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Animation: Friend or Foe in Today's Classrooms?

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Abstract

Classrooms hold a vast amount of knowledge for today's students. Through the advancement of technological devices, both hardware and software, the arsenal of today's teachers seems unlimited. Animation of intricate theories and processes has been touted to increase understanding of students (Larive, 2008; Wouters, Pass, & van Merriënboer, 2008; McGregor, 2002; Su, 2008) and this study engaged in analyzing the effects of animation in purposively selected classrooms through a counterbalance design. Theories of operation and carburetion were taught to the selected participates. Regarding cognitive achievement of the selected participants towards principles and theories tested, no significant differences were found between technology enhanced and traditional means of education. Further variables of study including gender, time of instruction, and tinkering self-efficacy were not found to have significant effects. This study concurs with previous research that technology enhanced teaching does not significantly affect cognitive achievement.

***Keywords*:** Animation, Instruction, Perceptions, Knowledge

Introduction

Technology has evolved society in recent decades. With technology becoming ever-more-important in today's economy, the workforce has also been affected (CORD, 1999). Just as technology has affected the way most jobs are addressed, technology has begun to play a huge role in education. The National Research Council (1988) called for instructors to seek out and share technology-enhanced instructional material for agricultural education to enhance student achievement. Based on the availability of technology related resources for today's teachers, it is paramount to understand the usage of these technologies in today's classroom. Furthermore, there are countless resources available for teachers which never before existed.

Digital technologies surround children growing up today. According to Phipps, Osborne, Dyer, and Ball (2008), "students of the millennial generation spend an average of nearly 6.5 hours in front of some type of media each day" (p. 291). Coinciding with this premise, there leaves little time for physical activities like disassembling and troubleshooting mechanical devices as in previous generations. While the ways of teaching have begun to change, the students of today have changed. Learners are foundationally different from those who came before them in their methods of processing information and reasoning (Prensky, 2001).

The use of information and communication technology in a creative way as an alternative to lecture can bring more excitement and interest into the classroom (Clark, 2008). Through the technologies available, teachers can transform the classroom from a *teacher-centered* to a *learner-centered environment* in an effort to adapt to students' needs (Simonson & Thompson, 1997). With nearly all schools today having a computer in every classroom, technology can be associated with learning. "As agricultural education enters the twenty-first century, it must change with emerging trends in society and the agricultural industry," (Talbert, Vaughn, & Croom, 2005, p. 61). Agricultural education programs can thrive or die in any community based solely upon the ability of the program to offer current, desirable, high-quality educational experiences in an affordable manner (Talbert et al., 2005).

A recognizable source of secondary level education in agricultural sciences is the classroom. Agricultural classroom instruction is a foundational basis for activities taking place in the laboratory and outside environment (Phipps et al., 2008). Activities in the agricultural laboratory require students to use their newly-gained knowledge from the classroom instruction while developing psychomotor skills (Phipps et al., 2008).

The mechanical technologies of agriculture require students to apply new principles in an even greater dimension. Students must take elements which are a challenge to see or visualize, moving too fast or slow, in an effort to apply and understand the mechanical processes taking place (McGregor, 2002). These are abstract concepts rather than concrete in the students' minds (Gagné, 1985). It is the instructor's role to help the students understand the theoretical processes (i.e., small gasoline engines) before students can utilize them in the laboratory. Many approaches have been used to address the vague concepts of agricultural mechanization: still images, drawings, focused demonstrations and aids, engine cutaways, and actual parts; however, these tools fail to show students the realistic motion of such machines (McGregor, 2002).

Agricultural teachers need to take advantage of the strengths and interests of today's students by using technology to develop the most effective means of educating their students (Phipps et al., 2008). By showing students mechanic technologies in an action-oriented, digital form, students can be exposed to views that are unattainable through traditional methods. Teachers of agriculture must look past the skills needed for the jobs of yesterday and today and begin preparing students for the jobs of the future (Talbert et al., 2005). Because of the emersion students in today's society undergo with technology, incorporating it in the classroom should benefit knowledge acquisition. The incorporation of technology has proven this in many other fields. Can technology-enhanced instruction benefit students in agricultural education? The use of digital technologies has begun to take hold in agricultural education; however, the question remains unanswered towards the benefit of this movement when compared to proven previous practices used in agricultural education classrooms.

Theoretical Framework

The theory of constructivism has been examined by many researchers as the framework more currently suited for education and more specifically, agricultural education (Doolittle & Camp, 1999). Constructivism is defined as the act of learners creating an understanding through an experience (Fosnot, 1996). Dewey (1938) stressed his view that "sound educational experience involves, above all, continuity and interaction between the learner and what is learned" (p. 10). "…While reality may exist separate from experience, it can only be known through experience, resulting in a personally unique reality" (Doolittle & Camp, 1999, p. 4).

Cognitive constructivism serves as the type of constructivism by which this study was framed. According to cognitive constructivism, in order for learning to take place, the student must have an accurate real world experience that corresponds to an internal conceptualization. Instructional technology can play a role in creating a more student-centered learning environment through the experience gained in a constructivist approach (Simonson & Thompson, 1997). This study examines the use of technology-enhanced instruction on student cognitive achievement as a means to provide the real world experience for abstract concepts that cannot always be seen or conceptualized first-hand in areas of mechanical technologies.

For centuries, imagery has been used to influence memory and other cognitive processes. The Dual Coding Theory (DCT) was introduced by Allan Paivio (1971) as an approach to cognitive thinking, using both language (verbal) and imagery (nonverbal). It is a multimodal theory comprised of structures and representational components of words and things on the behavioral and perceptual level instead of abstractions of the words and items (Paivio, 2007). "The representations are connected to sensory input and response output systems as well as to each other so that they can function independently or cooperatively to mediate nonverbal and verbal behavior" (Paivio, 2007, p. 13). Figure 1 is a visual depiction of the DCT. Both verbal and nonverbal stimuli are connected through sensory systems on the visual, auditory, and haptic level (Paivio, 2007). "When information is dually coded, the probability of retrieval is increased because if one memory trace is lost, another is still available" (Rieber, 1991, p. 319). DCT was supported by Su's (2008) study resulting in the enhancement of student learning through multimedia.

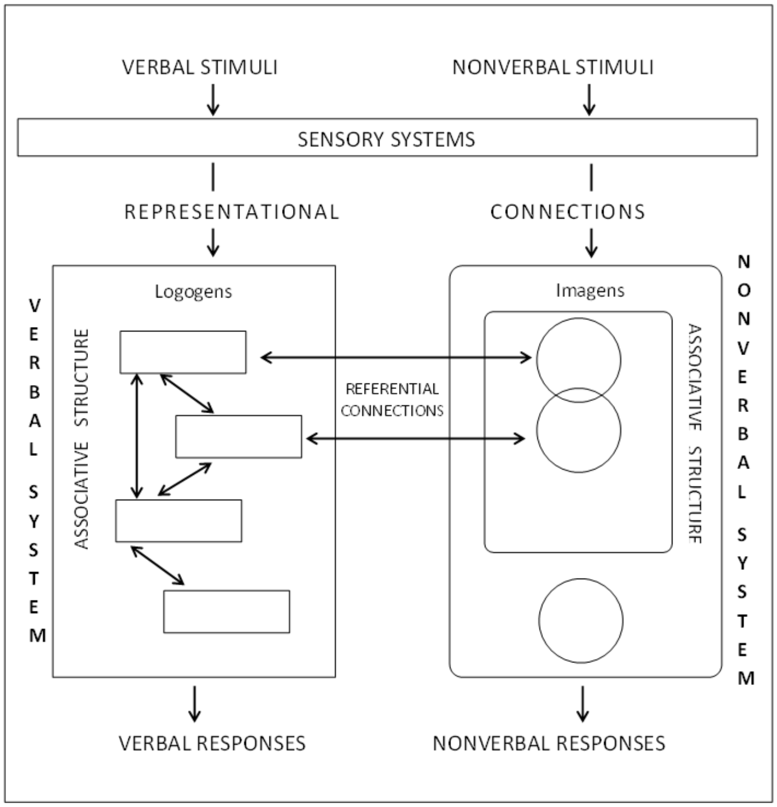

Figure 1. A dual coding model for adapting verbal and nonverbal information. Adapted from *Mind and Its Evolution: A Dual Coding Theoretical Approach*, Paivio, 2007.

With the influx of technologies in schools, many teachers fail to realize that technology should be used as a tool for enhancing instruction, rather than serve as the entire instruction, without guidance and direction from the teacher (Clark, 2008). Technologies in education can be both positive and negative, so how it is used, by whom, and for what purpose is key (Burbules & Callister, 2000). Clark (2008) concluded that instructors still have a role in creating a positive instructional setting through constructivism; technology does not solely create one on its own.

Visualizations such as animations present opportunities for supportive scientific environments to be designed which can “stimulate learners to reconsider their prior knowledge” (Kali & Linn, 2008, p. 194). Animations help in the visualization of abstract concepts through concrete representations and events (Wouters, Pass, & van Merriënboer, 2008; McGregor, 2002; Su, 2008). They can be manipulated, distorted, and shaped to improve the visualization of a concept (Hegarty, 2004). Many actions that may take a long time to put together or facilitate can be shown successfully through animation in addition to a lecture in order to fill in the knowledge gap unanswered by static pictures (Larive, 2008). Increased student cognitive achievement when using animation over static images has been seen in many other studies covering a range of subject areas other than agriculture (Boucheix & Guignard, 2005; Höffler & Leutner, 2007; Özmen, Demircioğlu, & Demircioğlu, 2009; Su, 2008). Edgar (2006) expressed the challenge of teaching abstract concepts of agricultural mechanization all-inclusively using only pictures, diagrams, chalk boards, and verbal explanations. Technological forms of instruction, like animation, may offer students an increased understanding of mechanical powers and science principles in agriculture (Dooley, Stuessy, Magill, & Vasudevan, 2000; McGregor, 2002).

Teachers expressed their beliefs that increased use of educational technologies would pose great future benefits for their programs (Alston, Miller, & Williams, 2003). In a study analyzing agricultural power technology systems no significant differences were found in student achievement (McGregor, 2002). Conversely, students showed an increased level of understanding in verbal explanations to the researcher when animations were used in addition to the lecture in a study conducted by Edgar (2006). Students also vocalized support for the use of animations giving the researcher a sense of promise in aiding the future instruction of cognitive processes (Edgar, 2006).

Methodology

The purpose of this study was to determine if there was a significant difference ($p \leq 0.05$) in the cognitive achievement between students enrolled in Agricultural Science and Technology at the secondary level taught by technology-enhanced instruction compared with traditional lecture of four-stroke cycle small gasoline engines. In addition, this study looked to identify any differences in student perceptions of instruction, in gender specific achievement, in achievement based on time of day of the instruction, and in achievement based upon tinkering self-efficacy as measured via test instrumentation.

The following hypotheses were formulated to guide this study:

Ho_1: There will be no significant difference in cognitive achievement between students taught by technology-enhanced instruction compared with traditional lecture in the principles of operation of four-stroke cycle small gasoline engines.

Ho_2: There will be no significant difference in cognitive achievement between students taught by technology-enhanced instruction compared with traditional lecture in the principles of carburetion of four-stroke cycle small gasoline engines.

Ho_3: There will be no significant difference in student perceptions between students taught by technology-enhanced instruction compared with traditional lecture in the principles of operation of four-stroke cycle small gasoline engines.

Ho_4: There will be no significant difference in student perceptions between students taught by technology-enhanced instruction compared with traditional lecture in the principles of carburetion of four-stroke cycle small gasoline engines.

Ho_5: There will be no significant difference in students' cognitive achievement based on gender, time of day of instruction, and/or tinkering self-efficacy between students taught by technology-enhanced instruction compared with traditional lecture in the principles of operation of four-stroke cycle small gasoline engines.

Ho_6: There will be no significant difference in students' cognitive achievement based on gender, time of day of instruction, and/or tinkering self-efficacy between students taught by technology-enhanced instruction compared with traditional lecture in the principles of carburetion of four-stroke cycle small gasoline engines.

A quasi-experimental, modified counterbalanced design (#11) with internal replication from Campbell and Stanley (1963) was chosen for this study. Following Campbell and Stanley's (1963) outlining of a counterbalanced research design, Table 1 served as the design of this study.

Table 1. Modified Counterbalanced Research Design

Group	Pretest	Lesson 1	Posttest	Lesson 2	Posttest
1	O_1	X_{C1}	O_2	X_{T2}	O_3
2	O_1	X_{T1}	O_2	X_{C2}	O_3

Subjects were selected from two Arkansas public schools. Of these two schools, two intact classes of Agricultural Science and Technology were chosen from each school to participate in this study. This sample was chosen based upon the selected characteristic of attainable intact classes of students enrolled in agricultural science and technology. Generalizations from this study's results made outside of the subjects whom took part in the experiment should be cautioned (Oliver & Hinkle, 1982).

Each class was coded based on time of day of instruction. Of the four classes chosen, a total of 71 (*n* = 71) students completed the study. Two separate lessons on small gasoline engines were taught at each school. Of the two intact classes per school, one was randomly chosen to serve as the control for the first lesson with the other serving as the treatment group. The groups were exchanged for the second lesson, having each class serve as both a control and a treatment for separate lessons.

Students were given a pretest one week before the treatment was taught to measure their knowledge prior to the treatments and collect demographic data. The pretest consisted of 30 questions covering small gasoline engine theory, 15 from operation and 15 from carburetion, as well as seven tinkering self-efficacy questions. The day following each lesson, an immediate posttest was administered. The posttest consisted of 15 questions addressing the lesson, as well as 20 Likert-style questions over student perceptions of the lesson.

The first lesson taught covered the principles of operation of four-stroke cycle small gasoline engines. The control group was taught the lesson content in the traditional lecture format. The experimental group was taught the same content, using PowerPoint® instead of the handout and white board. The researcher discussed the same principles while supporting his lesson with the technological-enhanced method of PowerPoint® while also presenting animations and video of the engine operation components and theory. The second lesson taught covered principles of carburetion of four-stroke cycle small gasoline engines. The control group, which served as the experimental groups for the first lesson, was taught the lesson through traditional lecture. The experimental group, which served as the control group for the first lesson, was taught with the researcher using PowerPoint while also presenting animations and video of the engine carburetion components and theory.

The cognitive achievement instrument (utilized for the pre and post-tests) was developed by the researcher. Examples of multiple-choice questions posed were *How many revolutions of the crankshaft occur after the completion of the four-stroke cycle?* and *The choke is a butterfly valve located at the "intake" end of the carburetor*. The student perceptions questions were adapted from an instrument by Silance and Remmers (1934) to fit each lesson. Twenty Likert-style questions were used ranging from 1 to 7. The tinkering self-efficacy questions were adapted from an instrument by Sallee (2010). It consisted of seven Likert-style questions. These questions sought to measure students' perceived ability of tinkering by requiring them to place themselves in a situation and answer each question as a result (Sallee, 2010). Tinkering self-efficacy is based on a person's perceived ability to manipulate, construct, assemble or disassemble devices or their components (Baker & Krause, 2007). The instrument was reviewed for face and content validity using a panel of agricultural education and mechanization experts' familiar with instruction on the secondary level. Improvements were made to insure that the instrument could answer the hypotheses of this study. The instrument was pilot tested with a group of twenty-one students enrolled in Agricultural Science and Technology at a local Arkansas public school similar to the sample of study. Cronbach's Alpha was used to measure the instruments' consistency of subjects' answers for similar questions. The pretest resulted in a Cronbach's Alpha (α) value of 0.82 while the posttest obtained a value of 0.88. In testing reliability of the tinkering self-efficacy questions, Sallee (2010) reported α = 0.89.

Data were organized and analyzed for each research hypotheses using SAS® 9.2 for Windows™ statistical package. Descriptive statistics were used to analyze the demographic variable data. Inferential statistics were used to analyze the instrument data for testing differences using independent *t*-tests. All data were also reexamined based on gender, time of day of instruction, and tinkering self-efficacy in order to reanalyze the group mean differences between the pretest and posttests from each lesson using the ANOVA procedure. Statistical power was also calculated for the instrument in order to detect the probability of detecting a meaningful difference if one truly did exist.

Findings

Demographics described for this study include gender, grade level, and time of day of instruction (AM/PM). Because all subjects served in both a control and treatment group, they will be represented as a whole sample. Of the original 94 students enrolled in classes that participated in this study, 21 were removed from the data sample due to an absence on any one or more of the five days required for the study resulting in a usable sample size of 73 students. Two students were identified statistically through box plot analysis as outliers, removed from final data analysis, resulting in the final sample size (n = 71).

A majority of the participants' gender was recorded as male (90.14%) with the remaining indicating female (9.86%). Ninth graders comprised 78.87% of the sample, tenth graders 14.09%, eleventh graders 1.41%, and twelfth graders 5.63%. Subjects' time of day of instruction was similar with 54.93% of the sample being instructed in the AM and 45.07% of subjects receiving PM instruction.

Null hypothesis one stated that there would be no significant difference in cognitive achievement between students taught by technology-enhanced instruction compared with traditional lecture in the principles of operation of four-stroke cycle small gasoline engines. Mean scores for the pretest and posttest for both the traditional and technology-enhanced classes at both schools (n = 71) were analyzed. While the control groups at each school recorded pretest scores of 48.52 (*SD* = 16.62) and 37.95 (*SD* = 13.71), the treatment groups recorded scores of 41.40 (*SD* = 19.45) and 46.98 (*SD* = 20.60), respectively. Posttest scores for the control groups were 62.59 (*SD* = 15.02) and 54.36 (*SD* = 13.57) with the treatment groups recorded scores of 51.58 (*SD* = 15.84) and 58.41 (*SD* = 17.88). An independent *t*-test was used to test this hypothesis. Table 2 indicates no significant difference in cognitive achievement between the traditional and technology-enhanced classes of principles of operation scores, $t(69) = 1.12$; $p = 0.27$. The null hypothesis was held to be true.

Table 2. t-test for Cognitive Achievement in Principles of Operation (n = 71)

Instructional Method	*n*	*M*	*SD*	*t*	*p*
Traditional (C)	31	15.05[1]	15.00	1.12	0.27
Technology-Enhanced (T)	40	10.83[1]	16.24		

[1] Derived from pretest score subtracted from posttest score.

Null hypothesis two stated that there will be no significant difference in cognitive achievement between students taught by technology-enhanced instruction compared with traditional lecture in the principles of carburetion of four-stroke cycle small gasoline engines. Mean scores for the pretest and posttest for both the traditional and technology-enhanced classes at both schools (*n* = 71) were analyzed. While the control groups at each school recorded pretest scores of 40.70 (*SD* = 16.31) and 38.09 (*SD* = 12.32), the treatment groups recorded scores of 44.07 (*SD* = 20.98) and 36.92 (*SD* = 14.30), respectively. Posttest scores for the control groups were 57.19 (*SD* = 17.96) and 67.94 (*SD* = 20.18) with the treatment groups recorded scores of 59.63 (*SD* = 20.13) and 59.49 (*SD* = 20.99). An independent *t*-test was used to test this hypothesis. Table 3 shows no significant difference in cognitive achievement between the traditional and technology-enhanced classes of principles of carburetion scores, $t(69) = 1.09$; $p = 0.28$. This analysis resulted in the null hypothesis to be held true.

Table 3. t-test for Cognitive Achievement in Principles of Carburetion (n = 71)

Instructional Method	*n*	*M*	*SD*	*t*	*p*
Traditional (C)	40	23.50[1]	20.14	1.09	0.28
Technology-Enhanced (T)	31	18.50[1]	18.03		

[1] Derived from pretest score subtracted from posttest score.

Null hypothesis three stated that there will be no significant difference in student perceptions between students taught by technology-enhanced instruction compared with traditional lecture in the principles of operation of four-stroke cycle small gasoline engines. The traditional groups recorded means of 3.01 (*SD* = 1.03) and 2.78 (*SD* = 1.29) with ranges from 1.35 to 5.65 while the technology-enhanced groups posted means of 2.96 (*SD* = 1.21) and 2.74 (*SD* = 1.09) with ranges from 1.05 to 6.30. An independent *t*-test revealed no significant (Table 4) difference between traditional lecture and technology-enhanced instruction perception scores in principles of operation, $t(69) = 0.25$; $p = 0.80$. The null hypothesis failed to be rejected.

Table 4. t-*test for Student Perceptions in Principles of Operation (n = 71)*

Instructional Method	*n*	*M*	*SD*	*t*	*p*
Traditional (C)	31	2.91[1]	1.13	0.25	0.80
Technology-Enhanced (T)	40	2.84[1]	1.14		

[1] Likert scale (1 to 7) with 1 representing *strongly agree* to 7 representing *strongly disagree*.

No significant difference in student perceptions between students taught by technology-enhanced instruction compared with traditional lecture in the principles of carburetion of four-stroke cycle small gasoline engines was the stated null hypothesis four. Perceptions were measured using a Likert Scale from 1 to 7: 1 = *strongly agree* to 7 = *strongly disagree*. The traditional groups recorded means of 3.47 (*SD* = 0.96) and 2.78 (*SD* = 1.02) with ranges from

1.55 to 5.90 while the technology-enhanced groups posted means of 2.93 (*SD* = 0.50) and 2.57 (*SD* = 1.21) with ranges from 1.45 to 5.95. This hypothesis was not found to be significant when analyzed using an independent *t*-test, $t(69) = 1.40$; $p = 0.17$. This finding resulted in the null hypothesis being held true (Table 5).

Table 5. t-*test for Student Perceptions in Principles of Carburetion (n = 71)*

Instructional Method	*n*	*M*	*SD*	*t*	*p*
Traditional (C)	40	3.11[1]	1.04		
				1.40	0.17
Technology-Enhanced (T)	31	2.78[1]	0.87		

[1] Likert scale (1 to 7) with 1 representing *strongly agree* to 7 representing *strongly disagree*.

Null hypothesis five stated that there will be no significant difference in students' cognitive achievement based on gender, time of day of instruction, and/or tinkering self-efficacy between students taught by technology-enhanced instruction compared with traditional lecture in the principles of operation of four-stroke cycle small gasoline engines. An overall mean score of 4.14 (*SD* = 0.70) was recorded for the classes with a range from 2.00 to 5.00. Mean tinkering self-efficacy scores for classes one through four were 3.97 (*SD* = 0.81), 4.11 (*SD* = 0.86), 4.08 (*SD* = 0.57), and 4.52 (*SD* = 0.38). Null hypothesis five was tested using a factorial analysis of variance (ANOVA) procedure. Table 6 reveals no significant difference in the cognitive achievement for principles of operation through the interaction of the main effects ($F = 0.96$, $p = 0.44$). Additionally, no significance was found through any of the main effects of gender ($F = 0.03$, $p = 0.86$), time of instruction ($F = 0.06$, $p = 0.81$), or tinkering self-efficacy ($F = 0.00$, $p = 0.99$).

Table 6. Cognitive Achievement Mean Comparison in Principles of Operation (n = 71)

Source	*df*	*SS*	*MS*	*F*	*p*
Model	7	988.08	142.58	0.55	0.79
Gender	1	8.41	8.41	0.03	0.86
Time of Instruction	1	15.10	15.10	0.06	0.81
Tinkering Self-efficacy	1	0.02	0.02	0.00	0.99
Main Effect Interactions	4	996.93	249.23	0.96	0.44
Error	63	16347.41	259.48		
Total	70	17345.49			

Null hypothesis six stated that there will be no significant difference in students' cognitive achievement based on gender, time of day of instruction, and/or tinkering self-efficacy between students taught by technology-enhanced instruction compared with traditional lecture in the principles of carburetion of four-stroke cycle small gasoline engines. The ANOVA procedure was used to test this hypothesis. Table 7 reveals no significant difference in the cognitive achievement for principles of carburetion through the interaction of the main effects ($F = 0.30$ $p = 0.87$). Additionally, no significance differences were found through any of the main effects of gender ($F = 2.94$, $p = 0.09$), time of instruction ($F = 0.23$, $p = 0.63$), or tinkering self-efficacy ($F = 0.08$, $p = 0.78$).

Table 7. Cognitive Achievement Mean Comparison in Principles of Carburetion (n = 71)

Source	*df*	*SS*	*MS*	*F*	*p*
Model	7	2205.77	315.11	0.83	0.56
Gender	1	1112.43	1112.43	2.94	0.09
Time of Instruction	1	86.70	86.70	0.23	0.63
Tinkering Self-efficacy	1	29.05	29.05	0.08	0.78
Main Effect Interactions	4	458.83	458.83	0.30	0.87
Error	63	23804.38	377.85		
Total	70	26010.15			

Conclusions and Discussion

Fosnot (1996) explained constructivism in learning as when learners create an understanding through an experience. Alston, Miller, and Williams (2003) strongly suggested that educational theory should guide any adoption of instructional technology within agricultural education. This study utilized technology, in verbal and nonverbal descriptions of the four-stroke cycle small gasoline engine, as a means of providing students with the accurate real world experience needed for developing an internal understanding set in DCT and cognitive constructivism. Although no significant differences were seen through this study, conclusions about the findings should be explored to further develop the answer towards animation being either a friend or foe to educators.

Given the setting in which this study was conducted, it is presumed that traditional lecture and technology-enhanced instruction served the participants equally well when learning principles of operation and carburetion of four-stroke cycle small gasoline engines. Although many people have called for the use of technology in education (Darling-Hammond & Bransford, 2005; National Research Council, 1988; Phipps et al., 2008), this study revealed that technology-enhanced instruction served no greater benefit at producing cognitive achievement than did traditional lecture for the lessons of principles of operation and carburetion of four-stroke cycle small gasoline engines. If in fact no significant difference actually exists (Type II error), the field of agricultural education should reexamine the push for technology-enhanced instruction in order to establish a better understanding of its advantages and disadvantages for future recommendations. However, it is surmised based on the findings of this study that when students are exposed to mechanical concepts for the first time at a young age, they could be distracted by the animations and video contained within the PowerPoint® countering any possible positive effect of the technology. Additionally, the question arises towards the effective use of technology-enhanced instruction with first-time learners lacking any basic knowledge of the content presented in this study. The findings from hypotheses one and two add to the varying results involving technology-enhanced instruction in education.

With the weak calculated statistical powers of the design for measuring cognitive achievement for principles of operation and carburetion (0.06 and 0.20), it is possible that a significant difference could truly exist but was not found in this study due to the small sample size, possibility of a Type II error being committed, strength of the instrument, and/or design of this study. If the study were to be replicated in the future, a larger sample size should be utilized, in addition to reexamining the instrument and design of the study, in order to maximize the difference between the independent variables, minimize the error, and control for extraneous variables at a higher level than previously attained.

These results mirror some others' results of no significant difference in cognitive achievement when various forms of technology-enhanced instructions in a range of educational areas, including post-secondary agriculture, were utilized (Daniels, 1999; Marrison & Frick, 1993; McGregor, 2002). However, the findings of the first two hypotheses are inconsistent with the results of previous studies which found a significant effect on student cognitive achievement through various forms of technology-enhanced instructions (Lowry, 1999; Mantei, 2000; Boucheix & Guignard, 2005; Höffler & Leutner, 2007; Özmen, et al., 2009; Su, 2008). This issue appears to be far from settled and deserves further study.

Clark (2008) stated that the innovative use of technology can increase interest and enthusiasm in the classroom. Technology may be the difference in restoring student interest from years of dull lectures (Gilroy, 1998). Both positive and negative results can arise from educational technologies; therefore, the who, what, and how surrounding the use of technologies is important (Burbles & Callister, 2000). No significant difference in student perceptions of the principles of operation lesson between traditional lecture and technology-enhanced instruction was evident. Student perceptions of the principles of carburetion lesson were also found to have no significant difference.

Furthermore, no significant difference between student perceptions among the control and treatment groups within each lesson; therefore, it is presumed that students view each type of instruction as equal means of instruction. The research posits, based on previous research (Edgar, 2006), if participants had been asked to qualitatively compare and contrast the traditional lecture and technology-enhanced instruction, more insight towards personal perceptions might occur and this should be further studied.

Results parallel Kask (2000) which found computer presentations having no significant effect on male cognitive achievement but disagree with Kask's (2000) finding on an impact of female cognitive achievement. It should be noted that females only represented less than 10 percent of the sample for this study, with all of those subjects originating from school 1. Although Sallee (2010) found a significant correlation between tinkering self-efficacy and cognitive achievement with a similar sample, the results of this study did not coincide.

Implications and Recommendations

Agricultural education instructors have been urged to seek out and share technological materials in order to enhance student achievement (National Research Council, 1988). The survival of agricultural education programs rely heavily on their ability to supply current, desirable, high-quality educational experiences to the students of their respective communities (Talbert et al., 2005). According to Phipps et al. (2008), with the interests current students hold in technology, agricultural teachers should utilize technology in developing the most effective means of educating their students. The fundamental purpose of this study was to identify any differences between traditional lecture and technology-enhanced instruction in lessons of four-stroke cycle small gasoline engines.

The results of this study reveal no significant impact on student cognitive achievement or student perceptions of teaching methods when technology is adopted for instructional methods of principles of operation and carburetion of four-stroke cycle small gasoline engines. Both forms of instruction were positively perceived while the demographic characteristics of gender, time of instruction, and tinkering self-efficacy were found to hold no significant impact on cognitive achievement.

Although differences due to the primary independent variable were not found in this study possibly due to design limitations, future replications of this study should be done to determine if a significant difference actually exists between technology-enhanced instruction and traditional lecture at producing gains in student cognitive achievement. If differences were found the field of agricultural education could have a stronger foundational standing for implementing technology-enhanced instruction in the classroom. Such findings could impact the methods used in current and future classroom settings.

When replicating this study in the future, researchers should include larger samples to ensure a more uniform, representative sample is measured. Future studies should examine the implementation of more in-depth and/or expansive lessons with more specific instruments of varying difficulties. More expansive lessons would also allow the researcher to separately analyze low-level and high-level question achievement between traditional and technology-enhanced groups. Although the principles of operation and carburetion cognitive achievement instruments were composed of questions of various difficulties, data were not analyzed within these constructs. A qualitative approach to gathering student perceptions may reveal the subjects' detailed perceptions when comparing traditional lecture to technology-enhanced instruction. Consistent findings on student interest in technology-enhanced instruction help to govern teachers' investment of time and the educational finances required in supplying technology in the classroom.

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