reliability

The two components of instrument reliability are stability and internally consistency. The field test and pilot test both served as means for testing stability and internal consistency. The Cronbach's Alpha statistic was measured to test the consistency of subjects' answers for similar questions. The pretest resulted in a Cronbach's Alpha value of .49. The posttest returned a value of .74.

Data Analysis

Data were organized by the researcher and analyzed using SAS 9.2 for Windows statistical package. The researcher used descriptive statistics to analyze the demographic characteristics of the data. Inferential statistics were used to analyze the data collected from the instrument. The researcher used independent *t*-tests for the null hypotheses one and two (Spatz, 2008). Statistical power was also calculated for the instrument to help detect if a meaningful different did exist if any of the hypotheses were rejected. This should help reduce the probability of a Type II error (Spatz, 2008). Pearson-Product Moment correlation coefficients were implemented for hypotheses three, four, and five

Data were collected on every treatment and each treatment used the same instrument. After implementation of the instrument, data was coded and entered into Microsoft Excel, 2010 spreadsheet for statistical analysis. Data was collected in the spring semester of 2011. Subjects' data that did not contain both parts of the instrument (pre-test and/or post-test) or missed part of the treatment were discarded and removed from the study.

CHAPTER IV

FINDINGS

Introduction

It has been seen that understanding of how learning occurs and learning styles can impact instructional techniques that are chosen by professionals to achieve knowledge gains (Cano & Garton 1992; Dewey, 1938; McGregor et al., 2004; Roberts & Ball, 2009; Tannahill, 2009; Tharp & Gallimore, 1991; Vygotsky, 1978). Also, student perception toward instructional technique and tinkering self-efficacy has positive influence on knowledge acquisition (Baker & Krause, 2007; Koch, 2010; Roberts, 2006; Sallee, 2012; Zimmerman, 2000). Research has also established that teaching is progressive and new methods of instructional delivery should be sought to effectuate learning (Hosseini et al., 2009; National Research Agenda, 2007-2010; O'Malley & McCraw, 1999; Rosenshine & Furst, 1971; Tharp & Gallimore, 1991; USDOE, 2012; Waldron & Moore, 1991). Educators are not only called to effectuate knowledge acquisition, but they are also charged with the task of guiding students to think at higher cognitive levels (Bloom, et al., 1956; Dyer & Osborne, 1996; Ewing & Whittington, 2007; Marconi, et al., 2009; Webb 2009). Therefore, this study is guided to aid in the process of finding the best instructional technique to effectuate knowledge and discover their impact of different levels of cognition. It also seeks to find results on the impact of student perceptions of instructional techniques as well as the impact of tinkering self-efficacy.

The population accessible was all students in Northwest Arkansas; and a sample size of 27 intact classes (N=333) was implored. The treatments were instructional techniques: lecture, demonstration, and a combination of lecture and demonstration. The instrument was modified from previous research and pilot and field tested. The study developed a true-experiment pretest-postttest control group design (#4) from Campbell and Stanley (1963).

Purpose

The purpose of this study was to determine if there was a difference ($p \leq .05$) in methods of instruction; including lecture, demonstration, and a combination of lecture and demonstration. Further, the study determined if there were differences in cognitive gains (high or low) between the different methods of instruction. Additionally, it was sought to determine if student perceptions of preferred method of instruction influenced cognitive gains. Tinkering self-efficacy was used to identify any achievement in higher cognitive levels of academic achievement.

Objectives

The following objectives guided this research:

1. Determine the effectiveness of different teaching methods and their effect on knowledge acquisition.
2. Determine high level cognitive development when treated with different instructional techniques.
3. Determine the perceptions of student preference toward instructional techniques.
4. Determine the influence of tinkering self-efficacy within students and how that influences their perceptions of instructional technique.

Null Hypotheses

The objectives guided the research and, based on the literature, the following hypotheses were formulated:

Ho_1: There will be no significant ($p < .05$) difference between instructional techniques on students' level of knowledge acquisition.

Ho_2: There will be no significant ($p < .05$) difference between instructional techniques on students' cognitive achievement.

Ho_3: There will be no significant relationship between student perceptions of instructional technique and knowledge acquisition.

Ho_4: There will be no significant relationship between tinkering self-efficacy and preferred instructional technique.

Ho_5: There will be no significant relationship between tinkering self-efficacy and knowledge acquisition.

Alternative Hypotheses

Ha_1: There will be no significant ($p < .05$) difference between instructional techniques on students' level of knowledge acquisition.

Ha_2: There will be no significant ($p < .05$) difference between instructional techniques on students' cognitive achievement.

Ha_3: There will be no significant relationship between student perceptions of instructional technique and knowledge acquisition.

Ha_4: There will be no significant relationship between tinkering self-efficacy and preferred instructional technique.

Ha_5: There will be no significant relationship between tinkering self-efficacy and knowledge acquisition.

The target population for this study was all high school agriculture science classes in Northwest Arkansas (NWA). Data were collected from an accessible population: all students enrolled in NWA high school agriculture science classes in the spring semester of 2011. Five schools were contacted and agreed to participate in the study. A total of 27 classes were sampled; nine classes allocated per treatment (*N*=333). The hypotheses were analyzed using group means (*N*=27). The schools were selected randomly upon agreement from the teacher to participate in the study. Data were analyzed using SAS 9.2.

Demographics

Demographics described in this study identified subjects' age, grade level, gender, grades made in school, grades made specifically in agricultural classes, whether or not they live on a farm, and if they use biodiesel. The study contained 333 subjects which were enrolled in agricultural science courses in NWA in the spring of 2011. Of the original 364 subjects, 31 subjects were removed from the study because of failure to participate due to an absence. Therefore, a usable sample size of *N*=333 was obtained for the study.

For all 27 classes in this study, 333 subjects are described. Table 4-1 illustrates gender for all subjects. The majority (66.67%) were identified as male, and the remaining (33.33%) were female.

Table 4-1

Participant Gender (*N*=333)

Gender	*f*	%
Male	222	66.67
Female	111	33.33
Total	333	100.00

Table 4-2 illustrates age for all subjects (*N*=333). Ages ranged from 14 to 19 with very few (*n*=3; 0.9%) 19 year olds. There were, in increase order of age, 46 (13.81%) 14 year olds, 103 (30.93%) 15 year olds, 92 (27.63%) 16 year olds, 56 (16.82%) 17 year olds, and 33 (9.91%) 18 year olds.

Table 4-2

Participant Age (*N*=333)

Age	*f*	%
14	46	13.81
15	103	30.93
16	92	27.63
17	56	16.82
18	33	9.91
19	3	0.90
Total	333	100.00

Subject grade level was also purported (Table 4-3) towards demographics (*N*=333) characteristics. Of participants, there were 130 ninth graders 39.04%, 90 tenth graders 27.03%, 70 eleventh graders 21.02%, and 43 twelfth graders 12.91%.

Table 4-3

Participants Grade Level (*N*=333)

Grade Level	*f*	%
9	130	39.04
10	90	27.03
11	70	21.02
12	43	12.91
Total	333	100.00

There were 333 subjects who reported grades made in school as well as grades in agriculture classes (Table 4-4). Subjects reported grades for general classes with a range from A-F on a normal 4.0 scale. Subjects also reported grades for agriculture classes with a range from A-F on a normal 4.0 scale. For general classes, in order, grades subjects made in school were; 69 A level (20.72%), 155 B level (46.55%), 93 C level (27.93%), 15 D level (4.50%), and 1 F level (0.30%). In agriculture science classes, students grades reported slightly higher; 172 A level (51.65%), 121 B level (36.34%), 35 C level (10.51%), 4 D level, (1.20%), and 1 F level (0.30%)

Table 4-4

Participants Grades in General Classes and Agricultural Classes (*N*=333)

Grades	*f*	%
A		
General	69	20.72
Agriculture	172	51.65
B		
General	155	46.55
Agriculture	121	36.34
C		
General	93	27.93
Agriculture	35	10.51
D		
General	15	4.50
Agriculture	4	1.20
F		
General	1	0.30
Agriculture	1	0.30
Total		
General	333	100.00
Agriculture	333	100.00

Table 4-5 illustrates subjects who live on a farm. A majority of subjects in NWA (*n*=213; 63.96%) do not live on a farm. 120 subjects (36.04%) reported living on a farm.

Table 4-5

Participants Living on a Farm (*N*=333)

Residence	*f*	%
Farm	120	36.04
No Farm	213	63.96
Total	333	100.00

The final demographic information reported is use of biodiesel. Because only 120 subjects reported living on a farm, only 120 subjects reported use, or not, of biodiesel (Table 4-6). This was done to satisfy the question asked; "If you answered 'yes' to living on a farm, do you use biodiesel?" However, the researcher recognizes multiple applications of biodiesel beyond agriculture/farm use (Sallee, 2010). A very large majority, 89.17%, of subjects living on farms reported no use of biodiesel (*n*=107). There were 13 subjects (10.83%) who reported yes to the use of biodiesel.

Table 4-6

Participants Who Use Biodiesel (*N*=120)

Biodiesel Use	*f*	%
Use	13	10.83
No Use	107	89.17
Total	120	100.00

Demographics by Treatments

For all 27 classes in this study, 333 subjects are described across three treatments of lecture, demonstration, and combination. The identified demographics by treatment are the same as previously listed. For demographics data was collected numerically. Gender was coded for male (1) and female (2). Grade level was coded 1-4, one being a freshman and four a senior.

Grades were coded 1-5, one representing an A and five representing F. Farm living and biodiesel use were both yes and no question in which yes=1 and no=2.

Table 4-7 illustrates the mean demographics for subjects who received the lecture treatment. Subjects who received the first treatment had a mean age of 15.85, and were mainly male (*M*=1.36). Other demographics include grade level (*M*=2.12), grades in school (*M*=2.23), grades in agriculture (*M*=1.74), living on a farm (*M*=1.62), biodiesel use (*M*=1.93).

Table 4-7

Demographics by treatment: Lecture (N=117)

Treatment Demographics	*M*	*SD*
Age	15.85	1.20
Gender	1.36	.48
Grade Level	2.12	1.11
Grades in Regular Class	2.23	.82
Grades in Agriculture	1.74	.82
Farm Living	1.62	.49
Use of Biodiesel	1.93	.31

Table 4-8 illustrates the mean demographics for subjects who received the demonstration treatment. Subjects who received the first treatment had a mean age of 15.89, and were mainly male (*M*=1.30). Most subjects for this treatment were sophomores (*M*=2.12), with grades in school (*M*=1.99), grades in agriculture (*M*=1.50), living on a farm (*M*=1.73), biodiesel use (*M*=1.95).

Table 4-8

Demographics by treatment: Demonstration (N=111)

Treatment Demographics	*M*	*SD*
Age	15.98	1.27
Gender	1.30	0.46
Grade Level	2.12	1.09
Grades in Regular Class	1.99	0.76
Grades in Agriculture	1.50	0.63
Farm Living	1.73	0.45
Use of Biodiesel	1.95	0.25

The combination group (Table 4-9) were also mainly male (*M*=1.34) and an average age of 15.58. Subjects who received the first treatment were mainly sophomores (M=1.99). Their grades in school averaged a B grade (*M*=2.3) and grades in agriculture (*M*=1.50). Most subjects did not live on farms (*M*=1.73), and few answered no (2) to the use of biodiesel (*M*=1.95).

Table 4-9

Demographics by treatment: Combination (N=105)

Treatment Demographics	*M*	*SD*
Age	15.58	1.14
Gender	1.34	0.48
Grade Level	1.99	0.97
Grades in Regular Class	2.30	0.84
Grades in Agriculture	1.63	0.75
Farm Living	1.57	0.50
Biodiesel Use	1.94	0.23

Null Hypothesis One

Null hypothesis one stated that there will be no significant difference between instructional techniques on students' level of knowledge acquisition. Table 4-10 shows the results of instructional techniques on knowledge acquisition on gain scores. The *F* value (2) =0.68, *p*=.52 resulted no significant difference between groups when measuring gain scores based on instructional technique. Treatments resulted in no difference of gain score from pretest to posttest; therefore, the null hypothesis is accepted.

Table 4-10

Means for knowledge acquisition (*N*=27)

	SS	*M*	*df*	*F*	*p*	*d*	Power
Group	1.86	.93	2	.68	.52	.05	.15
Error	33.12	1.38	24				
Total	529.15		27				

**Note*. Correlation is significant at the 0.05 level

Null Hypothesis Two

The second hypothesis stated that there will be no significant ($p < .05$) difference between instructional techniques on students' cognitive achievement across gain scores. Table 4-11shows the mean scores for groups' pretest and overall posttest scores for all 27 groups. All groups (*N*=27) received a treatment; nine received lecture, nine received demonstration, and nine received a combination of lecture and demonstration. Results indicated no significant difference of instructional techniques across low cognitive gains *F* (2) =1.69, *p* =.21. Lecture returned a mean score of 1.56, *SD* .83; demonstration (2.03, *SD* .63); combination (2.06, *SD* .45). Analysis did, however, return significant difference between instructional techniques across high cognitive processing F (2) =4.36, *p* =.02. The combination groups (2.92, *SD* .55) scored the best which was significantly different from the lecture groups (2.00, *SD* .65). However, the demonstration groups (2.38, *SD* .78) were significantly different from neither the lecture groups nor the combination groups. Due to a significant difference between treatments of combination and lecture on high cognitive processing, the null hypothesis is rejected.

Table 4-11

Group Mean Cognitive Scores (*N*=27)

	Low Cognitive		High Cognitive	
	M	*SD*	*M*	*SD*
Lecture	1.56_{A}	.83	2.00_{A}	.65
Demonstration	2.03_{A}	.63	2.38_{AB}	.78
Combination	2.06_{A}	.45	2.92_{B}	.55

Note. Subscript letters $_{A}$ and $_{B}$ indicate differences between treatments

Null Hypothesis Three

Null hypothesis three stated that there will be no significant relationship between student perceptions of instructional technique and knowledge acquisition. Table 4-12 illustrates the correlations between perceptions of demonstration and lecture on high and low cognitive achievement. Results indicate no significant difference among perceptions of lecture on low cognitive processing (-.09); nor was there significance on high level processing (-.25). Demonstration perceptions returned no significance between low (-.19) or high (-.25). There was also no significance found (.27, -.05) between group scores among perceptions of lecture and demonstration. As a result of the findings, the null hypothesis was accepted.

Table 4-12

Correlations between instructional technique perceptions and knowledge (*N*=27)

	Demo P	Lecture P	Low Cog.	High Cog.	Group
Demo P	-	.38	-.19	-.25	-.05
Lecture P		-	-.09	.25	.27
Low Cog.			-	.40*	.31
High Cog.				-	.51*
Group					-

*Correlation is significant at the 0.05 level

Null Hypothesis Four

Null hypothesis four stated that there will be no significant relationship between tinkering self-efficacy and preferred instructional technique (Table 4-13). Results indicate no significant correlation (.37) between student perceptions of tinkering self-efficacy and preference of a demonstration lesson. However, there was significance at the 0.05 level across tinkering self-efficacy and lecture (.51*). Students, who perceived themselves high tinkerers, did not prefer a lecture lesson format. The null hypothesis is rejected.

Table 4-13

Correlations between Perceptions (*N*=27)

	Demo P	Lecture P	Tinkering
Demo Perception	-	.38	.37
Lecture Perception		-	.51*
Tinkering			-

*Correlation is significant at the 0.05 level. Perception questions were asked on a 1-5 Lickert-type scale; 1 = strongly disagree, 5 = strongly agree.

Null Hypothesis Five

Null hypothesis five stated that there will be no significant relationship between tinkering self-efficacy and knowledge acquisition. Table 4-14 illustrates correlations found. Data resulted in no significant difference in one's tinkering self-efficacy towards achievement in cognitive levels. The correlation between tinkering and low cognitive processing was -.11; high resulted -.02. Therefore, null hypothesis five is accepted.

Table 4-14

Correlations between Tinkering Perceptions and Test Scores (*N*=27)

	Low Cognition	High Cognition	Tinkering
Low Cognition	-	.40*	-.11
High Cognition		-	-.02
Tinkering			-

*. Correlation is significant at the 0.05 level.

Chapter Summary

The findings from this study were presented in this chapter. Each of the five hypotheses was addressed with results provided for each. Demographics were provided in an effort to describe subjects and their backgrounds. Specifically, results presented cognitive achievement across treatments of lecture, demonstration, and lecture/demonstration. Further, results represented relationships between cognitive achievement, student perceptions on instructional technique, and tinkering self-efficacy.

The majority of subjects in this study were 15 year old (30.93%) males (66.67%) in the ninth grade (39.04%). Subjects purported mostly A's in agriculture classes (51.65%) and B's in general core classes (46.55%). The majority of subjects (63.96%) do not live on farms and of those subjects who do live on a farm (36.04%), only 10.83% reported any use or prior knowledge of biodiesel (the lesson content).

Significance was found on high cognitive achievement between treatments; but not on low cognitive achievement. Specifically, results indicated combination of lecture and demonstration to be the most effective means for affecting knowledge on high cognitive achievement. However, treatments did not return significance on knowledge acquisition across gain scores. For these reason, null hypothesis one was accepted, but null hypothesis two was rejected.

No significant relationship was found between student perceptions of instructional technique and knowledge acquisition; null hypothesis three was accepted. Significance was found across tinkering self-efficacy and student perceptions of lecture (.51). Student perceptions of tinkering self-efficacy significantly differ from their perceptions of lecture, therefore, students high in tinkering self-efficacy did not prefer lecture but they do prefer the demonstration technique. The hypothesis was not accepted. Lastly, there was no significance found between tinkering self-efficacy and low/high level cognitive knowledge acquisition; the hypothesis failed to be rejected.

CHAPTER V

SUMMARY, CONCLUSIONS, DICUSSION, IMPLICATIONS AND RECOMMENDATIONS

Purpose

The purpose of this study was to determine if there was a difference ($p \leq .05$) in methods of instruction; including lecture, demonstration, and a combination of lecture and demonstration. Further, the study determined if there were differences in cognitive gains (high or low) between the different methods of instruction. In addition, this study sought to determine if student self-perceptions of preferred method of instruction influenced cognitive gains. The study also identified any achievement in higher cognitive levels as influenced by students' perceptions of tinkering self-efficacy.

Hypotheses

The objectives guided the research and, based on the literature, the following hypotheses were formulated:

Null Hypotheses

Ho_1: There will be no significant ($p < .05$) difference between instructional techniques on students' level of knowledge acquisition.

Ho_2: There will be no significant ($p < .05$) difference between instructional techniques on students' cognitive achievement.

Ho_3: There will be no significant relationship between student perceptions of instructional technique and knowledge acquisition.

Ho_4: There will be no significant relationship between tinkering self-efficacy and preferred instructional technique.

Ho_5: There will be no significant relationship between tinkering self-efficacy and knowledge acquisition.

Alternative Hypotheses

Ha_1: There will be no significant ($p < .05$) difference between instructional techniques on students' level of knowledge acquisition.

Ha_2: There will be no significant ($p < .05$) difference between instructional techniques on students' cognitive achievement.

Ha_3: There will be no significant relationship between student perceptions of instructional technique and knowledge acquisition.

Ha_4: There will be no significant relationship between tinkering self-efficacy and preferred instructional technique.

Ha_5: There will be no significant relationship between tinkering self-efficacy and knowledge acquisition.

Data were collected from an accessible population of all students enrolled in NWA high school agriculture science classes in the spring semester of 2011: a total of 27 classes were sampled; there were nine classes per treatment (N=333). Each class received a pretest, treatment, and posttest (O_1 X_n O_2). Data were analyzed using SAS 9.2. Descriptive statistics were used to describe the demographics of age, grade level, gender, grades made in school and in agricultural classes, farm residence or not, and prior use of biofuels. Each hypothesis was tested using inferential statistics.

Summary of Findings

Null Hypothesis One

Null hypothesis one stated that there will be no significant ($p < .05$) difference between instructional techniques on knowledge acquisition. Treatments were lecture, demonstration, and combination (lecture/demonstration). Knowledge acquisition was determined based on gain scores achieved on the posttest. Null hypothesis one was tested using an analysis of variance (ANOVA). The hypothesis was accepted because significance was not found between treatments $F(2) = 0.68$, $p < 0.52$.

Null Hypothesis Two

In order to determine which treatment effectuated learning most greatly, null hypothesis two was formulated; which states that there will be no significant ($p < .05$) difference between instructional techniques on students' cognitive achievement. Null hypothesis two was tested using an ANOVA with a Tukey Test. Low cognitive achievement returned no significant results across treatments $F\ (2) = 1.69$, $p = .21$. Lecture (on low cognitive achievement) returned a mean score of 1.56, demonstration 2.03, and combination 2.06. Results for high cognitive achievement were lecture (2.00), demonstration (2.38), and combination (2.92): significance was found F (2) =4.36, $p = .02$. There was no significant difference between combination and demonstration nor was there significance between lecture and demonstration. However, results indicate that the combination lesson was significantly more effective than lecture; thus the hypothesis was rejected.

Null Hypothesis Three

Null hypothesis three stated that there will be no significant relationship between student perceptions of instructional technique and knowledge acquisition. A Pearson Product Moment

Correlation Coefficient was used to test null hypothesis three. There was not a significant relationship found. There were no correlations found when testing perceptions of lecture on low cognitive processing (-0.09) nor on high cognitive processing (-0.25). Demonstration perceptions also failed to return significant results when tested with low cognitive processing (-0.19) and high cognitive processing (-0.25). There was also no significance when testing overall test scores on lecture (0.27) and demonstration (-0.05). The hypothesis failed to be rejected.

Null Hypothesis Four

Null hypothesis four stated that there will be no significant relationship between tinkering self-efficacy and preferred instructional technique. Null hypothesis four was tested using a Pearson Product Moment Correlation Coefficient. Results indicate no significant correlation (.37) between student perceptions of tinkering self-efficacy and preference of a demonstration lesson. However, there was significance at between perceptions tinkering self-efficacy and lecture preference (.51). Students, who perceived themselves high tinkerers, preferred the lecture lesson as opposed to a demonstration lesson format. Student response between lecture perceptions and demonstration perceptions did not return significant results (0.38). The null hypothesis was rejected.

Null Hypothesis Five

Null hypothesis five stated that there will be no significant relationship between tinkering self-efficacy and knowledge acquisition. A Pearson Product Moment Correlation Coefficient was used to test this hypothesis. The data resulted no significant difference in one's tinkering self-efficacy towards achievement in cognitive levels. The correlation between tinkering self-efficacy and low cognitive processing was -0.11; high resulted -.02. Therefore, null hypothesis five is accepted.

Conclusions and Discussion

Null Hypotheses One and Two

Hypothesis one was developed to find if there was significance between the treatments on knowledge acquisition. Results indicated that there was no significant difference across treatments and knowledge acquisition. Hypothesis two was developed to find where significance occurred across treatments and cognitive (low and high) processing. Results indicated that there was not significance between treatments on low cognitive processing, but there was significance between treatments on high cognitive processing.

The research established that there could be a beneficial use of different methods of instruction; active and passive (Bonwell, 2000; Dewey, 1916; von Glaserfeld, 1989 Vygotsky, 1978). Bonwell (2000) established that lecture is a form of passive learning because the senses are not engaged beyond just listening. According to Bligh (2000) and Brookfield (1997) lecture is considered the best means of instruction because teachers can convey a lot of information in a short amount of time. However, this study does not agree with the previous research: no significance was found when using the lecture technique on low or high cognitive processing. Further, research was found which also disagrees with the results of this study by Hosseini, et al. (2009).

The other form of learning, active, (pertaining to this research) is demonstration (Bonwell, 2000). The literature and research suggests that demonstration is superior because it engages student senses and gets the students physically involved in learning (Bonwell, 2000; Dewey, 1916; Korwin & Jones, 1990; O'Malley & McCraw, 1999). Previous research by Korwin and Jones (1990) found statistically significant gains of knowledge when using a hands-on (active) approach to learning. This research found that students taught using the demonstration method did not significantly differ from those taught with the lecture lesson. Therefore, this study does not agree with previous research which found significance when using the demonstration (active) technique.

Elmoselhi et al. (2010) established, through research, that getting students more involved in what they learn provides student the ability to accomplish more complex, related tasks. Honigsfeld and Dunn (2010) also stated the best strategy for engaging students is through hands-on instructional methods allowing students to learn on their feet. This study does not align with the previous research.

Elmoselhi et al. (2010) also stated that providing students with active instructional techniques allows better understanding of basic concepts. Basic knowledge is similar to recall knowledge which is low level cognitive processing (Bloom et al., 1956; Webb, 2009). This research sought to find differences in levels of cognitive development; and the statement by Elmoselhi disagrees with the findings of this study. No significance was found across all treatments on low cognitive knowledge acquisition.

The demonstration instructional technique closely aligns with the philosophies of John Dewey (1916) whose focus was in experiential learning: learning by doing. Piaget's theory (1970) is very similar to Dewey's experiential learning theory. Piaget believed that learning occurs as a result of interactions with the environment surrounding the learner. The philosophies of Dewey and Piaget do not agree with the finding of this study on low cognitive achievement. However, on high cognitive achievement, lecture returned the lowest results and was significantly different from the combination technique; but not significantly different from the demonstration method. The combination method includes both techniques lecture and demonstration.

Previous research (Elmosilhi, et al., 2010; Honigsfeld & Dunn, 2010; Korwin & Jones, 1990; McKinney, 2011) pointed to greater gains in knowledge through demonstration. Reciprocal research (Bligh, 2000; Broadwell, 1980; Curry, et al., 2012; Hosseini, et al., 2009; Yadar, et al., 2010) showed that lecture was the more appropriate method for effectuating knowledge. This study disagrees with all indicated studies. Knowledge was not affected differently on low cognitive processing. Knowledge was also not effected on high cognitive processing between lecture and demonstration.

This study sought to test a third treatment of combining lecture with demonstration. The justification was based on inconclusive research comparing the two and a lack of research testing the combination of the two. It is noteworthy to state that all instructional techniques returned positive results signifying that all techniques were effective; but not significantly different from one another. Results from this study indicate that the combination method was not significantly different from lecture or demonstration on low level cognitive processing. However, on high level cognitive processing, the combination method was significantly better than the lecture method. The combination method was not significantly different from demonstration, even though the mean score was technically higher. Hypothesis two was rejected due to significance between lecture and combination on high cognitive achievement. But hypothesis one was accepted because subjects' gain scores were not different based on gain scores.

<u>Null Hypothesis Three</u>

The hypothesis was developed from the literature which discussed the importance of instructional methods on students' academic achievement (Hosseini et al., 2009; National Research Agenda, 2007-2010; Roberts, 2006; Tharp & Gallimore, 1991; Woolfolk, 2010). Teaching methods (instructional techniques) were labeled as important to student achievement because of different factors including learning styles, educational theories, and cultural backgrounds (Hosseini et al., 2009). It was stated that different methods targeted different learning styles and, therefore were essential to effective instruction (Hosseini, et al., 2009). Further, Roberts (2006) stated the importance of recognizing previous research indicating student preference to teaching method and the influence it has on learning. However, the data in this study resulted no significant differences in perceptions of instructional technique and knowledge acquisition. Although research states the importance of implicating different methods, the student perception of the methods, per this study, bear no significance.

The USDOE (2012) stated that teachers are important to student success because they can create the conditions to foster excellence in the classroom. Although this study found different results related to instructional technique, it does not disagree with this statement. The statement claims that teachers are responsible for student success by creating a school condition to generate that success. This, however, may not have to pertain to instructional technique because the use of ‘school condition’ may be interpreted to mean something else. If the statement is true, then for this study specifically, ‘school condition’ could not mean instructional technique. The purpose of teaching is to instill a desire to learn in students (Rogers & Freiberg, 1994). According to this study, that is not accomplished through instructional technique.

The philosophies of Vygotsky (1978) and Dewey (1916) state that teachers’ critical role in education is effectuating student learning by directing the experiences of the learner(s). This also does not align with the findings in this study. Dewey’s and Vygotsky’s theories are not limit to instruction technique, but this portion of the study disagrees with their ideals on directing instruction towards a hands-on (demonstration) approach.

Tannahill (2009) stated that demonstration is the more favorable to students who tend to be tactile and kinesthetic learners. He also stated that students who believe they are auditory learners learn best when material is presented in a lecture-type instructional technique. This study does not agree with Tannahill's statements.

<u>Null Hypothesis Four</u>

The findings of Sallee (2012) included a positive correlation between tinkering self-efficacy and preferred method of instruction. This study sought to find if there was a correlation between tinkering self-efficacy and preferred instructional technique. Data resulted in a positive correlation between tinkering self-efficacy and preferred method of instruction. Specifically, students who perceive themselves high in tinkering self-efficacy had a significant tendency to prefer the lecture method of instruction over demonstration. For this reason, the null hypothesis four was rejected.

Based on Dewey's philosophy of experiential learning (1916), it would stand to reason that students whom prefer the demonstration method would also perceive themselves as tinkerers. The research by Sallee (2012) did, indeed, find that positive correlation. This research did not. The demonstration method is considered active and the lecture is considered passive (Bonwell, 2000; von Glaserfeld, 1989). Therefore, the students that like to tinker are active and would prefer the demonstration technique. The findings of this study did not agree with the philosophy.

<u>Null Hypotheses Five</u>

Tinkering self-efficacy was defined as one's perceived comfort in their own ability to complete a task (Baker & Krause, 2007; Bandura, 1977). The provided definition only implies one's perception, not their actual, proven ability. Rowe, (1978) stated that tinkering is a very beneficial tool that can be used in education. However, this study indicated differing results. There was no significance found between tinkering self-efficacy and knowledge acquisition.

Sallee (2102) found a correlation between those which perceive themselves high in tinkering self-efficacy and cognitive achievement. However, this study did not coincide with the findings of Sallee. Koch, (2010) in a similar study also found no significant correlation between tinkering self-efficacy and instructional method used on knowledge acquisition: which aligns with the findings in this study.

Implications and Recommendations

Agricultural education instructors have a unique challenge to instruct students because the material is not the same as traditional core courses. Therefore, traditional instructional techniques may not be the most appropriate in agricultural education settings. While components of lecture and demonstration were effective in helping students to learn, the combination method was overall the best method used. The point of education is to provide students the ability to think at higher levels and to think holistically about subjects so that they may apply greater knowledge to real world problems. Although all treatments were the same in affecting knowledge gained, the instructional technique of combining lecture and demonstration is the most effective method of teaching agriculture students in Northwest Arkansas to achieve high levels of cognitive processing.

Students did not seem to learn better on low level cognitive processing across the three treatments (lecture, demonstration, and lecture/demonstration). Therefore, when instructing students with material that targets low level cognition, it should not matter which method is used. It may be suggested that lecture would be an effective method due to the fact that not as much time and preparation go into preparing a lecture as it would a demonstration for similar results.

A variable that is worth noting is the instructor delivering the lesson. Perhaps the idea of a guest speaker involves the students' interest more, engaging them more in the lesson regardless of which treatment they were receiving. It may be advantageous to the literature to allow the original (in-tact) instructor deliver the treatment.

At the heart of Dewey's philosophy, experiential learning, is the idea that if you involve someone in the learning and they do the lesson, they'll never forget. An interesting follow up would be to use the same study this research presents but test the long term effects. Which treatment overtime would allow students to retain more knowledge?

The effects of student perceptions of instructional techniques on knowledge acquisition were not significant. The implication of this result is that it does not matter which method the students prefer because they will either learn (or not) the material the same. It is recommended to further research this area since there is conflicting results in the literature. Also, a study which further isolates this variable may find more accurate results.

Tinkering self-efficacy was another component of this study that is worthy of discussion. The results of this study found that students who perceive themselves as tinkerers also prefer the demonstration method of instruction and do not prefer the lecture method of instruction. However, it is not complimentary with the fact that this study found no significance between knowledge acquisition and preferred method of instruction. Tinkerers prefer demonstration, but those who prefer demonstration do not score higher when they receive a demonstration. The study also found no significance between tinkering self-efficacy and knowledge acquisition. The correlations complement each other by being consistent. Tinkerers do not perform better across instructional techniques than do non-tinkerers. Again, further research is recommended to further examine and understand the relationship between perceptions of instructional technique and knowledge as well as the relationship between preference of instructional technique and knowledge acquisition.

Further on tinkering self-efficacy. Recalling the definition of self-efficacy as one's perceived ability to manipulate with their hands, destruct/construct, repair, or modify; it is noteworthy to consider the information used for instruction. This study used biofuels and the effect it has on diesel engines. As per tinkerers, the lesson component was not directly geared towards information that would benefit them. Basically, if the lesson were more along the lines of how to convert a gas engine to ethanol, it may be more affective. It might include components of actually taking an engine apart and putting it back together: actual tinkering.

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APPENDIX ONE

Lesson Plan
Lecture

This lesson is designed for a 50min class period using only lecture. The first 10 minutes are for testing with 40 minutes of instruction.

1) Objectives: All objectives are to be carried out in the classroom in a lecture-type format

- Identify different sources of biodiesel
- Identify the process in which biodiesel is made
- Compare engine torque when using biodiesel and petroleum diesel
- Compare engine Horsepower when using biodiesel and petroleum diesel
- Compare fuel consumption when using biodiesel and petroleum diesel
- Compare exhaust emissions when using biodiesel and petroleum diesel

2) Procedure:

a) Pre-test:

The pre-test shall be administered the day before the instruction. The students have exactly 10 minutes to complete the pre-test. You may either administer the test yourself or request that the appointed teacher/instructor delivers it.

b) Interest Approach:

Fill three different jars: one with petroleum (D2) diesel, one with B-100 biodiesel, and one with a blended (b-20) biodiesel. Hold up the different jars and ask the students if they can identify the substance of the jars. The correct answers of the students are not important. This should not take more than about a minute and is only to engage the students and direct their attention towards the lesson.

c) Reasons to Learn:

1. Why would we use alternative fuels?
2. Why are alternative fuels important?

d) Questions to Answer:

1. What kinds of aspects about an engine are important?
2. How are the types of fuels selected important to an engine?

4. How can using biodiesel help/hurt your engine?

e) Problem Solution:

Since this is a traditional lecture class, there should be little discussion.

B-100 has a higher viscosity than D2 diesel. If you were to pour D2 diesel into a funnel, you would notice that the rate at which it flows is much less than the rate at which B-100 would.

There is a need to find an alternative fuel source; research continues to find a cheaper alternative to diesel. This is where we get biodiesel. Biodiesel can be used in any engine which uses diesel (tractors, semis, construction vehicles, etc.). It can be made from and vegetable or plant containing oil (beans, sunflowers, algae, etc.) or any animal fat (beef, poultry, swine, etc.).

Many different sources can be used to create biodiesel. The easy explanation is anything that produces oil can be used to make biodiesel. This could include the oils found in seeds such as soybeans, corn, sesame, or cotton. It can also be made from the oils found in fats from animals: such as cattle (tallow), poultry, and swine. There are also plants that have been used to make biodiesel such as algae.

Biodiesel can be made through a very simple process. The process is called transesterification. You mix a feedstock (anything that is oil based) and add methanol. Most processes include some type of catalyst to speed up the process. Potassium hydroxide or sodium hydroxides, to name a few, are very common catalyst used in the transesterification process. The process yields biodiesel and a bi-product called glycerin. The glycerin cannot be used through an engine, but the biodiesel obtained has the same energy content as petroleum diesel.

Torque is a rotation output measurement. It is measured using distance (ft) and multiplying Force (lbs). Torque is important to engines because it can create more or less horsepower. So what about torque is important when discussing alternative energy? Obviously, the more torque you have, the greater the horsepower. Will burning a biodiesel decrease this? The research says that it does not. There is actually no difference in engine torque when using biodiesel against petroleum diesel. The fuels both have the same amount of potential energy and, when combusted, provide the same amount of torque.

Engine horsepower is a simple equation which measured from torque and engine speed (RPM) divided by a constant (5252). To increase horsepower, you must either increase your torque or increase your RPM. A common misconception is that biodiesel will rob an engine of its horsepower. However, since the fuels have the same energy potential and torque is not decreased when you used biodiesel, you don't lose any horsepower either.

The engine does not react any differently to the two different types of fuel. In other words, there are no engine modifications you have to make in order to use biofuels. Simply pour it in your tank and your engine will run just as well.

Another desire of a fuel is to obtain the best fuel mileage. Will using biodiesel decrease your fuel performance? The short answer is no. There are studies that show that biodiesel uses neither more nor less fuel than a petroleum diesel.

So far, there have been no differences in the two fuels. Torque, Horsepower, and fuel consumption have all been the same. So how, if there is a difference, do these two fuels differ? There actually is a difference once we start looking at emissions. Emissions are particles or fumes displaced from the engine after burning a fuel. Some that present a threat are carbon monoxide, particulate matter and, NOx (nitrogen and oxygen). Biodiesel has actually been proven to reduce all of these emissions, except for NOx. NOx has not been tested very much and is still in question, but what little research available says that it is neither reduced nor increased. But using a B-20 blend of biodiesel can decrease carbon monoxide and particulate matter by up to 12%.

Oxygen is necessary for combustion. B-100 has a greater amount of oxygen. The optimum combustion temperature of biodiesel is much less than that of D2 diesel.

f) Summary:

To conclude the lesson: on the following day, administer the posttest. The posttest consist of the same multiple choice questions in a different order and 10 questions about tinkering self-efficacy. Each student will have exactly 10 minutes to complete the posttest.

g) Posttest

Deliver the posttest in the final ten minutes of the lesson. Make sure the students have ten minutes to complete the test, even if they don't need the additional time.

APPENDIX TWO

Lesson Plan
Demonstration

This lesson is designed for a 50min class period using only lecture. The first 10 minutes are for testing with 40 minutes of instruction.

3) **Objectives:** All objectives are to be carried out in the classroom in a lecture-type format

- Identify different sources of biodiesel.
- Identify the process in which biodiesel is made.
- Compare engine torque when using biodiesel and petroleum diesel.
- Compare engine Horsepower when using biodiesel and petroleum diesel.
- Compare fuel consumption when using biodiesel and petroleum diesel.
- Compare exhaust emissions when using biodiesel and petroleum diesel.

4) **Procedure:**

c) Pretest:

The pre-test shall be administered the day before the instruction. The students have exactly 10 minutes to complete the pre-test. You may either administer the test yourself or request that the appointed teacher/instructor delivers it.

d) Interest Approach:

Fill three different jars: one with petroleum (D2) diesel, one with B-100 biodiesel, and one with a blended (b-20) biodiesel. Hold up the different jars and ask the students if they can identify the substance of the jars. The correct answers of the students are not important. This should not take more than about a minute and is only to engage the students and direct their attention towards the lesson.

c) Reasons to Learn:

1. Why would we use alternative fuels?
2. Why are alternative fuels important?

d) Questions to Answer:

1. What kinds of aspects about an engine are important?
2. How are the types of fuels selected important to an engine?

4. How can using biodiesel help/hurt your engine?

e) Problem Solution:

The students will gather outside of the classroom around the demonstration instrument. The engine should be previously warmed up and should have the necessary equipment hooked up to read the desired outputs (torque, horsepower, fuel consumption, and exhaust gases).

Obtain a jar and fill it with seeds from a plant that can be used to make biodiesel. If possible, obtain some lard from an animal that can be used to make biodiesel. Following the questions to answer, use the jars to discuss the different types of sources from which biodiesel can be made. Let the students handle and touch the jars so they can look at and examine them as they desire.

In addition to the jars used for the interest approach and the ones previously stated, obtain three additional jars; one for potassium chloride (the catalyst), one for methanol, and one for glycerin. Show the students the jars (again, let them hold them and examine them more closely) and discuss the transesterification process. Hold up the first jar (the feedstock, or the seeds/lard); this is the feedstock used to make biodiesel. It is mixed with methanol (pass around the methanol jar). Most often, a catalyst is used to create a more rapid process. There are many different kinds of catalyst, but we use sodium hydroxide (pass around the jar containing the catalyst). [**Caution:** Sodium hydroxide is a harsh chemical. We put flour in a jar because it looks exactly the same and will not harm the students if they were to come into contact with it.] Once the process is complete, there are two end results: glycerin, which is a by-product (show the jar of glycerin) and crude biodiesel. After it has been refined, the final result is 100% biodiesel (pass around the jar of neat biodiesel).

Ask the students what the two most desired traits are in an engine. Direct the question towards torque and horsepower. Briefly discuss how engine torque and engine horsepower are measured and then show how the computer will read torque from the engine. Also ask the students which fuel they think will provide more or less performance. Briefly discuss the importance of fuel consumption. Ask the students which fuel they think will have better performance as far as fuel consumption. And finally, discuss emissions and which fuel they believe will have higher or lower emissions. The emissions that will be measured are particulate matter, carbon monoxide, and NOx.

Provide the students with a piece of paper so they can record all of the previously stated measurements. Assign students, in pairs, for each measurement. One student in the pair will record biodiesel, and the other will record diesel. There are a total of 6 measurements, so there should be 6 pairs. If there are leftover students, let them be the ones to switch the lever for the fuels and/or make the adjustments on the load valve. Measurements should be taken at 4 different RPMs. Once the measurements are complete, return to the classroom and record the data into an Excel sheet and graph the data. Discuss how torque, horsepower, and fuel consumption demonstrate similarities across the two fuels used. Also, discuss how the different fuels (should have) had different reactions with regards to emissions.

f) Summary:

To conclude the lesson: on the following day, administer the posttest. The posttest consist of the same multiple choice questions in a different order and 10 questions about tinkering self-efficacy. Each student will have exactly 10 minutes to complete the posttest.

g) Posttest

Deliver the posttest in the final ten minutes of the lesson. Make sure the students have ten minutes to complete the test, even if they don't need the additional time.

APPENDIX THREE

Lesson Plan
Lecture/Demonstration

This lesson is designed for a 50min class period using only lecture. The first 10 minutes are for testing with 40 minutes of instruction.

5) Objectives: All objectives are to be carried out in the classroom in a lecture-type format

- Compare engine torque when using biodiesel and petroleum diesel
- Compare engine Horsepower when using biodiesel and petroleum diesel
- Compare fuel consumption when using biodiesel and petroleum diesel
- Compare exhaust emissions when using biodiesel and petroleum diesel

6) Procedure:

e) Pre-test:

The pre-test shall be administered the day before the instruction. The students have exactly 10 minutes to complete the pre-test. You may either administer the test yourself or request that the appointed teacher/instructor delivers it.

f) Interest Approach:

Fill three different jars: one with petroleum (D2) diesel, one with B-100 biodiesel, and one with a blended (b-20) biodiesel. Hold up the different jars and ask the students if they can identify the substance of the jars. The correct answers of the students are not important. This should not take more than about a minute and is only to engage the students and direct their attention towards the lesson.

c) Reasons to Learn:

1. Why would we use alternative fuels?
2. Why are alternative fuels important?

d) Questions to Answer:

1. What kinds of aspects about an engine are important?
2. How are the types of fuels selected important to an engine?
4. How can using biodiesel help/hurt your engine?

e) Problem Solution:

This lesson incorporates both lecture and demonstration. During the lecture, be brief and only include the key points to ensure enough time is left for the demonstration.

All material is the same from the other two lesson plans. Instead of being so thorough, try to get to the point and be brief allowing for plenty of time to do the demo.

You may find yourself running longer on this lesson plan than the other two. That is likely to happen as two lessons are being condensed into one. Make sure there is enough time to give a post-test. As the you lecture, demonstrate the same material as stated in the "demonstration lesson plan".

f) Posttest

Deliver the posttest in the final ten minutes of the lesson. Make sure the students have ten minutes to complete the test, even if they don't need the additional time.

APPENDIX FOUR

Pretest

1. Biodiesel is made through the process of ____________
   a. transesterification b. transfusion
   c. transjunction d. transduction
2. 100% Biodiesel can be made from the following except
   a. Petroleum
   b. Soybean Seeds
   c. Algae
   d. Beef Tallow
3. Which of the following is used in the process to make biodiesel?
   a. Feed stocks
   b. Sodium hydroxide
   c. Ethanol
   d. A and B
4. Torque is _________ when using B20 instead of petroleum diesel.
   a. Reduced by at least 25%
   b. Increased by at least 25%
   c. Not significantly affected
   d. Significantly affected
5. Horsepower is _________ when using B20 instead of petroleum diesel.
   a. Reduced by 25%
   b. Increased by 25%
   c. Significantly affected
   d. Not significantly affected
6. Fuel consumption is ____________ when using B20 instead of petroleum diesel.
   a. Reduced by 25%
   b. Increased by 25%
   c. Significantly affected
   d. Not significantly affected
7. Harmful exhaust is __________ when biodiesel is used instead of petroleum.
   a. Reduced
   b. Increased
   c. Not Significantly affected
   d. Not a threat because biodiesel doesn't create emissions
8. Can biodiesel be used in a diesel engine?
   a. No, it's not the same fuel
   b. Yes, it has the same combustibility
   c. Yes, but one must make engine modifications
   d. No, diesel engines run on diesel ONLY

9. Hydrocarbons, CO, and particulate matter emissions ____________ as more biodiesel is added to D2 diesel.

a. increase | b. both increase and decrease

c. decrease | d. are not affected

10. If the amount of torque was decreased, and speed (RPM) remained the same, what would happen to the amount of horsepower?
    a. HP would decrease
    b. HP would increase
    c. HP would remain constant
    d. Torque does not affect horsepower

11. Why can 100% biodiesel be made from algae, soybeans, and cattle fat?
    a. Because they are renewable resources
    b. Because they are all biological products
    c. Because they all contain oils or fats
    d. All of the above

12. Why can glycerin not be used in an engine?
    a. Because it is too expensive to make.
    b. Glycerin is not a product of biodiesel production.
    c. Because it is not combustible and would clog the engine.
    d. Glycerin is a product of biodiesel and can be used in an engine.

13. B100 has _________ energy content, per gallon, than petroleum diesel
    a. More
    b. Less
    c. The same
    d. Varies depending on which feed stock is used

14. Which is a better fuel system better lubricant?
    a. D2
    b. B20
    c. B50
    d. B100

15. If the amount of fuel used was held constant, which would provide the greatest horsepower?
    a. D2
    b. B20
    c. B50
    d. B100

16. Which fuel has the most complete combustion?
    a. D2
    b. B20
    c. B50
    d. B100

1= Strongly Disagree
2=Disagree
3= Neutral
4= Somewhat Agree
5= Strongly Agree

Tinkering Self-efficacy

I possess the ability to take something apart and put it back together.	1	2	3	4	5
I enjoy taking things apart to see how they work.	1	2	3	4	5
I enjoy working with my hands.	1	2	3	4	5
I enjoy working in the agriculture lab.	1	2	3	4	5
I enjoy rebuilding engines/equipment.	1	2	3	4	5
I enjoy demonstrated projects assigned by my teacher.	1	2	3	4	5
I enjoy learning how things operate.	1	2	3	4	5
I enjoy learning when I can use my hands.	1	2	3	4	5
I enjoy fixing broken items.	1	2	3	4	5
I enjoy troubleshooting to find a solution to problem and then fixing it.	1	2	3	4	5

Demographics

1. How old are you? _____

2. What is your current year in school? (Check one)
___Freshman ___Sophomore ___Junior ___Senior

3. What grades do you make in school? (Check one)
___A ___B ___C ___D ___F

4. What grades do you make in your agricultural classes? (Check one)
___A ___B ___C ___D ___F

5. What is you gender?
___Male ___Female

6. Do you live on a farm that has equipment that used diesel? (Check one)
___Yes ___No

7. If you checked yes above, do you use biodiesel?
___Yes ___No

First Name: ______________________

Last Name: ______________________

Group/Class: ____________________________

APPENDIX FIVE

Posttest

1. Harmful exhaust is __________ when biodiesel is used instead of petroleum.
    a. Reduced
    b. Increased
    c. Not Significantly affected
    d. Not a threat because biodiesel doesn't create emissions
2. If the amount of fuel used was held constant, which would provide the greatest horsepower?
    e. D2
    f. B20
    g. B50
    h. B100
3. Horsepower is _________ when using B20 instead of petroleum diesel.
    a. Reduced by 25%
    b. Increased by 25%
    c. Significantly affected
    d. Not significantly affected
4. Why can 100% biodiesel be made from algae, soybeans, and cattle fat?
    a. Because they are renewable resources
    b. Because they are all biological products
    c. Because they all contain oils or fats
    d. All of the above
5. Fuel consumption is ____________ when using B20 instead of petroleum diesel.
    a. Reduced by 25%
    b. Increased by 25%
    c. Significantly affected
    d. Not significantly affected
6. Which fuel has the most complete combustion?
    a. D2
    b. B20
    c. B50
    d. B100
7. Biodiesel is made through the process of _____________
    a. transesterification   b. transfusion
    c. transjunction   d. transduction
8. B100 has _________ energy content, per gallon, than petroleum diesel
    a. More
    b. Less
    c. The same
    d. Varies depending on which feed stock is used

9. Why can glycerin not be used in an engine?
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    a. increase   b. both increase and decrease

    c. decrease   d. are not affected
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    c. Not significantly affected
    d. Significantly affected
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    a. No, it's not the same fuel
    b. Yes, it has the same combustibility
    c. Yes, but one must make engine modifications
    d. No, diesel engines run on diesel ONLY
14. Which of the following is used in the process to make biodiesel?
    a. Feed stocks
    b. Sodium hydroxide
    c. Ethanol
    d. A and B
15. If the amount of torque was decreased, and speed (RPM) remained the same, what would happen to the amount of horsepower?
    a. HP would decrease
    b. HP would increase
    c. HP would remain constant
    d. Torque does not affect horsepower
16. Which is a better fuel system better lubricant?
    a. D2
    b. B20
    c. B50
    d. B100

1= Strongly Disagree
2= Disagree
3= Neutral
4= Somewhat Agree
5= Strongly Agree

Perceptions

I enjoy working in the agriculture lab	1	2	3	4	5
I prefer to work in the lab where I can use my hands to learn	1	2	3	4	5
I learn a concept best when I do something	1	2	3	4	5
I have the ability to pay attention when I am working on a task	1	2	3	4	5
I can learn better when things are demonstrated	1	2	3	4	5
I enjoy working in the classroom	1	2	3	4	5
I prefer to be in the classroom where I can learn by listening	1	2	3	4	5
I learn a concept best when I am told how something works	1	2	3	4	5
I have the ability to pay attention when I listen to a lecture	1	2	3	4	5
I learn better by studying/working in a classroom	1	2	3	4	5

APPENDIX SIX

IRB Protocol

April 26, 2012

MEMORANDUM

TO:	Don Johnson George Wardlow Ryan Siebenmorgen Chris Hunt Don Edgar
FROM:	Ro Windwalker IRB Coordinator
RE:	PROJECT CONTINUATION
IRB Protocol #:	09-04-590
Protocol Title:	*The Effects of Alternative Fuel Education Program on Knowledge Acquisition in Secondary Agricultural Settings*
Review Type:	☐ EXEMPT ☒ EXPEDITED ☐ FULL IRB
Previous Approval Period:	Start Date: 05/14/2009 Expiration Date: 05/13/2012
New Expiration Date:	05/13/2013

Your request to extend the referenced protocol has been approved by the IRB. If at the end of this period you wish to continue the project, you must submit a request using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. Failure to obtain approval for a continuation on or prior to this new expiration date will result in termination of the protocol and you will be required to submit a new protocol to the IRB before continuing the project. Data collected past the protocol expiration date may need to be eliminated from the dataset should you wish to publish. Only data collected under a currently approved protocol can be certified by the IRB for any purpose.

This protocol has been approved for 950 total participants. If you wish to make *any* modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 210 Administration Building, 5-2208, or irb@uark.edu.