

2017

Assessing the Effects of the Smartphone as a Learning Tool on the Academic Achievement and Motivation of High School Agriculture Students in Louisiana

Henry Eric Smith

Louisiana State University and Agricultural and Mechanical College

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_dissertations



Part of the [Human Resources Management Commons](#)

Recommended Citation

Smith, Henry Eric, "Assessing the Effects of the Smartphone as a Learning Tool on the Academic Achievement and Motivation of High School Agriculture Students in Louisiana" (2017). *LSU Doctoral Dissertations*. 4222.

https://digitalcommons.lsu.edu/gradschool_dissertations/4222

This Dissertation is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Doctoral Dissertations by an authorized graduate school editor of LSU Digital Commons. For more information, please contact gradetd@lsu.edu.

ASSESSING THE EFFECTS OF THE SMARTPHONE AS A LEARNING TOOL
ON THE ACADEMIC ACHIEVEMENT AND MOTIVATION
OF HIGH SCHOOL AGRICULTURE STUDENTS IN LOUISIANA

A Dissertation

Submitted to the Graduate Faculty of
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
Requirements for the degree of
Doctor of Philosophy

in

The School of Human Resource Education
and Workforce Development

By

Henry Eric Smith

B.S. Industrial Technology, Northwestern State University, 2001

M. Ed. Agricultural Education, Louisiana Tech University, 2006

May 2017

This work is dedicated to Angela Tynette Smith (August 25, 1971 - June 17, 1995).

ACKNOWLEDGEMENTS

This massive academic exercise would not have been completed without the help of my committee. I wish to thank Joey Blackburn and Kristin Stair for revising and re-revising every page. I would also like to thank Michael Burnett and Satish Verma for their guidance in the experimental design. Furthermore, I would like to thank Eugene Kennedy for his guidance with the statistical analysis.

My parents are deserving of acknowledgement. Thank you for teaching me the importance of determination, relationships, and hard work. Furthermore, I want to thank Connor for always being positive in every situation and Kinley for being energetic beyond belief. Both of you have my deepest love. Most importantly, I cannot begin to thank my wife Kathy enough for the sacrifice she has made for me to reach this point in my life. You are my best friend.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS	iii
ABSTRACT	v
CHAPTER 1: INTRODUCTION	1
CHAPTER 2: REVIEW OF LITERATURE	17
CHAPTER 3: METHOD	44
CHAPTER 4: RESULTS	69
CHAPTER 5: CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS	85
REFERENCES	111
APPENDICES	129
VITA	283

ABSTRACT

Perhaps the most influential device in modern society is the smartphone. Over 90% of Americans aged 18-29 own a smartphone and 74% of teenagers reported using a smartphone as their primary internet connection. Students perceived that using smartphones in the classroom aided learning. However, two-thirds of American high schools ban students from using phones in the classroom. Secondary science curriculum focuses on subjects that regard the biodiversity of plant and animal species, but disregard the student's ability to identify species. Consequently, secondary students in general are very poor at identifying species of trees. Previous research supports the idea that advanced smartphone applications in student centered learning environments can improve achievement and motivation. There is little in the agricultural education literature pertaining to smartphone enhanced learning among secondary agriculture students. Further, no research has focused on the use of smartphone applications in forestry education at the secondary level. This dual-purpose study compared achievement levels between two groups of students in a forestry curriculum learning with smartphones or printed materials and determined motivational differences between groups. Specifically, one group of students used the smartphone apps Leafsnap, V-Tree, Tree Book, and Quizlet to identify leaf samples while a comparison group utilized *Leaf Key to Common Trees of Louisiana* (Dozier & Mills, 2005), *Important Forest Trees of the Eastern United States* (Brockman & Merrilees, 1991), and *Louisiana Trees* (Hodges, Evans & Garnett, 2015). A non-equivalent comparison group design was employed. Secondary agricultural students (n = 263) from 13 schools across Louisiana completed a criterion referenced pretest and post-test created by the researcher via Test Generator Web[®]. Motivation was measured using the Course Interest Survey (Keller, 2010). Data were analyzed using Hierarchical Linear Modelling (HLM) for fixed effects with maximum

likelihood estimation to determine if any statistically significant differences existed between the groups in achievement or motivation. HLM accounted for differences between individual students in schools and prior knowledge. The analysis rendered no statistically significant differences between the groups in achievement or motivation. It was concluded that smartphones do not reduce learning and should be considered a learning enabler in agricultural education where policy permits.

CHAPTER 1: INTRODUCTION

Background

In 2009, United States Secretary of Education, Arne Duncan, addressed members of Congress in a letter which called for “applying the advanced technologies used in our daily personal and professional lives to the entire education system to improve student learning” (U.S. Department of Education, Office of Educational Technology, 2010, p. v). The device that has been most often used in American personal and professional life is the smartphone. Smartphones have become the leading device for information and communication technology (ICT) among American teenagers (Pew Research Center, 2015) because in one small device they can talk, text, email, record video, send pictures, check social media, play games, and watch movies (Smith, 2011). Kaku (2011) posited smartphones of today have more advanced technology than NASA had in 1969 during the moon landing. Between 1981 and the present, wireless network speed increased exponentially from first generation analog (1G) to fourth generation long term evolution (4G LTE) (Sharma, 2013). Demand for smartphones increased because they continued to become more powerful and less expensive over a relatively short period of time (Shuler, 2009). Smartphones are so intertwined in American culture that an overwhelming majority reported their smartphone as being indispensable (Chen & Katz, 2009). The most current data shows that 92% of Americans between the ages of 18 and 29 own a smartphone (Pew Research Center, 2017) and 73% of all teens reported access to a smartphone (Pew Research Center, 2015).

Approximately 69% of school districts in the United States currently ban mobile phones in the classroom (Commonsense Media, 2010). However, bans did not effectively stop students from bringing their devices to schools. Students reported that even though they go to a school

with a ban on cell phones, 65% carry them anyway (Lenhart, Ling, Campbell & Purcell, 2010). The 1:1 classroom initiative referred to a computer for each child and began in 2005 when Maine became the first state to fund a laptop for each child to personally own (Norris, Hossain, & Soloway, 2011). Longitudinal studies in 1:1 classrooms report student gains in knowledge and motivation (Keane & Keane, 2016). Ineffective bans on cell phones by schools (Lenhart, et al., 2010) coupled with cost savings advantages ushered a trend dubbed Bring Your Own Device (BYOD) into American high schools (Burns-Sardone, 2014). This personally owned model of 1:1 borrowed from the business world was based on demand from parents for underfunded schools to embrace 21st century mobile technology (Norris, Hossain, & Soloway, 2011). BYOD schools are not burdened with the financial responsibility to provide every student with a laptop or tablet (Norris, Hossain, & Soloway, 2011). This model has allowed students to use their own personal smartphones and tablets for learning (Ullman, 2010). BYOD has shown promise in learning and instruction because it was a more affordable way to achieve a 1:1 student to computer ratio (Norris et al., 2011).

The Evolution of the Cellular Phone

The humble beginning of wireless telephony was ship to ship radio communication for passengers which began more than a hundred years ago (Comer, & Wikle, 2008). Bulky radio telephones, called CB radios, made their way into police cars in the 1930's and eventually were made available for sale to the public in the 1950's (Comer, & Wikle, 2008). Design improvements in size and weight made for more usage of the phone away from automobiles (Comer, & Wikle, 2008). These first portables, called bag phones in the U.S., sparked a trend toward smaller phones (Comer, & Wikle, 2008). In 1984, Motorola introduced the 800-g DynaTAC handset phone (Comer, & Wikle, 2008). Throughout the next two decades several

companies entered the race for smaller, lighter, and more capable mobile phones (Comer, & Wikle, 2008).

The Social Construction of Technology Theory suggested that society and technology influence change, adoption, fulfillment, and needs in one another (Laskin & Avena, 2015). The desire to communicate while away from home was the original societal need cellular phone technology fulfilled (Laskin & Avena, 2015). Cellular phone purchases by American parents for their children followed normal diffusion rates between 1995 and 2001 (Rogers, 2010; Laskin, & Avena, 2015). However, nationally televised tragedies such as the Columbine high school shooting and the terrorist attacks of September 11, 2001 added an extra layer of safety concerns for parents (Obringer & Coffey, 2007). As a result, an adaptive change in parenting ensued as increasingly, parents desired constant contact with their children (Obringer & Coffey, 2007). As a result, parents began purchasing cell phones for their children at increasing rates at the turn of the century (Obringer & Coffey, 2007).

Cellular devices is perhaps the most remarkable technology in terms of worldwide adoption (Comer, & Wikle, 2008). In 2005, there were almost a billion more cellular subscriptions than landline telephone connections (Comer, & Wikle, 2008). Further, sales of smartphones surpassed sales of laptops in 2007 and more people browsed the internet via cellular phone than traditional computers (Romero, 2011). In the most recent decade, information and communication technology (ICT) experienced rapid developments lead by the internet capable cellular device named the smartphone (Christin, Tamin, Santosa, & Miharja, 2014). The smartphone has changed our daily lives more than any other technology in the past decade (Romero, 2011). The smartphone incorporated all the capabilities from music players, cameras,

televisions, Global Positioning Systems, remote controls, gaming consoles, personal computers, and even replaced routers by becoming wi-fi hotspots (Romero, 2011).

The Ericson Mobility Report to the Mobile World Congress (2015), reported it took five years for smartphone subscriptions to reach the first billion customers, a milestone that was reached in 2012. The report added that it only took two more years to reach the second billion smartphone subscribers. The Ericson report further predicted that in 2020, there would be 5.4 billion mobile broadband subscriptions, which translates to 90% of all cellular phone subscriptions.

Smartphone Use in Formal Education Settings

Despite the popularity of smartphones, there are still restrictions on their use, especially in secondary education (Laskin, & Avena, 2015). Most high schools ban smartphones while university policies allowed student use at the instructor's discretion (McCoy, 2013). College students drove the adoption of smartphones in higher education, convinced that technology improved learning (Gikas, & Grant, 2013). Most high school aged students share the same argument (Lenhart et al., 2010). One exploratory study on student perception concluded that six out of ten students believed mobile devices positively influenced their academic success (Gikas, & Grant, 2013). However, not all students used their phones for learning while in class (McCoy, 2013). In one study, college students reported spending 42% of their time on their mobile devices updating Facebook and playing games while in class (Laskin, & Avena, 2015). McCoy (2013) reported that students take up as much as 20% of lecture time on their phones for purposes unrelated to the lesson.

People born after 1980 are designated digital natives (Williams, et. al 2014; Prensky, 2001) because they grew up with technology, while digital immigrants, born prior to 1980, did

not grow up using digital echnology (Laskin, & Avena, 2015). Some digital immigrants viewed smartphones in the classroom as a distraction, opportunity for theft/heinous behavior, or simply a mode for entertainment (Laskin, & Avena, 2015). In secondary education, cheating was a concern of both teachers and students as 35% of students reported using their phones for cheating (Commonsense, 2010; Thomas & Muñoz, 2016). Unsurprisingly, the typical education administrations' response to mobile devices in the classroom is to ban them (Laskin, & Avena, 2015; Keengwe, Schnellert, & Jonas 2014). With the rapid development of the technology, some educators feel intimidated to incorporate applications they do not fully understand (Laskin, & Avena, 2015). However, O'Bannon and Thomas (2014) found that teacher's attitude towards the use of cell phones in the classroom has shifted. As a growing number of digital natives become classroom teachers, willingness to incorporate smartphones inside the classroom is on the rise (O'Bannon & Thomas, 2014). Therefore, the goal of educators should be to use students' passion towards smartphones to improve academic performance (Laskin & Avena, 2015).

Educational Technology Integration in Agricultural Education

Thomas & Muñoz (2016) conducted a study that identified which popular smartphone technologies were being utilized by teachers and students. They discovered the most often used smartphone technologies in classrooms were basic core technologies such as accessing the internet, calculator, clock, and calendar rather than advanced applications. Studies that measured achievement gains when comparing teaching with smartphones to traditional methods vary (Liu, Scordino, Renata, Navarrete, Yujung, & Lim, 2015; Liu & Huang, 2015; Su & Cheng, 2015). A very small portion of students used more advanced functions of their smartphones for developing 21st century skills such as creating content, posting content online, or recording audio/video (Bennett, Maton, & Kervin, 2008; Ertmer and Otterbein- Leftwich, 2010; Thomas & Obannon,

2014). However, empirical research findings have indicated that when more advanced applications of smartphones are applied in teaching and learning achievement gains are significant and students are more motivated to learn (Liu et al., 2015; Su & Cheng, 2015).

Several important studies have described how educational technology was implemented into secondary agricultural education. One study sampled 203 Louisiana agriculture teachers using the Kotrlik-Redmann Technology Integration Model (Kotrlik, Redmann & Douglas, 2003). Results of the study indicated that agriculture teachers in Louisiana were successfully using basic technology such as email, but were not fully incorporating technology into their curriculum. Significant predictors of technology integration were the teacher's own belief in their teaching effectiveness, computer anxiety, and teachers' perceived barriers to technology integration. Five years later, a follow-up study by Kotrlik and Redmann (2009) found that far more technology integration had taken place in Louisiana agriscience programs. Computer anxiety scores among the agriculture teachers collectively had decreased, internet availability had increased, and perceived barriers were smaller. Williams, Warner, Flowers, and Croom (2014) found that North Carolina secondary agriculture teachers used projectors, laptops, and desktop computer hardware most frequently. The software used most frequently by agriscience teachers were internet browsers, word processors, grading/attendance software, and presentation software (Williams et al., 2014; Coley, Warner, Stair, Flowers & Croom, 2015). Notably, more advanced hardware like student response clickers and iPads for teaching/learning were reported as not readily available (Williams et al., 2014; Coley et al., 2015). The use of advanced technology in agricultural education programs related to the development of 21st century skills (Ertmer & Otterbein-Leftwich, 2010) including contributing to blogs, using social media, creating movies, art and webcasts were rarely reported (Williams et al., 2014). Students most frequently used computers

and the internet at a basic skill level to develop presentations or conduct research (Williams et al., 2014).

The Importance of Forestry Education in Louisiana Agriscience Programs

Trees have always Louisiana's number one agricultural plant crop (LSU Agcenter, 2014). In 2014 alone, the Louisiana forestry industry employed 45,600 people with a total earnings estimate of \$2.67 billion dollars (LSU Agcenter, 2014). That accounts for almost 40% of total value of Louisiana's entire agricultural industry and 65% of the states total plant agricultural revenue (LSU Agcenter, 2014). About 50% of the state total land base is forested with 59 of 64 parishes sustainably producing southern yellow pine and hardwood timber (LSU Agcenter, 2014).

Agricultural education consists of three components: classroom, Supervised Agriculture Education (SAE) program and the National FFA Organization (Phipps, Osborne, Dyer, & Ball 2008). Louisiana secondary agriculture teachers have the local option to teach forestry as a stand-alone half credit course, or included within Agriculture I, II or III courses (Louisiana Department of Education, 2003). Through the National FFA Organization, students can compete in the Forestry Career Development Event (CDE) (Phipps, et al. 2008). Louisiana has traditionally competed well at the national level with a notable national runner up placing in 2013 and national reserve champion in 2014 (National FFA Organization, 2014). Tree identification was paramount to success in forestry competitions and was accepted as a skill of priority for all forestry related industries (Burton, 2010).

Foundational skills in plant species identification are stepping stones to higher understanding but are neglected in primary schools (Bebbington, 2005). Tree identification is a foundational skill in any forestry related career, but it often gets overlooked in secondary

education (Burton, L.D. 2000; Randler, 2008). Research suggested that students have a large capacity for identification (Balmford, Clegg, Coulson, & Taylor 2002). This capacity for identification is not likely focused on the natural world. For example, one study revealed that eight year olds recognized 80% of Pokemon characters but less than 50% of wildlife type's native to their area (Balmford et al., 2002). Middle and high school core curriculums overlook identification of species, yet more complex ideas about relationships between species are often assessed on high stakes tests (Randler, 2008; Bebbington, 2005). Secondary curriculum for studies in biology, ecology, botany, and wildlife are focused on subjects that regard the biodiversity of plant and animal species, but disregard the student's ability to identify species of plant and animals (Randler, 2008). Consequently, secondary students in general are very poor at identifying various species, including trees (Randler, 2008; Bebbington, 2005). This deficiency in tree identification knowledge belonging to secondary students warranted the experimentation of modern tree identification teaching methods (Randler, 2008; Bebbington, 2005).

Statement of the Problem and Significance

Today, millennials rely heavily on technology to study and learn as they have grown up with an iPad® and smartphone in their hands (Prensky, 2001). Digital native students have been perceived as an academically driven group who required an updated classroom lead by a skilled teacher armed with the most recent educational technology available (Williams et al., 2014). Because of this, teaching millennial students has often challenged instructors to employ new strategies. Millennial students have tended to prefer student-centered teaching rather than lecture-based teaching methods and they preferred using smartphones as learning enablers (Williams, et al., 2014; Su & Cheng, 2015). Further, in some studies, smartphones in the classroom led to increased student achievement (Liu et al., 2015). Students have demonstrated more comprehension when the most advanced functions of mobile devices were utilized

consistently in the learning process (Liu et al., 2015). Young people preferred using their phones for internet access rather than other computing devices. One study reported that 74% of teenagers used their smartphone as their primary internet access (Madden, Lenhart, Duggan, Cortesi, & Gasser, 2013). Lastly, millennial students were motivated by cutting edge uses of smartphone technologies that allowed them to be creative (Su & Cheng, 2015).

Past studies have been conducted to determine which types of educational technology agricultural educators utilized (Coley et al., 2015; Kotrlik & Redmann, 2009; Williams et al., 2014). Most teachers used teacher-centered technology that aided lecturing such as laptops, desktop computers, digital projectors, and PowerPoint (Coley et al., 2015; Kotrlik & Redmann, 2009; Williams, et. al 2014). Additionally, research has shown teachers also need training to effectively employ educational technologies. An overwhelming majority (95.5%) of Louisiana agriculture teachers claimed they were self-taught in terms of technology use (Kotrlik & Redmann, 2009). Additionally, age and experience shows effects towards teacher attitudes on the usefulness of technology (Stewart, Antonenko, Robinson, & Mwavita, 2013). Experienced teachers reported technology as a way to improve achievement and engagement while younger teachers reported that technology best aids in classroom management (Stewart et al., 2013).

Research has shown the availability of technology does not necessarily translate into maximized integration of technology (Coley et al., 2015). Mindset and attitude towards the usefulness of the technology was a determining factor of agriculture teachers implementing it into their teaching (Cullen & Green, 2011). Competency studies have identified the need for agriculture teachers to receive professional development that will train them on utilization of advanced technologies and help overcome second level barriers (Bunch, Robinson, Edwards, & Antonenko, 2014; Coley et al., 2015; Williams et al., 2014). Positive attitudes about technology

and high teacher motivation are two variables highly related to technology integration in agriculture classrooms (Kotrlik & Redmann, 2009).

There is little in the agricultural education literature pertaining to smartphone enhanced learning among secondary agriculture students. Additionally, no research has focused on the use of smartphone applications in forestry education at the secondary level. Furthermore, little is known about how teaching a forestry curriculum with advanced smartphone tools would affect student achievement in leaf identification. Lastly, little is known as to how teaching with smartphones in the context of leaf identification would affect student motivation. Therefore, the principle question that arose from the literature was what effect does smartphone teaching methods have on Louisiana high school agriculture student achievement for students engaged in a leaf identification unit? Furthermore, do smartphones increase student learning motivation?

Purpose of the Study

This dual-purpose study (a) compared achievement levels between two groups of students in a forestry curriculum learning with smartphones or with printed materials and (b) determined motivational differences between those groups. The following research questions guided the study:

1. What are the personal and educational characteristics of students enrolled in agriculture courses offering a forestry curriculum in Louisiana?
2. What difference existed in pretest and post-test leaf ID scores between students learning through smartphone technology and students learning through printed materials?
3. What differences existed in student motivation (e.g., Attention, Relevance, Confidence, Satisfaction, and Motivation) between students learning through smartphone technology and students learning through printed materials?

Null Hypotheses

Ho1: There were no statistically significant differences in leaf ID pretest and post-test scores between students learning through smartphones and students learning through printed materials.

$$(\mu 1 \text{ Smartphone} = \mu 2 \text{ Printed Materials})$$

Ho2: There were no statistically significant differences in Attention between students learning through smartphones and students learning through printed materials.

$$(\mu 1 \text{ Smartphone} = \mu 2 \text{ Printed Materials})$$

Ho3: There were no statistically significant differences in Relevance between students learning through smartphones and students learning through printed materials.

$$(\mu 1 \text{ Smartphone} = \mu 2 \text{ Printed Materials})$$

Ho4: There were no statistically significant differences in Confidence between students learning through smartphones and students learning through printed materials.

$$(\mu 1 \text{ Smartphone} = \mu 2 \text{ Printed Materials})$$

Ho5: There were no statistically significant differences in Satisfaction between students learning through smartphones and students learning through printed materials.

$$(\mu 1 \text{ Smartphone} = \mu 2 \text{ Printed Materials})$$

Ho6: There were no statistically significant differences in Motivation between students learning through smartphones and students learning through printed materials.

$$(\mu 1 \text{ Smartphone} = \mu 2 \text{ Printed Materials})$$

Scope of the Study

Agriculture teachers ($n = 155$) were surveyed during FFA leadership camps in July 2016. Bulletin 741 required that all secondary Louisiana agricultural educators attend summer camp in order to maintain 12 month employment status. Teachers were surveyed for demographic data,

information pertaining to their school board policy on smartphone use in schools, forestry teaching competency, and teacher attitudes towards smartphones as an educational tool. As an attempt to reduce teacher effect, teachers who had little or no experience teaching leaf identification were purposefully asked to participate in the experiment. Twenty-two teachers who volunteered to participate in this study served in a one day workshop pertaining to the identification of Louisiana trees at the Louisiana Agriscience Teachers Association annual conference in Vidalia, Louisiana on July 26, 2016. This study sample was comprised of 263 secondary agriculture students from 13 different Louisiana high schools.

Seven teachers taught the treatment group students and participated in a second workshop in August focused on using smartphones as a leaf identifier with the mobile apps: Leafsnap, V-tree and Tree book. The formative assessment application called Quizlet was also part of the training. Teachers were trained how to create a Quizlet account and join the leaf identification class their students would use for formative assessments.

Six teachers taught the control group students and participated in a second workshop where they learned how to teach tree identification using printed field manuals. These manuals were: *Leaf Key* printed by the LSU Agcenter, *Important trees of the Eastern United States* produced by the U.S. Forest Service, and *Louisiana Trees* produced by the Natural Resource Conservation Service (NRCS).

Both groups were also taught how to log-in to Test Generator Web[®], a web-based testing service owned and operated by Fain and Company[®], used for the pretests and post-tests. Both groups were provided strategies to allow students to use the resources independently for tree identification. The teacher was to provide facilitation, but not tree identification expertise. Further training involved the use of formative assessments using both technology and paper

based methods, depending on the group, to master identifying the 30 species chosen by the researcher for this experiment. Both groups were given researcher created lesson plans, color photocopies of the leaf species collected by the researcher (see Appendix G), and index cards with the tree names printed on them. Student participants were enrolled in an agriculture course offering a forestry unit taught by a teacher who attended the training seminar(s) in the academic year 2016–2017. In all, 263 students participated in the study in which 128 received the treatment and 135 were in the comparison group. Data were collected between September 19th and September 29th, 2016.

Assumptions

The following assumptions were made regarding this study:

1. Students performed to the best of their ability when participating in the lessons.
2. Students performed to the best of their ability when completing the tests.
3. Teachers presented the lessons as they were intended by the researcher.
4. Teachers in the control group did not use any mobile based computing technology to teach leaf identification or take formative quizzes.
5. Treatment group teachers allowed their students to utilize smartphones every day of the experiment to identify trees and take formative quizzes.
6. Treatment and control group teachers did not discuss the experiment before or during its implementation.
7. Students preferred student-centered learning rather than teacher-centered learning.

Delimitations

A purposeful sample of teachers was chosen based on preliminary data collected during leadership camp in July of 2016. The last question of the survey allowed teachers to leave contact information if they wished to participate in the study. Those who left contact information were invited to the initial training and became the sample.

Limitations

The following limitations should be considered:

1. Full power of random assignment was not utilized to select participating schools; therefore generalizability cannot extend beyond the participants in the study.
2. Variability, such as competence/interest in forestry or time of day forestry was taught, may have existed between schools in the study. Teacher effect may also be a limitation as factors such as years of experience, enthusiasm, and knowledge about forestry may have impacted teacher performance.
3. Non-treatment related variability, such as student background, prior knowledge or some other construct may have existed between the treatment and comparison groups.

Definitions of Terms

Agricultural Education is the teaching of agriculture, natural resources, agri-business and leadership through hands on experience and guidance to prepare students for entry level jobs, post-secondary education or advanced agricultural employment (Phipps, et al. 2008).

Cognitive learning theory emphasizes mental models and metacognitive processes that project the expert view. Linked to the creation of tutorial software (Anderson, Corbett, Koedinger and Pelletier, 1995).

Computer Based Assessments (CBA) is the full use of multimedia to deliver assessments that allow feedback and space/time flexibility (Kim, 2015).

Forestry is the science of planting and managing forests for specific purposes such as timber production, conservation and recreation (Burton, 2000).

Formative Assessment is carried out during the learning process which intends to provide students with an opportunity for feedback that in turn enables them to improve on subsequent tasks. Furthermore, it allows the instructor to assess where the students are at in terms of comprehension (Jiao, 2015; Lavene & Seabury, 2015).

Guided inquiry learning is a constructivist based, student-centered, learning method whereby students discover answers through exploration of meaningful questions. In guided inquiry the teacher's role is to stimulate inquisitiveness rather than dispense knowledge (Kuhlthau, Maniotes & Caspari, 2015).

Hierarchical Linear Model (HLM) is a statistical technique that permits the modeling of multilevel differences encountered in individuals and schools (Raudenbush & Bryk, 1986).

Mobile Learning (m-learning) learning that happens when a learner takes advantage of opportunities offered by mobile technology (O'Malley, Vavoula, Glew, Taylor, Shaples, & Lefrere, 2003).

Scaffolding the teaching (explanation) technique where an expert facilitates a learners transition from assisted to independent execution (Ozan, 2013; Berk & Winsler 1995 & Vygotsky 1986).

Smartphone is phone built on a mobile operating system with more advanced capabilities and connectivity than a regular cellular phone (Seneca, 2013).

Summative Assessment test given at the outcome of a unit of teaching in order to evaluate student learning (Kim, 2015).

Test Generator online test-making software designed to help streamline the process of test creation, delivery and administration to generating reports and analyzing results (Fain, 2016).

CHAPTER 2: REVIEW OF LITERATURE

Introduction

Chapter II is composed of related literature addressing the impact of smartphones as an instructional delivery aid on student achievement and motivation in regards to agricultural education. The review has been divided into the following sections: (a) Purpose of Secondary Agricultural Education, (b) Student-centered Teaching and Learning (c) Smartphone Enhanced Learning (d) Motivation (e) Theoretical Framework, and (f) Conceptual framework.

Purpose of Secondary Agricultural Education

History of American Agricultural Education

In 1794, the Philadelphia Society for Promoting Agriculture lobbied for legislation in Pennsylvania that would fund a “state society for the promotion of agriculture and connecting it with the education of youth” (True, 1929, p. 8). Although that particular bill failed, it was but one example of early attempts by agricultural societies in America to get agricultural education established (True, 1929). Manual labor schools and agricultural academies dotted the landscape of the Northeastern United States during the early 1800’s (True, 1929). Research pertaining to agricultural education soon followed. The first appropriation for publishing articles on agricultural education that congress ever passed was in 1839 (True, 1929). Adequate funding became agricultural education’s greatest need in the middle of the 19th century. Justin Smith Morrill authored the first land-grant bill meant to provide facilities and funding for colleges of agriculture in 1857 (True, 1929). The need for farmers to receive applied scientific research stimulated the passage of the Hatch Act into law in 1887 (Hillison, 1996). This act provided federal funding for agriculture research stations within the land-grant college system (Hillison, 1996). Between 1881 and 1889 private and state funded agricultural schools were established in

Connecticut, Rhode Island and Alabama (True, 1929) and various types of secondary agriculture classes were being taught (Foor & Connors, 2010; Stimson & Lathrop, 1942). During this time, corn clubs aimed at stimulating agriculture education in public schools began to spread (Uricchio, Moore & Coley 2013). It was the passage of the Vocational Education (Smith-Hughes) Act of 1917 led by Charles Prosser that secured federal funding to train supervisors, directors, and teachers of vocational agriculture (Foor & Connors, 2010; Roberts & Ball, 2011). A dichotomy in philosophy towards the purpose of secondary vocational education existed between educational leaders at the time (Roberts & Ball, 2009). David Snedden and Charles Prosser supported social efficiency (Gordon, 2003) and argued public vocational education should train youth in specialized industrial skills in order to ensure gainful employment for the average graduate (Snedden, 1910). John Dewey contradicted Snedden publicly and argued vocational education be blended with academics to facilitate lifelong learning and well-rounded graduates (Roberts & Ball, 2011).

The Smith-Hughes Act of 1917 funded state systems to train secondary students whose purpose was to learn practical skills to be used in farming (Stimson & Lathrop, 1942). Prior to the passage of the Smith-Hughes Act, agricultural education in secondary settings was more academic in nature and often a pathway to admission into the local land-grant college (Stimson & Lathrop, 1942). The influence Snedden had with policy makers (Roberts & Ball, 2011) impacted the language of the Smith-Hughes Act and granted oversight of agricultural education to the Federal Board of Vocational Education (Hillison, 1996). This resulted in a perceived loss of emphasis on academics in agricultural coursework and gave prominence to skills training in vocational agriculture classes (Hillison, 1996). For the next five decades vocational agriculture

departments trained the workforce that would make America the global leader in food production (Conroy, Dailey, & Shelley-Tolbert, 2000).

During the 1980's and early 1990's, shifts towards integrating science and technology into agricultural education reflected the evolution of the agricultural industry and governmental influence on educational policy (Balschweid & Thompson, 2002). Agents of this change included the National Commission on Excellence in Education (NCEE), the U.S. Department of Labor Secretary's Commission on Achieving Necessary Skills (SCANS) report, and the National Research Council (Balschweid & Thompson, 2002). Following this trend, the 1983 publication *A Nation at Risk* called for a requirement that all graduating high school students receive credit in computer science (NCEE, 1983). Similarly, *Understanding Agriculture: New directions for Education* called for integration of science into agricultural education in order to prepare students for the broadening demands of the agricultural industry which had become decreasingly farm related (NRC, 1988). The United States Department of Labor identified (a) resources, (b) interpersonal skills, (c) information skills, (d) system skills and (e) technology utilization skills as five necessary competencies for the workplace (SCANS, 1991). Chairman William E. Brock stated "our mission must be to bring the progressive forces of this country to bear on those changes in public education which would allow us to meet the stated objectives" (SCANS, 1991).

The demand for technology literacy ushered in even more changes. The No Child Left Behind (NCLB) Act of 2001 included recommendations for technology literacy courses to eighth grade students and frequently referred to technology as an important enabler for teacher effectiveness and student achievement across curricula (Culp, Honey, & Mandinach 2005). A study group for the National Association of the State Boards of Education (NASBE) advocated

acceptance of electronic learning (e-learning) nationwide (NASBE, 2001). Essential funding necessary for postsecondary and secondary agricultural education departments in 44 states to obtain educational technology since NCLB largely came from the Carl D. Perkins Vocational and Technical education Act of 1998 (USDE, 2005).

History of Louisiana Agricultural Education

The first mention of an agricultural education curriculum in Louisiana high schools came in 1904 at an educational conference by the state Superintendent of Education James B. Aswell (Stimson & Lathrop, 1942). Later, the superintendent of Avoyelles parish schools, Dr. V.L. Roy, was appointed inspector of agriculture in Louisiana public schools (Stimson & Lathrop, 1942). Between 1905 and 1910, Dr. Roy enrolled nearly 6,000 boys in corn clubs in 45 parishes. Each boy was expected to farm an acre of land in corn under the supervision of an expert (Stimson & Lathrop, 1942). In order for a high school to offer agriculture courses they needed (a) five fenced acres of land, (b) a barn with five stalls, (c) science lab facilities, (d) tools, (e) a \$250 appropriation, and (f) approval from Dr. Roy (Stimson & Lathrop, 1942). Professor Roy limited the number of high school programs to twenty initially (Stimson & Lathrop, 1942). However, in 1910 the legislature approved \$25,000 for the development of agriculture departments in high schools across the state (Stimson & Lathrop, 1942). The State Director of Agriculture Extension, E. S. Richardson was tasked with developing a curriculum and overseeing the creation of the departments (Stimson & Lathrop, 1942).

Passage of the Smith Hughes Act in 1917 funded 16 white and five African-American agriculture departments in Louisiana and resulted in a total enrollment of 323 boys (Stimson & Lathrop, 1942). In 1940, those numbers had grown to 205 white departments and 77 African-American agriculture departments with a total enrollment of 10,801 boys taking daily

coursework in agriculture (Stimson & Lathrop, 1942). Louisiana State University initiated a teacher training department in 1917 with J. G. Lee junior as the first teacher trainer on record (Stimson & Lathrop, 1942).

The first FFA chapters were formed in 1927 at Benton and Eunice (Stimson & Lathrop, 1942). These chapters were called the Future Pelican Farmers and were much like the organization for farm boys in Virginia created by Henry Groseclose (Stimson & Lathrop, 1942). In 1929, Louisiana received charter number 44 from the National FFA organization and elected officers for the upcoming year (Stimson & Lathrop, 1942). Currently, Louisiana has 188 FFA chapters with approximately 9,800 active FFA members taught by 244 FFA advisors (Louisiana FFA, 2016).

Forestry Curriculum in Louisiana Agricultural Education

The Louisiana Board of Elementary and Secondary Education (B.E.S.E) is the states' educational legislative body that enacts educational policies and regulations and hosts the most recent agricultural curriculum framework for Louisiana. Bulletin 106 (2003) is a restructuring of the Louisiana Agriscience/FFA program inspired by the National Governors Association, *A Nation at Risk* (1983), *Understanding Agriculture: New Directions for Education* (1988) and *Agricultural Education for the Year 2020*. Other projects such as the Southern Region Education Board's *High Schools that Work*, school to career legislation, and national education reform efforts initiated changes to the curriculum from an emphasis on learning about agriculture by lecture and reading, to learning about agriculture through inquiry and investigation. Furthermore, Bulletin 106 emphasized integrating science and agriculture, as well as viewing teachers as facilitators of learning, primary curriculum developers, and change agents (Louisiana Department of Education, Bulletin 106, 2003).

Under Bulletin 106 (LA D.O.E., 2003) Forestry is cross-referenced with environmental management standards. This benchmark directed teachers to focus on (a) tree identification of major species used in industry, (b) forest management (i.e. insects, fire, disease, laws), (c) forest products, (d) harvesting, (e) reforestation, and (f) measurement of land and timber. The curriculum for the stand alone Forestry course requires additional units in forest ecology, wildlife, job seeking skills, and pulp/paper products (LA D.O.E., 2003). Overall, there are twelve units of instruction which include a content guide for each unit in this curriculum. All units are aligned with standards in agricultural literacy, personal development, agribusiness, biotechnology, animal systems, plant systems, environmental management, agricultural processing and agricultural technology (LA D.O.E., 2003).

Tree Species Identification

Knowledge of trees that are of commercial, aesthetic, or wildlife value is an important component if the value of forestry to the state's economy is to be realized (Louisiana FFA, 2016). Furthermore, tree identification is a basic skill that leads to more advanced studies in the plant sciences (Dozier & Mills, 2005). However, the foundational role of tree identification often gets overlooked for more advanced topics, and most secondary environmental science coursework is focused on higher order skills pertaining to biodiversity, genetics, ecology, and evolution (Randler, 2008). Identifying tree species is based on patterns in leaf characteristics, bark, tree silhouette, and flowers with the most classroom friendly of these parameters being leaf characteristics (Burton, 2010).

All leaves can be categorized into simple, compound, or needle/scale type (Dozier & Mills, 2005; Burton, 2000). Simple leaves consist of a single blade, a single petiole, and are arranged in either an alternating, opposite, or whorled arrangement on the main stem (Dozier &

Mills, 2005; Burton, 2000). Compound broadleaf species carry more than one blade (three or more) arranged on a common stalk referred to as leaflets (Dozier & Mills, 2005; Burton, 2000). Leaflets can be arranged in several layouts including: evenly pinnate, oddly pinnate, or bi-pinnately (Dozier & Mills, 2005; Burton, 2000). Compound leaf arrangements can also be attached to the trees stem in alternating or opposite patterns (Dozier & Mills, 2005; Burton, L.D., 2000). Needle and scale like leaves are found on coniferous type species (Dozier & Mills, 2005; Burton, L.D., 2000) and cross section examination further reveals that some are flat, three angled or even cube (Dozier & Mills, 2005; Burton, 2000). Some needles have sharp points while others are dull (Burton, 2000).

Forest Industry Needs

Career and Technical Education (CTE) is tasked with filling the demand for skilled workers in the United States. The seminal report, *A Nation at Risk* (1983), is repeatedly credited with pointing out several problems in the U.S. educational system. The report suggested higher graduation standards are one of many reforms needed to stop America's educational decline on a global scale. A year later, the passage of the Carl D. Perkins Act of 1984 sparked more attention on research assessing vocational education effects on academic achievement. Large scale educational reforms including *No Child Left Behind*, the college for all movement, and the dichotomous classification of students as either being vocational or academic ensued (Aliaga, Kotamraju, & Stone III, 2014). Currently, 92% of American high school students have taken at least one CTE course, and 16% have taken at least three CTE courses with a career pathway identified on their diploma (Aliaga, Kotamraju, & Stone III, 2014).

Baby boomers are defined by those who were born between 1946 and 1964 (Neumark, Johnson, Mejia, 2013). Survey data from 2008 showed they comprised 38% of America's

workforce (Neumark, Johnson, Mejia, 2013). It has been hypothesized that the retirement of the baby boomer generation may slow the growth of skill levels in America's workforce (Neumark, Johnson, Mejia, 2013). In 20 states, there are a higher percentage of college educated retirement age workers (55-64) than young adults aged 25 to 34 (Neumark, Johnson, Mejia, 2013). Further, Louisiana has more college educated workers in the baby boomer generation than in the millennial generation (Neumark, Johnson, Mejia, 2013). This is counter factual with previous generations of replacement and retiring cohorts (Neumark, Johnson, Mejia, 2013). By the year 2018, it is estimated that the post-secondary system will supply three million fewer college graduates than the economy demands (Carnevale, Smith & Strohl, 2010). Growth in low level positions that only require a high school diploma or less are not projected to grow significantly (Carnevale, Smith & Strohl, 2010), with more than eight million workers available for only 200,000 low level positions in 2018 (Carnevale, Smith & Strohl, 2010).

As the citizens of the United States become increasingly conscience of the importance of preserving the natural environment, more jobs dealing with the conservation of natural resources will become available (Bureau of Labor Statistics, 2015). In the forestry sector, jobs are expected to increase by about seven percent over the next decade (Bureau of Labor Statistics, 2015), following normal expected gains for an industry (Bureau of Labor Statistics, 2015). Nationwide this will mean a total of 36,500 professional forester and conservation scientist positions will exist with an average salary of \$60,000 per year (Bureau of Labor Statistics, 2015). The starting educational level for these particular positions in the forestry sector is a bachelors degree (Bureau of Labor Statistics, 2015).

Student-Centered Teaching/Learning

Guided Inquiry

Guided inquiry is a constructivist learning approach that requires investigation by the learner to discover solutions for authentic problems (Kuhlthau, Maniotes & Caspari, 2015). This approach to learning became the hallmark to instructional reform, especially in science classrooms (Bell, Smetana & Binns, 2005). Guided inquiry lends itself to deeper understanding of concepts by building student confidence in their own abilities to teach themselves (Pedaste, Mäeots, Siiman, De Jong, Van Riesen, Kamp, & Tsourlidaki, 2015). Furthermore, guided inquiry has shown to fit well into blended learning environments that incorporate smartphones and other personal mobile technology (Kuhlthau, Maniotes & Caspari, 2015)

It is important for students to practice inquiry skills in order to gain confidence in their abilities to locate the best answers (Edelson, Gordin, & Pea, 1999). The beginning of success through exploration lies in the question itself (Kirschner, Sweller, & Clark, 2006). However, some scholars believe that basic questioning skills are deteriorating in American education (Leslie, 2014). As the Google[®] search engine becomes smarter, we all become more inadequate at asking good questions (Leslie, 2014). Often the key to overcoming this shortfall in inquiry was teacher guidance (Arends, 2014). Research has shown this approach works best when an entire faculty of teachers actively participate in the process (Pedaste et al., 2015). Findings from this research suggested that the learner must encounter guided inquiry in every class available at their school in order to realize sufficient gains (Pedaste et al., 2015). Guided inquiry scholars believe that systemic inquiry based teaching empowered students to separate good solutions from poor ones (Arends, 2014; Kuhlthau, Maniotes & Caspari, 2015).

Kuhlthau, Maniotes & Caspari, (2015) described the key to students giving their best effort is determining how to spark their interest. Their findings concluded students were highly motivated to answer questions that were meaningful to them (Leslie, 2014). To further student motivation, the most successful teachers maintained close relationships with their students which allowed them to help guide students to further understanding of complex notions (Kuhlthau, Maniotes & Caspari, 2015). The most successful guided inquiry practitioners build motivation to help student's experience deeper learning and overcome barriers (Edelson, Gordin, & Pea, 1999).

Technology can aid inquiry based learning. However, one barrier to technology in general was illustrated by a modern interpretation of Moore's law (Cumming, Furber, & Paul, 2014) which stated that technology continued to become outdated every 18 months. This rapid advancement of technology left people behind who were not conditioned to accept upgrading to newer innovation (Cumming, Furber, & Paul, 2014). The most useful solutions and resources, such as websites, that were once cutting edge, can quickly become obsolete (Kuhlthau, Maniotes & Caspari, 2015). Perhaps the greatest long term potential for the inquiry based learning approach is to condition students for technological evolution in school, work, and daily life (Kuhlthau, Maniotes & Caspari, 2015).

Formative Assessment

Inquiry based learning is improved when the instructor can quickly determine students' progress, offer feedback, and adjust teaching strategies. The most efficient way to accomplish this is through formative assessments (FA). Black and Wiliam (1998) provided an operational definition for formative assessment as "encompassing all activities undertaken by teachers, and/or by their students, which provide feedback to modify the activities in which they are engaged" (p 7-8). The Black and Wiliam (1998) analysis of formative assessment literature is

considered the pivotal study in the field; it has been cited over 7,000 times (Sly, 1999; Bell & Cowie, 2001; Buchanon 2000; Wininger, 2005; Ruiz-Primo & Furtak, 2006; Wang, 2007; Dunn & Mulvenon, 2009; Aldon & Dempsey, 2016; Townsend & Mulvey, 2016). The results of the study provided evidence that FA improved achievement (Dunn & Mulvenon, 2009). Several different types of research were included in the literature collected by Black and Wiliam (1998). Martinez and Martinez (1992) gave one summative test per chapter to a control group and three formative tests per chapter to a treatment group. The students who practiced formative assessments scored statistically significantly higher than those who only took summative tests. Fontana and Fernandez (1994) studied 254 Portuguese students with the treatment group belonging to teachers trained in daily self-assessment and a control group nested in teachers that were not. The daily self-assessment group outperformed the control group on summative assessments. One longitudinal study from San Francisco measured over 7,000 students in a period of 18 years of mastery teaching where students retested until they achieved a passing test grade. The results of that study conclude that learning through retesting is an effective way to prevent leaving students behind (Whiting, Van Burgh, & Render 1995).

Wiliam (2010) explained effective FA accomplished three goals: (a) diagnoses where students are now; (b) monitors where students are heading; and (c) directs students how to get there. Formative assessments that monitored and gave direction must communicate learning opportunities to the students. Feedback is one of the most important components in FA (Black & Wiliam, 1998; Wiliam, 2010). Wininger (2005) gave feedback on incorrect answers to one group of students and reported only incorrect answers to a control group. The students who received feedback achieved significant gains over the control group (Wininger, 2005). Wiliam (2010) described feedback in FA as prospective (like a medical diagnosis) and feedback on a

summative assessment as retrospective (like an autopsy). Further, Bell and Cowie (2001), stressed that feedback in FA must happen during instructional time. Immediate feedback was proven more conducive to learning than delayed feedback (Stiggins, 2002).

Formative assessments can give students the repetitions they need to make cognitive connections with learning material (Schmidmaier, Ebersbach, Schiller, Hege, Holzer, & Fischer, 2011). Studies have shown that repetitive test practice improved achievement (Schmidmaier et. al, 2011). Repetitive quizzing has been accepted more effective in short term knowledge retention than repetitive studying (Schmidmaier et. al, 2011). One dependent samples study supported the hypothesis that students experienced gains on web-based self-assessments through repetition (Velan, Rakesh, Mark, and Wakefield, 2002). Henly (2003) found students who scored in the top 10% on a unit test in nutrition had accessed online practice tests twice as often as the rest of the class.

FA delivered by technology became a rich source for research experimentation. In terms of early educational technology, Sly (1999) found significant achievement gains in an undergraduate economics course from students who chose to take practice exams online prior to summative assessment. Buchanon (2000) achieved similar results in voluntary online practice testing in psychology undergraduates. Wang (2007) developed an online formative assessment system that graded formative assessments and gave feedback to students immediately. When compared to a control group who took formative assessment with pen and paper, the online assessment system proved to be a better model for learning (Wang, 2007).

Smartphones became a standard teaching tool and a preferred delivery method for FA strategies in language acquisition (Townsend & Mulvey, 2016). FA research followed the educational technologies evolution into mobile platforms. Vocabulary acquisition, in particular,

has been proven to be more effective via mobile delivery than computers or traditional teaching methods (Lu, 2008). Most recently, Aldon & Dempsey (2016) used multiple FA strategies with iPads® in the context of secondary science courses. Their research concluded that mobile devices accelerate and amplify the effects of FA (Aldon & Dempsey, 2016). The study further supported the role of the teacher as a facilitator and found students took significant ownership of their own learning with FA strategies using iPads® (Aldon & Dempsey, 2016). One the most notable strengths of using advanced smartphone applications for FA was real time diagnosis of student weaknesses (Townsend & Mulvey, 2016).

Smartphone Enhanced Learning

Mobile Learning Environment

Mobile learning (ML) is “electronic learning through mobile computational devices independent of location in time or space” (Quinn, 2000, p 1). One study defined ML simply as the use of a personal sized device that can access the internet (Sarrab, Alalwan, Alfarraj, & Alzahran, 2015), however, in regards to all types of mobile devices, ML via smartphone is most favored among millennials (Chen et al., 2015). Part of the popularity surrounding smartphones is their ubiquitous nature. Smartphones potentially gave people the ability to learn in almost any environment (Ozdamli & Uzunboylu, 2015). Because of the ease of availability, ML has experienced considerable growth at the University level. Results from a multi-year study of the entire student body at the University of Central Florida yielded growth in m-learning of 19% between 2012 and 2014 (Chen et al., 2015). ML often takes place outside of formal learning environments but can also be accomplished inside traditional educational settings (Sharples, Taylor, & Vavoula, 2007). Studies indicated that students and teachers in general preferred

combining mobile apps with constructivist methods while utilizing a mobile learning agenda inside their classrooms (Ozdamli & Uzunboylu, 2015).

One important finding is that ML puts more emphasis on learning than teaching which may force educators to adjust their views towards teaching routines (Kukulska-Hulme, 2010). Earlier studies reported agricultural educators at the secondary level did not possess the same level of mobile technology skill as their students (Murphrey, Miller, & Roberts, 2009). However, that digital divide has begun to close as millennial aged teachers replaced digital immigrant teachers (Thomas & Muñoz, 2016). Another study investigated perceptions and found teacher groups had positive perceptions about an integrating ML with existing teaching strategies (Ozdamli & Uzunboylu, 2015). Teacher attitudes and student technology acceptance were identified as important precursors for successful M-learning designs (Iqbal, & Qureshi, 2012; Irby & Strong, 2015; Ozdamli & Uzunboylu, 2015). Nevertheless, it is apparent that learning motivation and understanding can be affected by ML because of the augmentation of physical space, active learning capability, and the immediate ability to access content (Liu & Huang 2015).

Blended Learning Environment

Blended learning is the act of employing multiple instructional delivery methods to impart knowledge and/or skills to students (Lothridge, Fox, & Fynan 2013). One key difference from traditional classroom models of instruction was improved ability to satisfy different learning styles (Lothridge, Fox, & Fynan 2013). The most common definition of blending learning is teacher instruction infused with technology (Lothridge, Fox, & Fynan 2013; Francis, & Shannon, 2013; Olapiriyakul, & Scher, 2006; Vacik, Wolfslehner, Spörk, & Kortschak, 2006; Wasoh, 2016). The term blended learning is often interchanged with *mixed mode learning*,

technology enhanced learning and *hybrid instruction* (Yuping, Xibin, & Juan, 2015). As a system, blended learning seamlessly fuses traditional instruction with technology enhanced learning (Yuping, Xibin, & Juan, 2015).

Some studies indicated that students perform better academically in a blended learning model than other learning models (Moskal, Dziuban, & Hartman, 2013). Blended learning research found positive effects in terms of the knowledge transfer when gathering foundational understanding at basic application levels (Vacik et al., 2006; Lothridge et al., 2013; Olapiriyakul, & Scher, 2006). Students who were in blended learning environments outperformed students who only received face to face instruction (UD DOE, 2010). Other principle measurements recorded in the blended learning literature that are of interest are effects on student motivation (Leithner, 2009) and creating interest (Adas, & Bakir, 2013; Pearcy, 2009).

Image Sensing Technology

Image sensing technologies, once used for facial recognition, are gaining traction in scientific fields pertaining to the identification of plant species based on leaf segmentation and shape estimation (Cerutti, Tougne, Vacavant, & Coquin, 2011). There are many different, complex methods being tested for leaf recognition on mobile devices. Some utilize parametric active polygons (Cerutti et al., 2011), others have tested using grid and a graph cuts-based method to extract features (Iwata & Saitoh, 2013), and others use binary classifiers applied to gist features (Kumar, Belhumeur, Biswas, Jacobs, Kress, Lopez & Soares, 2012). Gist is an abstract representation of an image (Oliva, A., & Torralba, A. 2001) that sensing technology strives to replicate through complex mathematical equations.

The basic steps that all image sensing software completes are (a) classification, (b) segmenting, (c) extracting, and (d) comparing (Kumar et al., 2012). Classification is determining

if the picture taken of an image is worthy of further processing (Kumar et al., 2012). Most image sensing mobile technology requires that single leaf samples be placed on a completely white background so that the image quality and edges can be more easily detected (Kumar et al., 2012). For example, the classifier function for Leafsnap scales all photos to 300 x 400 pixels and measures it against 5,972 individual images in storage (Kumar et al., 2012). Processing takes on average 1.4 seconds per image photographed (Kumar et al., 2012). Most classification issues arise from poor lighting, textured backgrounds, or clutter (Kumar et al., 2012).

Leaf shape is currently the most accurate way to accomplish segmentation (Kumar et al., 2012). Smartphone cameras are not strong enough to detect identifying characteristics like venation patterns (Kumar et al., 2012). Also, color varies from leaf to leaf of the same species, and flowers are too varying across species as well as seasonal in nature (Kumar et al., 2012). The edges of the leaves are detected by the change in foreground color (leaf) and background (white sheet of paper) using Expectation-Maximization (Kumar et al., 2012). Figure 1 illustrates a leaf that underwent classification and segmentation (Kumar et al., 2012).

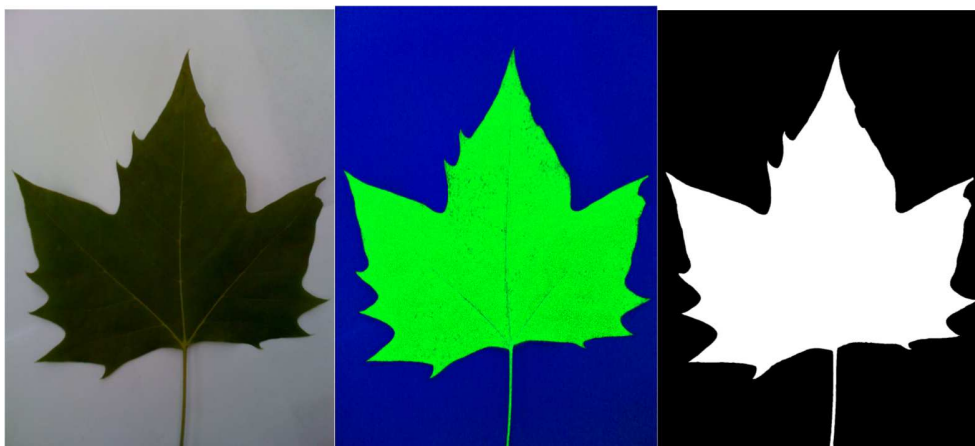


Figure 1. First Two Steps all Image Sensing Technology Complete: Classification and Segmentation. A leaf image in original (left), classification (middle), and segmentation (right).

Leaf shapes are then represented by measures of their curvature along the boundaries of the leaf (Kumar et al., 2012). This extraction of the segmented shape into a curvature image represents the leaf for comparison to other curvature images in the database (Kumar et al., 2012). Curvature images are then converted into histograms of curvature over scale (HoCS) which are the features that will be used for comparison of other HoCS in the database to identify the nearest match for identification (Kumar et al., 2012). HoCS use measures of leaf area at several contour points along the leaf (Kumar et al., 2012). Histograms are an uncomplicated, space saving and rapid metric to use for comparison to the database of extracted features (Kumar et al., 2012). In the Leafsnap database, specifically, there are 23,915 images of pressed leaves from 184 different species (Kumar et al., 2012). See Figure 2 for an illustration of an extracted curvature image produced from a segmented leaf and converted to HoCS.

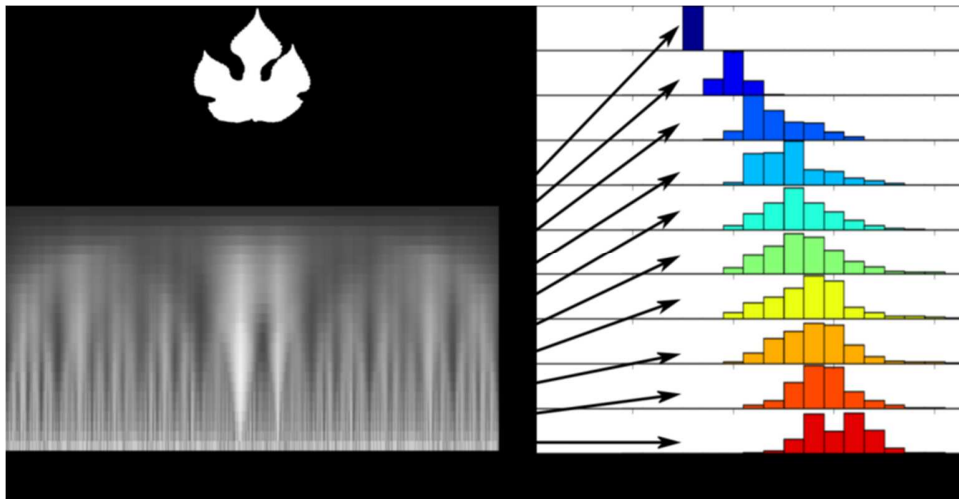


Figure 2. Final Steps all Image Sensing Technology Complete: Extraction and Comparison. The Segmented leaf (top left) is extracted into a curvature image (bottom left) and converted into Histograms of Curvature over Scale (HoCS) for comparison of other leaf HoCS in a database for identification match.

Motivation

The simplest explanation of motivation as a science is an attempt to discover why people do the things they do. Furthermore, it is an attempt to answer (a) why people make the choices they make, (b) what puts people into action, and (c) what internal and external factors cause people to increase effort towards attaining goals? Motivation includes elements that cross the affective, cognitive, and psychomotor domains (Keller, 2010). People are motivated by many sources including but not limited to: (a) emotions (i.e. fear/desirability); (b) psychomotor characteristics (i.e. aggression/maturity); (c) physiological factors (i.e. hunger/vivication); and (d) cognitive components (i.e. expectations/personal beliefs). A common pattern of learner motivation may be illustrated as energy→volition→direction→involvement→completion (Keller, 2010). Following this model, it can be reasoned that a student who has the capacity to engage (energy) and chooses (volition) to do so with a certain purpose (direction), coupled with their continued effort (involvement) leads to finishing the learning task (completion). This pattern brings forth five points of motivational conflict for a single learning task in which some motivational problem may arise. Multiplying those points by the number of tasks given to a student per academic day uncovers hundreds of potential dilemmas faced by the typical student in terms of learner motivation (Wlodkowski, 1978).

Motivation is intangible, yet it can be the difference in student success or failure. Since it cannot be directly observed or measured, inferences have to be made based on peoples actions. In the educational realm, persistence and completion are displays of student motivation. There are a substantial number of findings that link motivation to fundamental educational accomplishment. If two students are equally matched in cognitive abilities and opportunities to

learn, then it is the motivated student who will outperform the unmotivated student. (Glyn, Aultman, & Owens, 2005; Huett, Moller, Young, Bray, & Huett, K. C. 2008; Keller, 2010).

Motivation to learn is a person's propensity to view learning activities as meaningful and beneficial (Wlodkowski, 1999). Learning motivation literature suggests that motivation is positively related to academic success (Keller, 2010; Lin-Siegler, Dweck, & Cohen, 2016; Wlodkowski, 1999). However, student variations in emotions, needs, values, beliefs, expectations, and attitudes may obstruct learning (Wlodkowski, 1999). The challenge of formal education instructors is to accept that students must be motivated to some degree in order to learn. Furthermore, teachers should identify differences in culture, beliefs, and notions within the student body in order to find a way to motivate them to learn. Finally, teachers should accept the challenge that making learning important to students is paramount to learner motivation (Wlodkowski, 1999).

Intrinsic and Extrinsic Motivation

People are said to be intrinsically motivated when they get pleasure from the performance of a task rather than a reward attached to the completion of a task (Keller, 2010). Intrinsically motivating activities are those in which the reward is the activity itself (Deci & Ryan, 1975). Stipek (2002) theorized there are internal human forces which inherently motivate people to develop their own intellect. This reasoning also concluded that people are more motivated when they have choices and some control related to their work (Stipek, 2002). As a result, instructors have found it beneficial to offer students choice in whom they team with for collaboration, flexibility in materials, flexibility in methods to complete assignments, and even grading options (Stipek, 2002).

Extrinsically motivating tasks may be enjoyable, but by definition the rewards associated with their completion are the means to an end (Keller, 2010). Assigning grades and cumulative GPA is often considered a form of extrinsic motivation. The assumption for extrinsic motivation is that students are inspired to perform when they are rewarded for learning and/or penalized for their shortcomings (Wlodkowski, 1999). Extrinsically motivating endeavors often result in instrumental value (Keller, 2010). For example, students may enroll in an ACT preparatory class because they want a higher ACT score in order to attain college acceptance. The motivational factor emphasized is based on the value of college acceptance and not the intrinsic value of enhancing knowledge of ACT material (Keller, 2010).

Educators tend to advertise the merit of having intrinsically motivated students that aspire to become lifelong learners. However, researchers pose the questions: (a) how many students would attend school if they had a choice; and (b) how many of those who would choose to attend would do so for the intrinsic value of learning compared to the extrinsic value of career preparedness? (Keller, 2010). Motivation is not simply a dichotomy, but rather a very complex phenomena of intertwined motivational factors that alternate back and forth depending on the situation. It is possible to find people who are motivated only from within as well as people who are motivated only by reward. However, realizing the complexity of human behavior, it is more probable to find components of both in a given students' response to an academic scenario (Keller, 2010).

Theoretical Framework

Previous notions held by researchers like Traxler (2007), was that the ML field was so new that few well-developed learning theories and evaluation methodologies were well aligned. However, Piaget's idea of individualistic constructivism is conducive to mobile learning because

learners have personal access to content, quizzes and resources at all times (Levene, & Seabury, 2015; Tam, 2000).

Constructivist learners are considered to be more actively engaged compared to objectivist learners, who were passive receptors of knowledge (Tam, 2000). Objectivist teaching seeks to educate students about the real world by dispensing a finite set of skills and facts to the student. The student therefore would process and absorb the information like a sponge (Tam, 2000). In contrast, constructivist learning seeks student empowerment to actively solve authentic problems (Pedaste et al., 2015; Tam, 2000). Constructivist learning research has investigated how students initiated their own learning and were motivated by authentic problems (Mueller, Knobloch & Orvis, 2015). Authentic learning involves real-world problem solving and projects that have perceived importance to the learner (Traxler, 2007). Constructivist teaching methods have been accomplished successfully with smartphones (Tam, 2000). Results suggested that when students engaged in advanced functions of smartphones in student-centered learning environments, they were more likely to achieve (Thomas & Muñoz, 2016).

Activity theory is an attempt to analyze an individual's actions with learning materials controlled by a set of instructions and shared through a division of labor (Engeström, 2009). Activity theory has been adapted to fit ML research in the past (Park, 2011). However, Sharples and Taylor (2007) concluded that activity theory did not fully account for complex relationships between learning and technology. Therefore, Sharples and Taylor (2007) developed the Theory of Learning for the Mobile Age (TLMA) which focused on the interaction between learners and technology which resulted a broader theoretical lens through which ML research could be viewed (Sharples & Taylor, 2007). TLMA was rooted in constructivism, borrowed from activity theory, and defined learning "as the process of coming to know through continuous

conversations across multiple contexts amongst people and interactive technologies” (Sharples & Taylor, 2007 p 22). TLMA was developed on the notion that learning is a process of acquiring knowledge through communication across continuously shifting contexts (Taylor, Sharples, O’Malley, Vavoula & Waycott, 2006). Therefore, it is a valid theoretical framework for analyzing contexts such as traditional teacher-centered learning, student-centered learning, or combinations of multiple learning approaches (Sharples, Taylor, & Vavoula, 2007).

Further, Sharples and Taylor (2007) produced the Task Model for Mobile Learners (see Figure 3) which is modified from Engeström’s (2009) expansive activity model. The task model divided learning into semiotic and technological activity (Sharples & Taylor, 2007). The semiotic layer represented learner actions moderated by culture, environment, and meaningful signals (Sharples & Taylor, 2007). Semiotic referred to an abstract domain inside the mind where personal language events such as previous conversations, lectures, and private thoughts are synthesized (Taylor et al., 2006). The technological layer represented a physical domain. This technological layer has helped explain smartphones as a tool for “creating a human-technology system” that enables learning (Sharples & Taylor, 2007 p 11). Sharples and Taylor (2007) insisted that the semiotic and technological layers can be separated to provide a more semiotic or technological model or combined for a more holistic model. The purpose of the theory and model was to move forward the investigation of ML (Sharples, Taylor, & Vavoula, 2007).

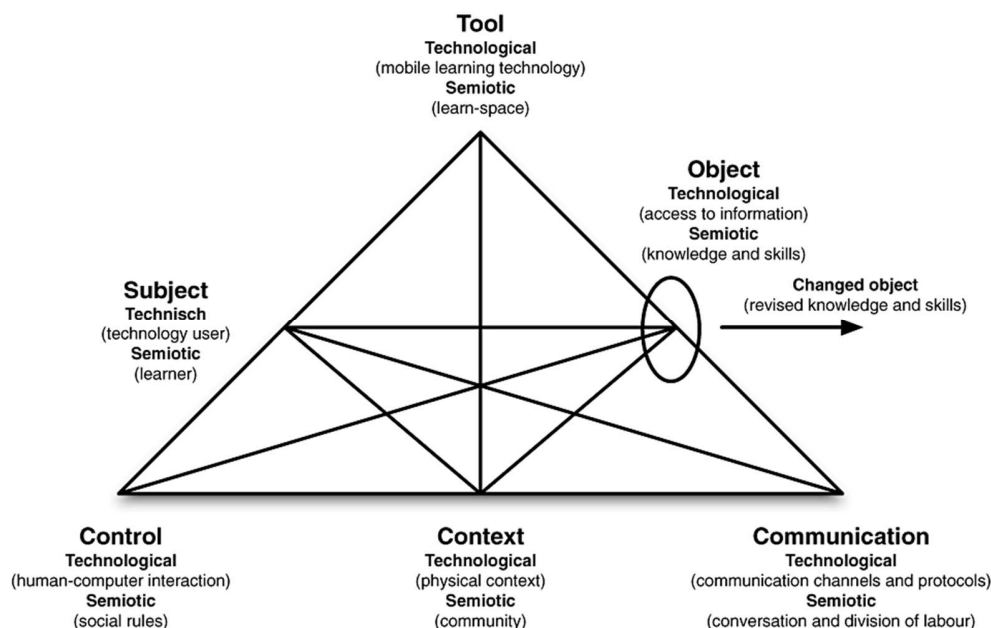


Figure 3. Sharples and Taylor (2007) Task Model for Mobile Learners. This model can be utilized as a framework for analyzing several types of ML and coincides with the Theory of Learning for the Mobile Age (TLMA).

The model can be used to illustrate learning through smartphone technologies in a traditional classroom, distance education environment, or an informal learning context (Sharples & Taylor, 2007). In the triangular model, all factors (i.e. Object, Tool, Subject, Control, Context and Communication) are connected to one another. This represents the complex relationship and dependency the factors possess (Taylor et al., 2007). The intertwined yet flexible structure of the model allows ML projects of any kind to be examined (Sharples & Taylor, 2007). An object is the material or problem which learning affected and was often the dependent variable in experimental designs (Sharples & Taylor, 2007). Tools were determined to be any device that serves the purpose of inquiry (Sharples & Taylor, 2007). Subjects are learners or technological devices and may be considered one in the same (Sharples & Taylor, 2007). Control of learning may depend on a teacher, be distributed to learners, or may pass between learners and

smartphones (Sharples & Taylor, 2007). Context embraced multiple formats including but not limited to (a) classrooms, (b) social media, (c) text messaging, and (d) interpersonal conversation (Sharples & Taylor, 2007). Communication also embraced traditional and technological means of people sending and receiving messages (Sharples & Taylor, 2007)

Conceptual Framework

This study was conceptually underpinned by the Attention, Relevance, Confidence, Satisfaction (ARCS) model for measuring the impact of motivation on student performance on a situational basis (Keller, 2010). The ARCS model derived from empirical work completed by Tolman (1932) and Lewin (1944) that resulted in Expectancy Value Theory (Huett, Moller, Young, Bray, & Huett, 2008). The theory postulated students work harder toward activities they perceive are valuable and where success is reachable (Keller, 1987). There are findings in the literature that credit motivation for 16%-38% explanation of the variance in student achievement scores (Means, Jonassen, & Dwyer, 1997). Keller's (1987) ARCS model is highly regarded as one of the best known motivation based instructional design models in the United States (Bohlin, 1987). In the current study, student performance was defined as the difference between academic gains measured on a pretest and post-test. The level of academic knowledge measured in the study is foundational in nature.

The first construct of the model was Attention and was related to interest (Keller, 1987). Capturing student interest and maintaining that interest in a learning environment is essential to instructional success and student achievement. "Attention is a combination of some key concepts including: arousal, boredom, and curiosity" (Keller, 2010, p. 76). Arousal research attempts to explain how learning behavior initiates and flows (Keller, 2010). Small levels of arousal as well as high levels of arousal result in poor performance (Keller, 2010). If a student is asleep he/she cannot learn anything; consequently if a student is displaying hyperactivity, he/she also cannot

be taught (Keller, 2010). Being below one's optimal level of arousal due to boredom can be attributed to unpleasantness, constraint, monotony, and repetitiveness (Geiwitz, 1966). Curiosity embodies a diverse theoretical background in and of itself. Stimulus-generated curiosity or drive theory (Berlyne, 1954) suggested curiosity may be an instinctive desire that is activated when the appropriate stimuli appear and deactivated once the desire has been met. Others argued that curiosity was self-activated and emanated from an amiable experience not satisfied completely by success (Maw & Maw, 1964). This viewpoint considered curiosity a motive and not a driver. It is derived from the idea that humans want to make sense of the world they live in (Maw & Maw, 1964). Finally, Kagan (1972) coined the concept of incongruity as a motive for curiosity. Kagan (1974) posited that people have a need to remove uncertainty and this lead to exploration and curious behaviors.

Relevance was a construct best explained in pragmatic terms. Students often question how a lesson or topic of study will be useful in everyday life. Motivation research has suggested that more effective teachers better demonstrated relevance to their students with animated stories that were derived from a deep understanding of the material (Keller, 2010). Communication research supports relevance as the central factor in determining whether or not people respond to a novel stimulus (Sperber & Wilson, 1986). It has been reported that people only pay attention to the extent that a connection is found between the stimuli and significance to the subject's personal lives (Sperber & Wilson, 1986). When a person reaches the highest state of perceived relevance they have a heightened interest in a task, they are fully concentrated and unconcerned about success/failure, and they experience pleasure while working (Keller, 2010). Those who experienced this heightened state could not be distracted by environmental or psychological

forces for an extended period of time (Csikszentmihalyi, 1975). The term that explained this ultimate state of focus was flow (Csikszentmihalyi, 1975).

Confidence is generally aligned with how highly people expected to succeed or fail and how much control over a situation people perceived they owned (Keller, 2010). Individual perception of control and predictability strongly relate to the psychological aspects of confidence (Keller, 2010). Rotter (1954) developed the notion of people's perception of control as either internal or external. If test results are lower than student expectations, they may blame their teacher (Keller, 2010). This would be an example of external locus of control (Rotter, 1954). People with internal locus of control tend to search inwardly for what could have affected their scores. They most often blame themselves rather than outside forces (Keller, 2010). People with internal locus of control tend to be more successful academically (DuCette & Wolk, 1974; Phares, 1976; Dollinger, 2000). Differences in levels of locus of control were based on several factors. Studies have concluded to varying degree that ethnicity, culture, and socio-economic status (SES) influenced whether a person has an internal or external locus of control. Self-efficacy is closely related notion to Confidence (Bandura, 1977; Keller, 1987) and predictive of school achievement (Schunk, 1996). Keller (2010) recommended teachers build confidence in students by ensuring they knew what was expected and understand how to maximize their likelihood for success.

Satisfaction was often influenced by one's subjective reflection of a personal outcome compared to societal outcomes (Keller, 2010). People are often not satisfied if they are not achieving the same goals or receiving the same rewards as their peers (Keller, 2010). Festinger (1957) introduced the idea of cognitive dissonance where dissonance was an uncomfortable state that people will attempt to reduce by achieving equally with their peers. Clinical research

attempts into intrinsic factors and extrinsic reward attempted to uncover a concrete explanation of Satisfaction (Keller, 2010). However, interpersonal relationship research on satisfaction, based on Equity Theory, identified inputs and outcomes that were useful in learning environments (Adams, 1965; Keller, 2010). The most satisfying outcomes were respect, feedback, status, and meaningful work (Keller, 2010). Undesirable conditions for satisfaction included monotony, isolation, and micro-management (Adams, 1965; Keller, 2010). Student satisfaction should be founded on equity (Keller, 2010). In terms of satisfaction, it was recommended that teachers use praise for correct responses liberally, avoid boring tasks and drills, give students personal attention, and avoid the use of threats to get results (Keller, 2010).

CHAPTER 3: METHOD

Purpose of the Study

This dual-purpose study (a) compared achievement levels between two groups of students in a forestry curriculum learning with smartphones or with printed materials and (b) determined motivational differences between those groups. The following research questions guided the study:

1. What are the personal and educational characteristics of students enrolled in agriculture courses offering a forestry curriculum in Louisiana?
2. What differences existed in pretest and post-test leaf ID scores between students learning through smartphone technology and students learning through printed materials?
3. What differences existed in student motivation (e.g., Attention, Relevance, Confidence, Satisfaction, and Motivation) between students learning through smartphone technology and students learning through printed materials?

Null Hypotheses

The following null hypotheses guided the data analysis.

Ho1: There were no statistically significant differences in leaf ID pretest and post-test scores between students learning through smartphones and students learning through printed materials.

$$(\mu 1 \text{ Smartphone} = \mu 2 \text{ Printed Materials})$$

Ho2: There were no statistically significant differences in Attention between students learning through smartphones and students learning through printed materials.

$$(\mu 1 \text{ Smartphone} = \mu 2 \text{ Printed Materials})$$

Ho3: There were no statistically significant differences in Relevance between students learning through smartphones and students learning through printed materials.

(μ 1 Smartphone = μ 2 Printed Materials)

Ho4: There were no statistically significant differences in Confidence between students learning through smartphones and students learning through printed materials.

(μ 1 Smartphone = μ 2 Printed Materials)

Ho5: There were no statistically significant differences in Satisfaction between students learning through smartphones and students learning through printed materials.

(μ 1 Smartphone = μ 2 Printed Materials)

Ho6: There were no statistically significant differences in Motivation between students learning through smartphones and students learning through printed materials.

(μ 1 Smartphone = μ 2 Printed Materials)

Louisiana State University Institutional Review Board Approval

Permission for the study was requested from the Institutional Review Board (IRB) at Louisiana State University. Included in the application (see Appendix M) were all documents proposing research protocol (see Appendix N), instruments (see Appendices H and K), and participation permission forms for students, parents, teachers, and principals (see Appendices B, C, D, and E). All federal stipulations pertaining to the safe and considerate treatment of human subjects were met, and IRB# 3754 was approved on August 12th, 2016 (see Appendix A).

Design of the Study

This pre-experimental study design utilized nonequivalent comparison groups. There was an untreated comparison group and a treatment group with a pretest and post-test completed by the sample (Campbell & Stanley, 1963; Shadish, Cook & Campbell, 2002). Versions of the nonequivalent comparison group design are commonly used designs for pre-experimental studies

(Shadish et al, 2002). Random sampling and random assignment were not feasible because only a small number of treatment schools were available due to school district policy regarding smartphones. Furthermore, one of the positive associations found with pre-experimental designs is the ability to study outside of the laboratory and in real world conditions (Campbell & Stanley, 1963; Shadish et al., 2002). When such conditions exist, it is recommended that an experimenter should “design the very best experiment which the situation makes possible” (Campbell & Stanley, 1963, p 34). That is what was attempted in this study. Since random assignment was not used to assign subjects to levels of the treatment or the level of treatment to the groups, pre-experimental equivalence was not assumed. However, a pretest was employed to establish group equivalence on prior knowledge.

Students were pretested to determine prior knowledge of leaf identification and to establish a baseline to measure leaf identification achievement effects. The research design regarding student achievement in leaf identification is illustrated in Figure 4. According to Campbell and Stanley (1963) X represents the independent variable, subscript E represents the experimental level of the treatment, subscript C represents the comparison level of the treatment, and O represents a measurement made during the study. Numerical subscripts are used to indicate when the measurements were taken during the study. This results in O₁ being the pretest for the treatment group and the comparison group. O₂ is the post-test for the treatment group and the comparison group. NR stands for nonrandom assignment (Shadish et al, 2002).

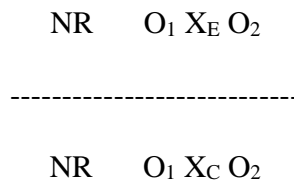


Figure 4. Research Design for Student Achievement. Adapted from Shadish et al., (2002) and Campbell & Stanley (1963), this figure represents participants purposefully (NR) assigned to a treatment group (X_E) or non-treatment comparison group (X_C) which utilized a pretest (O₁) and post-test (O₂) to measure achievement gains after the learning process.

Pretest and post-test data were collected using an online testing platform named Test Generator created by Fain and Company. Test Generator is an online platform that allowed the researcher to receive instant results from the tests, and it eliminated the need for the teachers participating in the study to grade the tests. Both groups completed the pretest on Test Generator the day before any leaf identification lessons were taught.

In addition to student achievement in leaf identification, levels of student motivation (i.e. Attention, Relevance Confidence, Satisfaction and overall Motivation) were also measured using the course interest survey (CIS) developed by Keller (1988) (see Appendix K). Students completed demographic items as well as the 34 item CIS instrument via Qualtrics, an online survey provider licensed by Louisiana State University. All students who completed the pretest and instructional portion of the study completed the online survey directly prior to taking the post test.

Participants

Recruitment of Teachers

Louisiana agriculture teachers from each Area (I, II, III, & IV) were surveyed by the researcher during teacher meetings at each FFA leadership camp session in the summer of 2016. The survey collected data on demographics, use of technology, parish policy towards mobile

devices in the classroom, forestry teaching competence, and offered each participant a chance to volunteer ($n = 160$). Thirty teachers identified themselves as willing to volunteer on the survey and provided their contact information.

Of the 30 identified teachers, 16 indicated their parish had favorable policy towards smartphones in the classroom. This group was identified as potential members of the treatment group. From those 16 willing participants, four were not contacted because they taught junior high level agriculture courses. The remaining 12 were invited to attend a professional development seminar at the annual conference for Louisiana agriculture teachers. The seminar was held on July 26th, 2016 and 10 of the 12 teachers who were invited attended the seminar.

There were 14 teachers who volunteered and indicated parish policy that prohibited smartphones in the classroom. Among this group of willing teachers, 2 were not contacted because they taught junior high level courses. This cohort of 12 teachers was identified as potential teachers of the comparison group and was invited to attend a professional development seminar at the annual conference for Louisiana agriculture teachers. The seminar was held on July 26th, 2016 and all 12 potential comparison group teachers who were invited attended the seminar.

In all 22 willing teachers volunteered to participate in the study. Upon examination of survey data, it was discovered that each cohort contained teachers who taught classes at different time intervals. The dominant teaching time was 50 minutes ($n = 19$). Therefore, all teachers who taught 90 minute class periods ($n = 3$) were contacted via personal phone call and notified that only teachers who taught a 50 minute period would be asked to continue. This preliminary result of the purposive sample after considering minutes per class period yielded 10 teachers in the treatment group and nine teachers in the control group.

Threat to External Validity

On Saturday August, 13th at 7:00 a.m. it was reported that over the previous 48 hours, rain in some areas of Southern Louisiana had fallen at rates as much as three inches per hour. Labeled The Great Flood of 2016, this rain event devastated South Louisiana. In three parishes the rainfall amounts had a statistical chance of occurring every 1,000 years. In seven parishes the rainfall event would be considered one that occurs every 100 years statistically (Schleifstein, 2016). The subsequent flooding that occurred from approximately 24” of rain in just two days resulted in thirteen confirmed deaths, 110,000 homes flooded, and approximately twenty billion dollars in damage in the Baton Rouge area alone (Gallo & Russell, 2016).

In total, eight potential participant schools closed for an extended period of time due to flooding. Two of the schools flooded, two were needed for use as a shelter and supply distribution, and two had communities where the flood waters did not recede for two weeks. Campbell and Stanley (1963) contend that history is a threat to external validity when an event occurs between the first and final measurements of a study. In this case, the event occurred before the intervention. Nevertheless, devastation from the flood eliminated three schools (two comparison and one treatment) from continued professional development of the research study. This resulted in nine potential teachers in the treatment group and seven in the comparison group after The Great Flood of 2016. One teacher continued on with the study and saw it through completion even though her house flooded. Another teacher from the treatment group quit the profession before the study began. Yet another teacher from the treatment group completed all of the training and decided not to participate in the study for personal reasons. Unexpectedly, one teacher from the comparison group quit in the middle of the study because of an emergency

family illness. In total, 13 teachers completed all phases of the research study. Seven teachers facilitated the treatment group and six facilitated the comparison group.

This final group of participating teachers was asked to sign consent forms (see Appendix B). Participating teachers were then asked to gain permission from their principals to allow the study to take place on their campus (see Appendix C).

Teachers

Louisiana agriculture teachers who participated in this study were assigned to treatment and control groups based on their parish's policy towards mobile device use in the classroom. Those who indicated their parish had policies in place that allowed mobile devices to be used by students were invited to participate as teachers of the treatment group. Those who indicated the parish prohibited student smartphones in the classroom were placed in the comparison group. A comparison group by definition "receives an alternative intervention and a treatment group receives the intervention of interest" (Shadish et al., 2002). Participating teachers were contacted via email by the researcher inviting them to participate in the study (see Appendix F). A total of thirteen teachers, seven in the treatment group and six in the control group completed all phases of the study.

Treatment group. Louisiana agricultural teachers ($n = 7$) who taught a leaf identification unit using mobile learning apps as a delivery method during the Fall of the 2016-2017 academic year.

Comparison group. Louisiana agricultural teachers ($n = 6$) who taught a leaf identification unit using paper based manuals as a delivery method during the Fall 2016-2017 academic year.

Students

After the recruitment of teachers was completed, students enrolled in the teachers courses were asked to participate in the study and sign a consent form (see Appendix D). The students were then asked to gain permission from their parents to continue in the study (see Appendix E). A total of 263 students agreed to participate in the study and gained the permission of their parents/guardians to do so.

Louisiana high school students ($n = 263$) from 13 schools who were enrolled in agricultural education course in which forestry was taught during the 2016-2017 school year participated in the study.

Treatment group. Students who used smartphones to identify leaf samples and take formative assessments during the 2016-2017 academic year ($n = 128$).

Control group. Students who used printed resources to identify leaf samples and take formative assessments during the 2016-2017 academic year ($n = 135$).

Treatment

The treatment evaluated in this study was using smartphones to identify and formatively assess knowledge of tree species. Participants engaged in a student-centered learning approach to identify unknown species of trees with their smartphone. Teachers used guided inquiry to facilitate student identification of tree species and formatively assessed learning with advanced smartphone applications. The treatment group used three free mobile apps (Leafsnap, Vtree, and Tree Book) to identify tree species they were unfamiliar with. Students took a picture of a leaf with Leafsnap and the app suggested the species identity. All of the treatment apps were designed to aid foresters, students, teachers, or anyone with an interest in leaf identification. The electronic flashcard app Quizlet was used by students in the treatment group to take formative

tree identification assessments on their smartphones. The researcher created study sets using Quizlet that the treatment groups used for practice. Quizlet assesses students through games played on a mobile platform that reports results to the teacher instantly on their teacher account.

The following is a basic description of Leafsnap user functions. First, the user takes a picture of the leaf in question against a white background. Then, Leafsnap determines the contours of the leaf and uses visual-recognition software to find a match for it in the database. Results are returned in seconds, depending on the speed of the internet or wireless connection. Next, Leafsnap brings up images of the species it has identified, along with supporting identification images of the species' leaf, flower, fruit, seeds, and bark. The app also gives the user information on the species and its native range. When the identification is not 100% certain, Leafsnap gives users several options. The user then has to scroll through other related images in its database, such as fruit shape or bark pattern. In this case, it is up to the user to decide the identification of the species, which reinforces learning (Farnsworth, Chu, Kress, Neill, Best, Pickering, & Ellison, 2013).

On the first day of the study, treatment groups were instructed to download all three identification apps and use them to identify the samples. The Quizlet app was used by students in the treatment group to take formative assessments on their mobile device. Quizlet presents formative assessment games played on a mobile platform to students. Teachers received instant reports of student progress in the form of graphs and percentages on their Quizlet teacher account. Quizlet is an electronic flashcard mobile app that allowed students to access study sets created by their teacher, or co-created by other students. Quizlet re-shuffled content after every small quiz was completed. Therefore, no two attempts were the same. Quizzes that use matching, true/false, multiple choice and fill in the blank type questions can be completed. More

importantly, the student decides what type of assessment is taken and how many items are included. Quizlet has been researched in vocabulary retention; however the app also supports photographs used for identification. The Quizlet app purposefully will not report grades as it advertises itself as a study aid exclusively. The researcher created study sets using Quizlet for the treatment group.

Comparison

The comparison group used printed materials instead of smartphones. This group used a student-centered learning approach to identify 30 unknown leaf samples with three different printed resources. Teachers used guided inquiry to facilitate students to identify tree species and formatively assess learning with printed materials. Those printed resources were *Leaf Key to Common Trees of Louisiana* (Dozier & Mills, 2005), *Important Forest Trees of the Eastern United States* (Brockman & Merrilees, 1991), and *Louisiana Trees* (Hodges, Evans & Garnett, 2015). Comparison group students completed formative assessments on paper media. One assessment matched leaf samples to the names of the trees they belong to with index cards that had the name of the tree printed on them. The index cards were supplied to each teacher and an electronic copy was also emailed to each. Students also completed quizzes using the scorecard provided by the researcher (see Appendix I). Live samples were provided by the researcher to each comparison group teacher to use in the study.

Initial Professional Development

The teachers were invited to participate in an hour long seminar at the Louisiana Agriscience Teacher Association annual conference on July 26th, 2016. They were presented a basic leaf identification characteristics PowerPoint (see Appendix L) created by the researcher. These characteristics ranged from leaf parts, arrangements on a stem, and leaf types. After the

basic explanation of how the PowerPoint should be used for both groups of students participating in the study, teachers were separated into two training groups.

The treatment teachers met with the researcher in a conference room separate from the meeting room where the control group teachers received training. During the next hour, the researcher trained the treatment group teachers how to download and briefly how to use: Leafsnap, V-Tree, Tree Book and Quizlet. Treatment teachers used the apps to identify the photocopied leaves (see Appendix G) that would be used in their classrooms for the study.

The day prior to this workshop the researcher met with four experienced agriculture teachers who are experts at tree identification and demonstrated to them how to help train the comparison group teachers. Comparison group training utilized these four experts in tree identification to train the comparison group teachers on how to properly identify the 30 species of interest with printed field manuals and leaf keys. The tree identification training for both of these groups happened simultaneously. After an hour, the treatment group was reunited with the comparison group and the researcher demonstrated the use of the Test Generator Web for testing the identification of trees. Finally, all of the teachers took a quiz identifying live samples prepared by the researcher in advance. All phases of the research design were implemented in abbreviated formats at this seminar. In all, the seminar lasted two hours.

Professional Development for Treatment Group Teachers

A second training for the treatment group was scheduled for the afternoon of August 20th, 2016 on the campus of Louisiana State University, however this was postponed due to the Great Flood of 2016 (see Appendix O). Three teachers from the treatment group met on Saturday, September 10th, 2016. Three more treatment school teachers completed training one on one with the researcher in their classrooms after school hours on September 12th, 13th and

14th. One treatment teacher met with the researcher on the campus of Louisiana State University on the night of September 13th, 2016. At these training meetings more time was dedicated to instructing how the apps worked and how to follow the study protocol. All 30 samples were identified by the teachers using the mobile apps. Teachers also received more detailed instruction using the Quizlet app. They learned how to access the study sets created by the researcher for the study. They also learned how to create student Quizlet accounts for the study. High quality color copies of thirty leaf samples printed on a white background of standard copy paper were given to the teachers (see Appendix G). An identification number labeled on the back of each sample was provided with a key so the teachers could positively identify the species. Treatment group teachers received binders containing a lesson plan, master tree list (see Appendix Q), and a daily fidelity report (see Appendix P). Lastly, the treatment group was taught how to login and test on Test Generator Web testing software. A practice exam was created by the researcher on Test Generator Web to give the teachers experience with the software. It was necessary for the teachers to understand how to properly login, answer the questions, and submit a testing attempt.

Professional Development for Comparison Group Teachers

A second training meeting for the comparison group was scheduled for the afternoon of September 7th, 2016 at a participating schools campus. Four comparison group teachers attended. Two other comparison group teachers were met with individually at their school campus after school hours on August 25th, 2016 and September 8th, 2016. Comparison group teachers were given binders containing high quality color copies of thirty leaf samples printed on a white background (see Appendix G). Also included in the binders were lesson plans, a daily fidelity report (see Appendix P), and scorecards for formative quizzes (see Appendix I). An identification number labeled on the back of each sample was provided with a key so the

teachers could positively identify the species. Furthermore, each comparison group teacher was given 30 copies of the printed resource created by Dozier & Mills (2005), five copies of the resource created by Brockman & Merrilees (1991), and five copies of the resource created by Hodges, Evans, & Garnett (2015). One hour was dedicated to practice identifying all 30 specimens using the leaf keys. The control group was trained to use student-centered learning activities and formative assessments using the paper scorecards. Teachers were also trained how to employ formative assessment games using the index cards with printed names of the tree species. The comparison group was instructed how to use the Test Generator Web software for pretesting and post-testing. In all, each teacher from each group received four hours of professional development focused on how to deliver the interventions.

Both groups received the same leaf samples on white backgrounds. However, the day before the study was initiated all teachers received from the researcher live samples of each species collected in a large plastic storage bag and were advised to keep the samples in an ice chest or refrigerator when not being used for learning. These live samples were given so that the teachers could utilize more realistic samples for instruction. Variations in leaf size are common due to where the leaf is positioned on a tree (i.e. upper canopy vs. lower canopy) and live samples help students gain an understanding of approximate size that pictures often cannot (Bebbington, 2005; Burton, 2000; Dozier & Mills, 2005).

Instrumentation

Student Leaf Identification Achievement

The instrument used to collect leaf identification data for this study consisted of a criterion-referenced pretest and post-test (see Appendix H) delivered electronically with Test Generator Web testing software donated by Fain and Company. Test Generator Web gives the

students a picture in a pop-up window which the student closes and answers the identification question that follows. The student may recall the photo at any time during the question attempt as well as scroll back and forth through the questions. The test consisted of pictures of leaf samples cut from live trees resting on solid backgrounds, which students were to identify. The test employed 15 multiple choice items, 10 fill in the blank items, and five true/false items. The scoring of the instrument was based on 100% point scale. Each item was worth 3.33 percentage points with the exception of item number one which was worth 3.34 percentage points.

Thirty leaf samples resting on solid backgrounds were photographed by the researcher using an iPad® camera and uploaded into Test Generator Web. The authentic photos were chosen by the researcher based on experience in the subject of tree identification. Furthermore, the 30 species were chosen because they could be found in all of the learning materials given to each group of student participants in the study. All photos were formatted so that each were presented to the student in the same size. A panel of three tree identification experts, consisting of two secondary agriculture instructors and Dr. Hallie Dozier, an assistant professor of Forestry Extension and Natural Resources at Louisiana State University, reviewed the exam for content validity. All photos chosen for the instrument were deemed to be of high quality, easy to distinguish, and correct in species identification content.

There are eight reliability components that should be addressed by those who create criterion-referenced examinations (Wiersma & Jurs, 1990). The actions taken by the researcher to address each of the eight components to ensure reliability of the leaf identification test can be viewed in Appendix T.

Student Motivational Instrument

Student motivation was determined by using the Course Interest Survey (CIS) created by Keller (2010). The overall goal Keller (2010) explained for the CIS (see Appendix K) is to assess how motivated students are with respect to a specific lesson or class being taught. The instrument contained 34 items which measured the four subscales of the ARCS model. The likert-type items recorded student levels of agreement using a five point scale. All students in the study completed the instrument online immediately before they logged in to take the post-test. Cronbach's alpha reliability estimates were tabulated based on pretesting, revising, and retesting procedures conducted at a University in the Southeastern United States and are displayed in Table 1 (Keller, 2010). Internal consistency measures were satisfactorily high for each subscale and overall. Situational validity was tested by correlating CIS scores for students who participated in the reliability testing with GPA and course grades. All correlations between the CIS and course grade were significant at or above the alpha level .05 and no correlations between GPA and CIS scores were significant in the population. This supports validity of the CIS as a situational measure of motivation and not as an overall construct measure of formal learning (Keller, 2010).

Table 1

CIS Internal Consistency Estimates Obtained by Keller (2010)

Scale	Reliability Estimate Cronbach's α
Attention	0.84
Relevance	0.84
Confidence	0.81
Satisfaction	0.88
Total Scale (CIS)	0.95

The scoring guide used to attain measures of ARCS using the CIS is illustrated in Table 2 (Keller, 2010, p 280). Those items that are labeled *reverse* were reverse coded in the Qualtrics software when the instrument was entered. Students identified themselves by their student identification number created by the researcher and organized by the teacher on the first question of the instrument.

Table 2

Scoring Guide for the Course Interest Survey (Keller, 2010)

Attention	Relevance	Confidence	Satisfaction
1	2	3	7 (reverse)
4 (reverse)	5	6 (reverse)	12
10	8 (reverse)	9	14
15	13	11 (reverse)	16
21	20	17 (reverse)	18
24	22	27	19
26 (reverse)	23	30	31 (reverse)
29	25 (reverse)	34	32
	28		33

Fidelity of the Treatment

To ensure fidelity of the treatment, binders were made for both teacher groups that detailed step-by-step instructions for each instructional period. Within the detailed binders was a lesson plan, and daily agenda (see Appendix P) that teachers were to check off as they progressed through the lessons. Also included in the agenda was a notes section where teachers

could document any major changes or disruptions experienced during the instructional periods. These daily agendas and notes sections were mailed back to the researcher upon completion of the lessons. To ensure students received the same amount of instruction, there was a testing window created for the post-test that allowed students who missed instructional days due to illness, sports, or other excused absences to take the post-test upon completion of five days of instruction.

Data Collection Protocol

Upon permission from the Institution Review Board of Louisiana State University (see Appendix A) and dissertation committee, the researcher utilized Test Generator Web and Qualtrics to collect data from the student sample. Students completed the pretest (see Appendix H) via Test Generator Web on Monday, September 19th, 2016 by logging into the website with their individual student identification number assigned by the teacher. These tests were automatically graded and reported to the researchers' administration portal on Test Generator Web. The software was programmed so that the student could not retake the exam or see it after completion. Scores were emailed to each individual teacher the night of the pretest.

On Tuesday, September 20th, 2016 teachers began the instructional process. Participating teachers were provided a PowerPoint presentation that contained foundational knowledge pertaining to the identification of leaf types (see Appendix L). After this presentation the treatment group teachers then facilitated their students in the downloading and proper usage of Leafsnap to identify high quality photographs of thirty species of trees using leaf samples provided by the researcher (see Appendix G). Treatment group teachers also facilitated their students in the downloading and creation of a Quizlet account. Students in the comparison group

began identifying the same leaf samples provided by the researcher with the use of printed materials.

Each of the remaining instructional days began with a formative assessment and ended with a formative assessment. Formative assessments were administered to the treatment group with the flashcard app Quizlet. Teachers who administered the treatment were given study sets created by the researcher with Quizlet that contained different photos of all 30 trees in the study. The comparison group students also began and ended each instructional day with formative assessments that either utilized paper-based flashcards with the trees name or a scorecard created by the researcher that contained all thirty species (see Appendix I). The remaining instructional time was spent identifying leaf samples using smartphones or manuals. Teachers were also instructed to check each student's leaf collection on Leafsnap to ensure the students were positively identifying the samples. Likewise, comparison group teachers were trained to check student's accuracy when identifying the photos using paper manuals. Tuesday, September 27th, 2016 was the scheduled day to administer the CIS (See Appendix K) and the post-test (see Appendix H). Students logged in to Qualtrics and completed the online instrument that collected demographic (see Appendix J) and CIS data before they were allowed by the teacher to log in to Test Generator Web to take the post-test.

Data Screening

The initial phase of data analysis began with screening data to ensure quality from a thorough check for missing data, outliers, and normality. Coding for the survey was performed by the researcher *a priori* in Qualtrics. Grading and reporting results were reported automatically by the Test Generator Web software package. Pretest, post-test scores, demographic, and CIS

data were exported into an excel document for screening ($n = 306$). Data were then analyzed with IBM SPSS version 23 for Windows.

Exploring for missing exam data presented seven cases where students missed the pretest and two cases missing post-test data. These nine cases were deleted from the data set. Exploring for outliers on the pretest revealed two students belonged to the treatment group with extremely high pre-knowledge scores of tree identification (97% and 70%). These subjects were deleted because they fell three standard deviations above the mean pretest score (16.5%, $SD = 8.29$). It was later discovered that these two students trained on the schools' FFA forestry team for two years. Post-test scores revealed three subjects in the comparison group who scored a zero on the post-test. Those three outliers were deleted from the data based on criteria they fell three standard deviations below the post-test mean ($M = 42.8\%$, $SD = 20.7$). Exploring the remaining data resulted in 29 cases with missing data in at least one construct item on the CIS instrument. All 29 cases missing construct responses were deleted from the data set. Three additional cases were found to have missing demographic data, but were not deleted from the data set. After data screening, the overall sampled size was 263.

The assumption of normality for the dependent variables (i.e., post-test, Attention, Relevance, Confidence, Satisfaction and Motivation) was also tested. Kolmogorov-Smirnov (K-S) testing suggested the distributions for each DV were not significantly non-normal. Furthermore, visual inspection of histograms and scatterplots were conducted by the researcher under the guidance of a faculty member in educational research. When a sample size is larger than 200 it is better to evaluate normality visually (Field, 2009). Visual inspection of the distributions for each DV supported the assumption of normality.

Furthermore, in samples over 200, skewness values compared to zero are more useful than Shapiro-Wilk significance tests for skewness (Field, 2009). Skewness and kurtosis values were converted to z -scores to determine the extent of skewness and kurtosis. Skewness and kurtosis z -scores did not exceed the critical value of 2.58 (Field, 2009) for this sample size. Therefore, it was concluded that the data were not excessively skewed.

Data Analysis

Data associated with research question number one were analyzed with IBM SPSS version 23 for Windows. The first research question asked, what are the personal and educational characteristics of students enrolled in agriculture courses in Louisiana? Gender, race, and high school classification, were described using frequency and percent, which is appropriate for nominal and ordinal data. Age and number of agricultural classes taken were interval data and were described using means and standard deviations. The items used to collect personal and educational information (item numbers two through nine) are shown in the research instrument in Appendix J.

Research question number two asked if differences existed in pretest and post-test leaf identification scores between students who learned with smartphones and students who learned with printed materials. The data collected for inferential analysis in this study was a classic example of nested data (Raudenbush & Byrk, 1986). The treatment and comparison group contained students nested within schools. Because the students were grouped within their natural school setting, the synergy between students in the same school makes them more alike than students in the other schools (Raudenbush & Byrk, 2002). As a result, the measurements of students pretest and post-test achievement cannot be considered statistically independent (Raudenbush & Byrk, 2002) rendering traditional approaches like ANOVA and regression

unsuitable. Failure to recognize the hierarchical nature of a nested data set in educational settings may result in unreliable data analysis and misguided educational policy (Raudenbush & Byrk, 2002). Therefore, a two-level hierarchical linear model (HLM) with fixed effects was employed. This statistical method has advantages over tests that assume independence of groups because it accounts for variance in the dependent variable (DV) by students across the school level. The independent variable (IV) in the model that predicted achievement was group (treatment or comparison). The dependent variable (DV) was post test score on the leaf identification test. The covariate was the pretest (centered). Grand mean centering is most often preferred when models will involve level one and level two predictors (Peugh, 2010; Wu & Wooldridge, 2005). Centering scores means rescaling them in a way that a researcher can determine if a relationship exists between the predictor and the outcome based on school level factors (Peugh, 2010; Wu, & Wooldridge, 2005). Therefore, grand mean centering was performed on the covariate in SPSS by subtracting the individual students pretest score from the sample mean ($X_{ij} - \bar{x}$).

Not all nested data sets warrant HLM (Peugh, 2010). Several steps were taken to ensure that HLM was a viable statistical procedure. Conceptually, the Intraclass correlation coefficients (ICC) is an effect size calculation similar to R^2 for regression and eta-squared for ANOVA (Peugh, 2010). ICC helped determine if sufficient variance existed across students within schools to warrant HLM (McGraw & Wong, 1996).

An ICC calculation that equals zero implies no variation in post-test scores exists across schools, and that all variation exists between students. If this were the case, then traditional techniques like ANOVA are warranted. However, as ICC increased, statistical evidence supported the variation of scores occur across schools and the assumption of independence is

violated. In order to determine the ICC for the DV, an unconditional model (i.e. one-way random effects ANOVA) was utilized (Castro, 2001).

The following equation represent the unconditional means model that lead to calculating the ICC for post-test (Peugh & Enders, 2005).

$$ICC = \tau_{00} / \tau_{00} + \sigma^2$$

Where τ_{00} = variance across schools (intercept) and σ^2 = residual

An unconditional model for post-test by school was calculated using the mixed model command in SPSS (Peugh & Enders, 2005). Schools accounted for 9.4% of the variance in post-test scores (see Table 3).

Table 3

Unconditional Model Estimates of Covariance Parameters for Post-test (n = 263) and the Resulting ICC to Determine if Enough Variation Occurred Across Schools to Warrant HLM Analysis of Achievement Data

DV	Parameter	Estimate	ICC
Post-test	Residual (σ^2)	368.32	9.4%
	School variance (τ_{00})	37.63	

Studies support that ICC values between 5% and 20%, warrant social science research to utilize HLM (Muthén, 1994; Raudenbush & Bryk, 2002; Peugh, 2010). This variation across schools suggested post-test scores are not statistically independent and HLM is warranted to properly analyze the nested data.

After calculating the ICC from the unconditional model, the HLM technique had three steps. The first step produced the level one model which measured student differences in

achievement between groups as a function of school. The second step produced the full model which measured group level outcomes on achievement as a function of school while controlling for prior knowledge. The third step utilized likelihood ratio testing to determine if adding a school level variable improved the model. This model building process was necessary to determine if adding school level effects improved the model. Most importantly, step two (full model) specifically addressed research question number two.

The following equations pertain to building the models for research question number two. The independent variable was the group (i.e. treatment or control), the dependent variable was post-test.

$$\text{Level 1: } Y_{ij} = \beta_j + \beta_1 \text{ Pre}_{ij} + r_{ij}$$

Where Y_{ij} = post test score (Y) for student (i) nested in school (j), β_j = mean achievement score in school (j), β_1 = slope relating pretest to post-test [this value does not vary by school], Pre_{ij} is the score of student (i) in school (j) on the pretest, and r_{ij} = residual of for student (i) in school (j). The pretest scores were grand-mean centered for these analyses. The grand mean centered pretest variable at level one adjusted post-test means by the influence at level two much the same way as an analysis of covariance (ANCOVA) (Wu & Wooldridge, 2005).

The Level 2 model can be depicted as follows:

$$\text{Level 2: } \beta_j = \gamma_{00} + \gamma_1 Z_{1j} + u_j$$

Where β_j is the adjusted mean post-test in school (j), γ_{00} is the overall adjusted mean post-test for schools, Z_{1j} is an indicator variable [0=treatment school, 1=comparison school], γ_1 captures the difference in means for the treatment and control schools, and u_j is random error.

The full model is as follows:

$$Y_{ij} = \gamma_{00} + \gamma_1 Z_{1j} + \beta_1 \text{ Pre}_{ij} + r_{ij} + u_j$$

Power was addressed using Optimal Design software by Raudenbush. This sample provided medium power for a moderate effect size equaling 0.33. A chart illustrating power for this study can be viewed in Appendix R.

Research question number three asked what differences existed in student motivation between students who learned through smartphone technology and students who learned through printed materials. Motivation can be affected by perceived performance on an exam (Keller, 2010). Therefore, to ensure the students' perceptions were directed solely at the motivation they received from the instructional methods, the CIS was taken by the students as a prerequisite to the leaf identification post-test. The measurement was only taken once at the end of the study. Both the treatment and comparison groups completed the CIS instrument on Qualtrics and the data was instantly reported to the researcher by the Qualtrics system. The independent variable was group (i.e., treatment or control). The dependent variables were the four constructs measured by the CIS (i.e., Attention, Relevance, Confidence, and Satisfaction) as well as overall Motivation. Since the instrument was only completed one time at the end of the study, the HLM could not control for prior motivation. An unconditional model was run and an ICC was calculated for each DV. All constructs in the scale warranted HLM and all ICC can be seen in Appendix U.

After calculating the ICC from the unconditional model, the HLM technique had three steps. The first step produced the level one model which measured student differences in each DV at the school level. The second step produced the full model which measured group level outcomes on the DV nested in schools. The third step utilized likelihood ratio testing to determine if adding a school level variable improved the level one model. This model building

process was necessary to determine if adding school level effects improved the model. Most importantly, step two (full model) specifically addressed research question number three.

The following pertains to building the models for research question number three. The independent variable was group (treatment or control), the dependent variables were Attention, Relevance, Confidence, Satisfaction and Motivation.

$$\text{Level 1: } Y_{ij} = \beta_{ij} + r_{ij}$$

Where Y_{ij} = construct scores (Y) for individual student (i) nested in schools (j), β_{ij} = mean construct score for a given school and r_{ij} = residual of individual student difference in construct score around the school mean. School names were deleted and each school was given a school number to account for j in the analysis.

$$\text{Full Model: } \beta_{1j} = \gamma_{00} + (\text{GROUP})_{1j} + u_{1j}$$

Where β_{1j} = mean construct score for treatment group schools, γ_{00} = grand mean, $(\text{GROUP})_{1j}$ = treatment group variable, u_{1j} = treatment group schools deviation from the grand mean.

$$\text{Full Model: } \beta_{0j} = \gamma_{00} + (\text{GROUP})_{0j} + u_{0j}$$

Where β_{0j} = mean construct score for comparison group schools, γ_{00} = grand mean, $(\text{GROUP})_{0j}$ = comparison group variable, u_{0j} = comparison group schools deviation from the grand mean.

CHAPTER 4: RESULTS

Purpose of the Study

This dual-purpose study (a) compared achievement levels between two groups of students in a forestry curriculum learning with smartphones or with printed materials and (b) determined motivational differences between those groups. The following research questions guided the study:

1. What are the personal and educational characteristics of students enrolled in agriculture courses offering a forestry curriculum in Louisiana?
2. What differences existed in pretest and post-test leaf ID scores between students learning through smartphone technology and students learning through printed materials?
3. What differences existed in student motivation (e.g., Attention, Relevance, Confidence, Satisfaction, and Motivation) between students learning through smartphone technology and students learning through printed materials?

Null Hypotheses

The following null hypotheses guided the data analysis.

Ho1: There were no statistically significant differences in leaf ID pretest and post-test scores between students learning through smartphones and students learning through printed materials.

$$(\mu 1 \text{ Smartphone} = \mu 2 \text{ Printed Materials})$$

Ho2: There were no statistically significant differences in Attention between students learning through smartphones and students learning through printed materials.

$$(\mu 1 \text{ Smartphone} = \mu 2 \text{ Printed Materials})$$

Ho3: There were no statistically significant differences in Relevance between students learning through smartphones and students learning through printed materials.

($\mu 1$ Smartphone = $\mu 2$ Printed Materials)

Ho4: There were no statistically significant differences in Confidence between students learning through smartphones and students learning through printed materials.

($\mu 1$ Smartphone = $\mu 2$ Printed Materials)

Ho5: There were no statistically significant differences in Satisfaction between students learning through smartphones and students learning through printed materials.

($\mu 1$ Smartphone = $\mu 2$ Printed Materials)

Ho6: There were no statistically significant differences in Motivation between students learning through smartphones and students learning through printed materials.

($\mu 1$ Smartphone = $\mu 2$ Printed Materials)

Research Question One: Student Characteristics

Research question number one sought to describe the personal and educational characteristics of students enrolled in secondary agriculture courses in Louisiana. These students were enrolled in Louisiana secondary agriculture classes offering a forestry curriculum in the fall of 2016. In total, 263 students completed all parts of the study. Frequency and percentage were used to describe the personal (see Table 4) and educational (see Table 5) characteristics reported by the sample.

Regarding the sample personal demographics, most were male (73.4%), 15 & 16 years old (60.5%), and White/Caucasian (71.5%).

Table 4

*Personal Characteristics of Louisiana Students Enrolled in Secondary Agriculture Classes
Offering a Forestry Curriculum in the Fall of 2016 (n. = 263)*

Variable	<i>f</i>	%
Gender		
Male	193	73.4
Female	70	26.6
Age		
13	10	3.8
14	37	14.1
15	77	29.3
16	82	31.2
17	44	16.7
18	12	4.6
19	1	0.4
Ethnicity		
Caucasian	188	71.5
African-American	51	19.5
Asian	3	1.1
American Indian	3	1.1
Hispanic	9	3.4
Other	9	3.4

Regarding high school classification, seniors (9.1%) made up the smallest portion of the sample (see Table 5). Almost half (46.8%) of the students indicated they had taken two agriculture classes (see Table 5).

Table 5

Educational Characteristics of Louisiana Students Enrolled in Agriculture Classes Offering a Forestry Curriculum in the Fall of 2016 (n. = 263)

Variable	<i>f</i>	%
Classification		
Freshman (9 th grade)	68	25.9
Sophomore (10 th grade)	92	35.0
Junior (11 th grade)	79	30.0
Senior (12 th grade)	24	9.1
Agricultural Courses		
1	100	38.0
2	123	46.8
3	24	9.1
4	10	3.8
5	2	0.8
6	3	1.1
7	1	0.4

Research Question Two: Achievement

The second research question sought to determine if differences existed in achievement between students who learned with smartphones and those who learned with printed materials. A 30 item pretest was employed to assess prior knowledge and used as a covariate to control for prior knowledge in the analysis. The same 30 items constituted the post-test, and were used to measure achievement differences after the student-centered learning process was complete. All independent and dependent variables of students nested in schools, clustered into groups (i.e. treatment and comparison) were analyzed using Hierarchical Linear Modeling (HLM) with maximum likelihood estimation. The pretest covariate was adjusted by grand mean centering. Centering scores means rescaling them in a way that a researcher can determine if a relationship exists between the predictor and the outcome based on school level factors (Peugh, 2010; Wu, & Wooldridge, 2005). Therefore, grand mean centering was performed on the covariate in SPSS by subtracting the individual students pretest score from the sample mean ($X_{ij} - \bar{X}$).

HLM consisted of three phases. Phase one produced the level one model which measured student differences in achievement between groups as a function of school. Phase two produced the full model which measured group level outcomes on achievement as a function of school while controlling for prior knowledge. Phase three utilized likelihood ratio testing to determine if adding a school level variable improved the level one model. Most importantly, the full model (phase two) specifically addressed research question number 2.

Pretest and Post-test Descriptive Data

The final analysis conducted consisted of a treatment group ($n = 128$) and a comparison group ($n = 135$) that completed the pretest, the learning interventions, and the post-test. The pretest and post-test consisted of 30 items and scores ranged from 0–100%. Pretest mean for the treatment ($n = 128$) group was 16.5% ($SD = 8.29$). Pretest mean for the comparison group (n

= 135) was 17.0% ($SD = 6.05$). Therefore, groups had equivalent prior knowledge before the intervention. The post-test mean for the treatment group ($n = 128$) was 46.0% ($SD = 19.6$) and the post-test mean for the comparison ($n = 135$) was 42.8% ($SD = 20.7$). A box and whisker plot illustrating post-test scores by school can be seen in Appendix S.

Achievement Level One Model

The level one predictor for Achievement was the grouping variable (i.e. treatment or comparison). The intercept in this model was based on fixed effects and was the treatment group mean ($M = 46.0$). No statistically significant difference ($p > .05$) was found in Achievement between the treatment ($n = 128$) and comparison group ($n = 135$) at level one ($\gamma_{00} = -3.26$, $SE = 2.48$, $t = -1.31$, $df = 263$, $F = 1.73$ and $p = .190$) (see Table 6).

Table 6

Level One Model for Achievement Between Treatment and Comparison Group After Accounting for Individual Student Differences as a Function of School

Fixed effects	Coefficient (SE)	t (df)	F (p)
Level one model			
Intercept (μ_j mean)	46.0 (1.78)	25.9 (263)	1281.3 (.000)
Group (α_j) variance nested in school (γ_{00})	-3.26 (2.48)	(-1.31) (263)	1.73 (.190)

Note: Deviance (maximum likelihood) $X^2 = 2325.1$; 3 estimated parameters.

Achievement Full Model

The full model analyzed Achievement between groups as a function of school while controlling for prior knowledge. Specifically, this model addresses research question number 2. Prior knowledge is controlled for in the full model by adding a covariate (pretest) which was centered. The new intercept estimate ($M = 45.8$) was the mean for the treatment group adjusted

for individual differences by school. There was no statistically significant difference ($p > .05$) in Achievement ($\gamma_{00} = .56$, $SE = .35$, $t = 1.62$, $df = 262$, $F = 2.63$ and $p = .106$) between the treatment and comparison groups nested in schools. Therefore, the first null hypothesis was not rejected (see Table 7).

The critical value for X^2 ($df = 3$) was 11.34 ($p < .01$). The -2LL ratio test between the models yielded a statistically significant difference ($p < .01$) when the variance due to group was confounded with the variance due to school ($X^2 = 22.1$, $df = 3$ $p < .01$).

Table 7

Full model for Achievement Between Treatment and Comparison Group as a Function of School While Controlling for Prior Knowledge

Fixed effects	Coefficient (SE)	t (df)	F (p)
Full model			
Intercept (adjusted β_{1j} mean) ^a	45.8 (2.89)	15.8 (14.3)	446.9 (.000)
Grouping (γ_{0j}) variance nested in school (γ_{00})	-3.68 (4.16)	-.844 (13.2)	.782 (.392)
Group * Pretest (β_{0j})	.56 (.35)	1.62 (262)	2.63 (.106)

Note: Deviance (maximum likelihood) $X^2 = 2303.0$; six estimated parameters.

fixed effects = group (IV) and random effects = school (subject)

Research Question Three: Motivation

The final research question sought to determine if differences existed in motivation between students who learned with smartphones and those who learned with printed materials. Motivational constructs (Attention, Relevance, Confidence, Satisfaction, and Motivation) and

grouping variables with students nested in schools were analyzed using HLM with maximum likelihood estimation.

After calculating the Intraclass Correlation Coefficient (ICC) from the unconditional model, the HLM technique consisted of three phases. Phase one produced the level one model which measured student differences in each DV at the school level. Phase two produced the level two model which measured group level outcomes on the DV nested in schools. Phase three utilized likelihood ratio testing to determine if adding a school level variable improved the level one model. Most importantly, the full model (phase two) specifically addressed research question number three.

Attention, Relevance, Confidence, Satisfaction and Motivation Descriptive Data

The final analysis conducted on all variables in the model consisted of a treatment group ($n = 128$) and a comparison group ($n = 135$) that completed the CIS instrument after the learning process was completed. Means (range = 1-5) were utilized for the individual constructs (i.e. Attention, Relevance, Confidence, and Satisfaction) Means from the treatment and comparison group for each construct can be seen in Appendix V. Overall Motivation was calculated with the summated score (range = 34-170) of the Course Interest Survey (CIS). The summated score for the treatment and comparison group can be seen in Appendix V.

Attention Level One Model

The level one predictor for Attention was the grouping variable (treatment or comparison). The intercept in this model was based on fixed effects and was the treatment group mean (3.24). There was no statistically significant difference ($p > .05$) in Attention (see Table 8) between the treatment ($n = 128$) and comparison group ($n = 135$) at level one ($\gamma_{00} = .18$, $SE = .10$, $t = 1.84$, $df = 263$, $F = 3.37$ and $p = .068$).

Table 8

Level One Model for Attention Between Treatment and Comparison Group Before Accounting for Individual Differences

Fixed effects	Coefficient (SE)	<i>t</i> (df)	<i>F</i> (<i>p</i>)
Intercept (μ mean)	3.24 (.07)	46.9 (263)	4764.9 (.000)
Group (α_j) variance nested in school (γ_{00})	.18 (.10)	1.84 (263)	3.37 (.068)

Note: Deviance (maximum likelihood) $X^2 = 617.3$; three estimated parameters.

Attention Full Model

The full model analyzed Attention between groups as a function of school. The new intercept estimate (3.22) was the mean for the treatment group adjusted for individual differences by school. There was no statistically significant difference ($p > .05$) in Attention between the nested treatment ($n = 128$) and comparison group ($n = 135$) at level two ($\beta_{0j} = .10$, $SE = .21$, $t = .476$, $df = 12$, $F = .227$ and $p = .642$). Therefore, the second null hypothesis was not rejected (see Table 9).

The critical value for X^2 ($df = 1$) was 6.63 ($p < .01$). The -2LL ratio test between the models yielded a statistically significant difference when the variance due to group was confounded with the variance due to school ($X^2 = 22.27$, $df = 1$, $p < .01$). This results shows an improvement from the level one model which does not allow for individual student differences and full model which accounts for school level differences.

Table 9

Full Model for Attention Between the Treatment and Comparison Group After Adjusting for Individual Student Differences as a Function of School

Fixed effects	Coefficient (SE)	<i>t</i> (df)	<i>F</i> (<i>p</i>)
Intercept (adjusted β_{1j} mean) ^a	3.22 (.14)	22.2 (13)	972.8 (.000)
Group (β_{0j}) variance nested in schools	.10 (.21)	.476 (12)	.227 (.642)

Note: Deviance (maximum likelihood) $X^2 = 595.1$; four estimated parameters.
fixed effects = group (IV) and random effects = school (subject)

Relevance Level One Model

The level one predictor for Relevance was the grouping variable (treatment or comparison). The intercept in this model was based on fixed effects and was the treatment group mean (3.52). There was no statistically significant difference ($p > .05$) in Relevance (see Table 10) between the treatment ($n = 128$) and comparison group ($n = 135$) at level one ($\gamma_{00} = .08$, $SE = .10$, $t = .833$, $df = 263$, $F = .695$ and $p = .405$).

Table 10

Level One Model for Relevance Between Treatment and Comparison group before accounting for individual differences.

Fixed effects	Coefficient (SE)	<i>t</i> (df)	<i>F</i> (<i>p</i>)
Level one model			
Intercept ($_{1j}$ mean)	3.52 (.07)	48.6 (263)	4955.8 (.000)
Group ($_{0j}$) variance nested in school (γ_{00})	.08 (.10)	.833 (263)	.695 (.405)

Note: Deviance (maximum likelihood) $X^2 = 641.8$; three estimated parameters.

Relevance Full Model

The full model analyzed Relevance between groups as a function of school. The new intercept estimate (3.51) was the mean for the treatment group adjusted for individual differences by school. There was no statistically significant difference ($p > .05$) in Relevance between the nested treatment ($n = 128$) and comparison group ($n = 135$) at level two ($\beta_{0j} = .04$, $SE = .17$, $t = .226$, $df = 11$, $F = .05$ and $p = .826$). Therefore, the third null hypothesis was not rejected (see Table 11).

The critical value for X^2 ($df = 1$) was 6.63 ($p < .01$). The -2LL ratio test between the models yielded a statistically significant difference when the variance due to group was confounded with the variance due to school ($X^2 = 7.4$, $df = 1$, $p < .01$).

Table 11

Full Model for Relevance between the Treatment and Comparison Group After Adjusting for Individual Student Differences as a Function of School

Fixed effects	Coefficient (SE)	t (df)	F (p)
Intercept (adjusted β_{1j} mean) ^a	3.51 (.12)	29.2 (12)	1679.0 (.000)
Group (β_{0j}) variance nested in schools	.04 (.17)	.226 (11)	.05 (.826)

Note: Deviance (maximum likelihood) $X^2 = 634.4$; four estimated parameters.
fixed effects = group (IV) and random effects = school (subject)

Confidence Level One Model

The level one predictor for Confidence was the grouping variable (treatment or comparison). The intercept in this model was based on fixed effects and was the treatment group mean (3.86). There was no statistically significant difference ($p > .05$) in Confidence (see Table

12) between the treatment ($n = 128$) and comparison group ($n = 135$) at level one ($\gamma_{00} = .07$, $SE = .08$, $t = 775$, $df = 263$, $F = .600$ and $p = .439$)

Table 12

Level One Model for Confidence Between Treatment and Comparison group before accounting for individual differences.

Fixed effects	Coefficient (SE)	t (df)	F (p)
Level one model			
Intercept ($_{ij}$ mean)	3.86 (.06)	63.7 (263)	8465.8 (.000)
Group ($_{0j}$) variance nested in school (γ_{00})	.07 (.08)	.775 (263)	.600 (.439)

Note: Deviance (maximum likelihood) $X^2 = 548.1$; three estimated parameters.

Confidence Full Model

The full model analyzed Confidence between groups as a function of school. The new intercept estimate (3.87) was the mean for the treatment group adjusted for individual differences by school. There was no statistically significant difference ($p > .05$) in Confidence between the nested treatment ($n = 128$) and comparison group ($n = 135$) at level two ($\beta_{0j} = .01$, $SE = .15$, $t = .076$, $df = 11$, $F = .006$ and $p = .941$). Therefore, the fourth null hypothesis was not rejected (see Table 13).

The critical value for X^2 ($df = 1$) was 6.63 ($p < .01$). The -2LL ratio test between the models yielded a statistically significant difference when the variance due to group was confounded with the variance due to school ($X^2 = 8.9$, $df = 1$, $p < .01$).

Table 13

Full Model for Confidence Between the Treatment and Comparison Group After Adjusting for Individual Student Differences as a Function of School

Fixed effects	Coefficient (SE)	<i>t</i> (df)	<i>F</i> (<i>p</i>)
Intercept (adjusted β_{1j} mean) ^a	3.87 (.11)	37.1 (12)	2672.5 (.000)
Group (β_{0j}) variance nested in schools	.10 (.15)	.076 (11)	.006 (.941)

Note: Deviance (maximum likelihood) = 539.2; four estimated parameters.

fixed effects = group (IV) and random effects = school (subject)

Satisfaction Level One Model

The level one predictor for Satisfaction was the grouping variable (treatment or comparison). The intercept in this model was based on fixed effects and was the treatment group mean (3.55). There was no statistically significant difference in Satisfaction (see Table 14) between the treatment ($n = 128$) and comparison group ($n = 135$) at level one ($\gamma_{00} = .05$, $SE = .10$, $t = .535$, $df = 263$, $F = .287$ and $p = .593$).

Table 14

Level One Model for Satisfaction Between Treatment and Comparison group before accounting for individual differences.

Fixed effects	Coefficient (SE)	<i>t</i> (df)	<i>F</i> (<i>p</i>)
Level one model			
Intercept (γ_{1j} mean)	3.55 (.07)	49.5 (263)	5110 (.000)
Group (γ_{0j}) variance nested in school (γ_{00})	.05 (.10)	.535 (263)	.287 (.593)

Note: Deviance (maximum likelihood) $X^2 = 636.7$; three estimated parameters.

Satisfaction Full Model

The full model analyzed Satisfaction between groups as a function of school. The new intercept estimate (3.54) was the mean for the treatment group adjusted for individual differences by school. There was no statistically significant difference in Satisfaction between the nested treatment ($n = 128$) and comparison group ($n = 135$) at level two ($\beta_{0j} = -.01$, $SE = .20$, $t = -.05$, $df = 11$, $F = .003$ and $p = .961$). Therefore, the fifth null hypothesis was not rejected (see Table 19).

The critical value for X^2 ($df = 1$) was 6.63 ($p < .01$). The -2LL ratio test between the models yielded a statistically significant difference (see Table 15) when the variance due to group was confounded with the variance due to school ($X^2 = 15.2$, $df = 1$, $p < .01$).

Table 15

Full Model for Satisfaction between the Treatment and Comparison Group after Adjusting for Individual Student Differences as a Function of School

Fixed effects	Coefficient (SE)	t (df)	F (p)
Intercept (adjusted β_{1j} mean) ^a	3.54 (.14)	25.1 (12)	1198.8 (.000)
Group (β_{0j}) variance nested in schools	-.01 (.20)	-.05 (11)	.003 (.961)

Note: Deviance (maximum likelihood) = 621.5; four estimated parameters.
fixed effect was group (IV) and random effect was school (subject)

Motivation Level One Model

The level one predictor for Motivation was the grouping variable (treatment or comparison). The intercept in this model was based on the fixed effects and was the treatment group mean (120.5). There was no statistically significant difference ($p > .05$) in Motivation (see

Table 16) between the treatment ($n = 128$) and comparison group ($n = 135$) at level one ($\gamma_{00} = 3.18$, $SE = 2.95$, $t = 1.10$, $df = 263$, $F = 1.17$ and $p = .281$).

Table 16

Level One Model for Motivation Between Treatment and Comparison group before accounting for individual differences.

Fixed effects	Coefficient (SE)	t (df)	F (p)
Level one model			
Intercept (μ_j mean)	120.5 (2.11)	57.0 (263)	6853.4 (.000)
Group (γ_{0j}) variance nested in school (γ_{00})	3.18 (2.95)	1.10 (263)	1.17 (.281)

Note: Deviance (maximum likelihood) $X^2 = 2415.8$; three estimated parameters.

Motivation Full Model

The full model analyzed Motivation between groups as a function of school. The new intercept estimate (120.2) was the mean for the treatment group adjusted for individual differences by school. There was no statistically significant difference ($p > .05$) in Motivation between the nested treatment ($n = 128$) and comparison group ($n = 135$) at level two ($\beta_{0j} = 1.04$, $SE = 5.94$, $t = .176$, $df = 11$, $F = .031$ and $p = .864$). Therefore, the sixth null hypothesis was not rejected (see Table 17).

The critical value for X^2 ($df = 1$) was 6.63 ($p < .01$). The -2LL ratio test between the models yielded statistically significant differences when the variance due to group was confounded with the variance due to school ($X^2 = 15.1$, $df = 1$, $p < .01$).

Table 17

Full Model for Motivation Between the Treatment and Comparison Group After Adjusting for Individual Student Differences as a Function of School

Fixed effects	Coefficient (SE)	<i>t</i> (df)	<i>F</i> (<i>p</i>)
Intercept (adjusted β_{ij} mean) ^a	120.2 (4.11)	29.2 (12)	1648.7 (.000)
Group (β_{0j}) variance nested in schools	1.04 (5.94)	.176 (11)	.031 (.864)

Note: Deviance (maximum likelihood) = 2400.7; four estimated parameters.
fixed effect was group (IV) and random effect was school (subject)

CHAPTER 5: CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Purpose of the Study

This dual-purpose study (a) compared achievement levels between two groups of students in a forestry curriculum learning with smartphones or with printed materials and (b) determined motivational differences between those groups. The following research questions guided the study:

1. What are the personal and educational characteristics of students enrolled in agriculture courses offering a forestry curriculum in Louisiana?
2. What differences existed in pretest and post-test leaf ID scores between students learning through smartphone technology and students learning through printed materials?
3. What differences existed in student motivation (e.g., Attention, Relevance, Confidence, Satisfaction, and Motivation) between students learning through smartphone technology and students learning through printed materials?

Null Hypotheses

The following null hypotheses guided the data analysis.

Ho1: There were no statistically significant differences in leaf ID pretest and post-test scores between students learning through smartphones and students learning through printed materials.

$$(\mu 1 \text{ Smartphone} = \mu 2 \text{ Printed Materials})$$

Ho2: There were no statistically significant differences in Attention between students learning through smartphones and students learning through printed materials.

$$(\mu 1 \text{ Smartphone} = \mu 2 \text{ Printed Materials})$$

Ho3: There were no statistically significant differences in Relevance between students learning through smartphones and students learning through printed materials.

(μ 1 Smartphone = μ 2 Printed Materials)

Ho4: There were no statistically significant differences in Confidence between students learning through smartphones and students learning through printed materials.

(μ 1 Smartphone = μ 2 Printed Materials)

Ho5: There were no statistically significant differences in Satisfaction between students learning through smartphones and students learning through printed materials.

(μ 1 Smartphone = μ 2 Printed Materials)

Ho6: There were no statistically significant differences in Motivation between students learning through smartphones and students learning through printed materials.

(μ 1 Smartphone = μ 2 Printed Materials)

Participants

Louisiana high school students ($n = 263$) from 13 schools who were enrolled in an agricultural education class in which forestry was taught during the 2016-2017 school year participated in the study. In all, 128 students received the treatment and 135 were in the comparison group. This purposive sample clustered students in groups based on school policy. The treatment group consisted of students attending six schools that allowed students to use smartphones in class. The comparison group consisted of students belonging to seven schools that did not allow students to use smartphones in class.

Design

The pre-experimental study design utilized nonequivalent comparison groups. A treatment group and an untreated comparison group completed a pretest before the intervention

and a post-test afterwards (Campbell & Stanley, 1963). Versions of the nonequivalent control group design are the most commonly used in pre-experimental designs (Shadish et al., 2002). Random sampling and random assignment were not feasible because of differences in parish policies towards the treatment. Since random assignment was not used to assign subjects to levels of the treatment or the level of treatment to the groups, pre-experimental equivalence was not assumed. However, a pretest was employed to establish group equivalence prior leaf identification knowledge.

Students were pretested to determine prior knowledge of leaf identification and to establish equivalence in prior knowledge. The research design regarding student achievement in leaf identification is illustrated in figure three. According to Campbell and Stanley (1963) X represents the independent variable, subscript E represents the experimental level of the treatment, subscript C represents the comparison level of the treatment, and O represents a measurement made during the study. Numerical subscripts are used to indicate when the measurements were taken during the study. This results in O₁ being the pretest for the treatment group and the comparison group. O₂ is the post-test for the treatment group and the comparison group. NR stands for nonrandom assignment (Shadish et al., 2002).

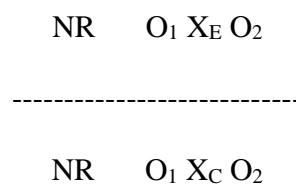


Figure 4. Research design for student achievement. Adapted from Shadish et al., (2002) and Campbell & Stanley (1963), this figure represents participants purposefully (NR) assigned to a treatment group (X_E) or non-treatment comparison group (X_C) which utilized a pretest (O₁) and post-test (O₂) to measure achievement gains after the learning process.

Pretest and post-test data were collected using an online testing platform named Test Generator created by Fain and Company. Owner and CEO David Fain donated the software and 200 user licenses to be used for the study. Test Generator is an online platform that allowed the researcher to receive instant results from the tests, and it eliminated the need for the teachers participating in the study to grade tests. Both groups completed the pretest on Test Generator the day before any leaf identification lessons were taught.

In addition to student achievement in leaf identification, levels of student motivation (Attention, Relevance, Confidence and Satisfaction [ARCS]) were also measured using the course interest survey (CIS) developed by Keller (1988) (see Appendix K). Students completed demographic items, as well as the 34 item CIS instrument via Qualtrics. All students ($n = 263$) who completed the pretest and instructional portion of the study completed the online survey as a pre-requisite to the post test. Data were collected between September 19th and September 29th, 2016.

Treatment

The treatment evaluated in this study was utilizing smartphones to identify tree species and complete formative assessments. Participants engaged in a student-centered learning approach to identify unknown species of trees with their smartphone. Teachers used guided inquiry to facilitate students to identify tree species and formatively assess learning with advanced smartphone applications. The treatment group used three free mobile apps (Leafsnap, Vtree, and Tree Book) to identify tree species. Students took a picture of a leaf with Leafsnap and the app suggested the species identity. The electronic flashcard app, Quizlet, was used by students in the treatment group to complete formative tree identification assessments on their smartphones. The researcher created study sets using Quizlet that the treatment groups used for

practice. Quizlet assesses students through games played on a mobile platform that reports results to the teacher instantly.

Achievement Measurement

The instrument used to collect leaf identification data for this study consisted of a criterion-referenced pretest and post-test (see Appendix H) delivered electronically with Test Generator Web testing software donated by Fain and Company. The leaf identification exam was built by the researcher. Test Generator Web gives the students a picture in a pop-up window which the student closed and answered the identification question that followed. The student could recall the photo at any time during the question attempt as well as scroll back and forth through the questions. The test employed 15 multiple choice items, 10 fill in the blank items, and five true/false items. The scoring of the instrument was based on 100% point scale. Each item was worth 3.33 percentage points with the exception of item number one which was worth 3.34 percentage points.

Thirty leaf samples resting on solid backgrounds were photographed by the researcher using an iPad® camera and uploaded into Test Generator Web. The authentic photos were chosen by the researcher based on experience in the subject of tree identification. Furthermore, the 30 species were chosen because they could be found in the learning materials given to each group of student participants in the study. A panel of three tree identification experts, consisting of two secondary agriculture instructors and Dr. Hallie Dozier, an assistant professor of Forestry Extension and Natural Resources, Louisiana State University, reviewed the exam for content validity. All photos chosen for the instrument were deemed to be of high quality, easy to distinguish, and correct in identification content.

Motivational Measurement

Student motivation was determined by using the Course Interest Survey (CIS) created by Keller (2010). The CIS (see Appendix K) was created to assess student motivation situational to teaching methods. The overall goal Keller (2010) explained for the CIS is to determine how motivated students are with respect to a specific lesson or class being taught. The instrument contained 34 items which measured the four subscales of the ARCS model (Attention, Relevance, Confidence, and Satisfaction) and overall motivational level. The likert-type items recorded student's level of agreement using a five point scale (1 = *not true*; 2 = *slightly true*; 3 = *moderately true*; 4 = *mostly true*; 5 = *very true*). All students in the study completed the instrument online immediately before they logged in to take the post test.

Procedures

Students completed the pretest via Test Generator Web on Monday, September 19th, 2016 by logging into the website with their individual student identification number assigned by the teacher. These tests were automatically graded and reported to the researchers' administration portal on Test Generator Web. The software was programmed so the student could not retake the exam or see their score after completion. Scores were emailed to each teacher the night of the pretest.

On Tuesday, September 20, 2016 teachers began the instructional process by teaching all students in both groups the identifying characteristics of common tree leaves. Participating teachers were provided a PowerPoint presentation that contained foundational knowledge pertaining to the identification of leaf types (see Appendix L). After this initial lesson, the treatment group teachers facilitated their students in the downloading and proper usage of Leafsnap, Vtree, and Tree Book. Students used the apps to identify high quality photographs of

thirty different leaf samples provided by the researcher (see Appendix G). Treatment group teachers also facilitated their students in the downloading and creation of a Quizlet account. Students in the comparison group began identifying the same leaf samples provided by the researcher with the use of leaf identification manuals.

Each of the five days of instruction started with a formative assessment and ended with a formative assessment. Formative assessments were administered to the treatment group with the flashcard app Quizlet. Teachers were given study sets created by the researcher with Quizlet that contained all 30 trees in the study. The comparison group students also began and ended each instructional day with formative assessments that either utilized paper-based flashcards with the trees name, or a scorecard created by the researcher that contained all thirty species (see Appendix I). The remaining instructional time was spent identifying leaf samples using smartphones or printed materials.

Tuesday, September 27th, 2016 was the scheduled day to begin administering the CIS and the post-test (see Appendix H). Students logged in to Qualtrics and completed the online survey that collected demographic data as well the CIS (see Appendix K) before they were allowed by the teacher to log in to Test Generator Web to take the post-test. The post-test window closed on September 29th, 2016.

Data Screening

The initial phase of data analysis began with screening data to ensure quality with a thorough check for missing data, outliers, and normality. Coding for the survey was performed by the researcher a priori in Qualtrics. Grading and reporting results were reported automatically

by the Test Generator Web software package. Pretest scores, post-test scores, demographic, and CIS data were exported into an Excel file for screening ($n = 306$).

Exploring for missing exam data presented seven cases where students missed the pretest and two cases missing post-test data. These nine cases were deleted from the data set. Further, exploring for outliers on the pretest revealed two students in the treatment group with extremely high pre-knowledge scores of tree identification (97% and 70%). These subjects were deleted because they fell three standard deviations above the mean pretest score ($M = 16.5\%$, $SD = 8.29$). It was later discovered that these two students trained on the schools' FFA CDE forestry team for two years. Post-test scores revealed three subjects in the comparison group who scored a zero on the post-test. Those three outliers were deleted from the data based on criteria they fell three standard deviations below the post-test mean ($M = 42.8\%$, $SD = 20.7$). Exploring the remaining data resulted in 29 cases with missing data in at least one construct item on the CIS instrument. All 29 cases missing construct responses were deleted from the data set. Three additional cases were found to have missing demographic data, but were not deleted from the data set. After data screening, the treatment group consisted of 128 students and the comparison consisted of 135 students.

The assumption of normality for the dependent variables (i.e., post-test, Attention, Relevance, Confidence, Satisfaction and Motivation) was also tested. Kolmogorov-Smirnov (K-S) testing suggested the distributions for each DV were not significantly non-normal. Furthermore, visual inspection of histograms and scatterplots were conducted by the researcher under the guidance of a faculty member in educational research. When a sample size is larger

than 200 it is better to evaluate normality visually (Field, 2009). Visual inspection of the distributions for each DV supported the assumption of normality.

Furthermore, in samples over 200, skewness values compared to zero are more useful than Shapiro-Wilk significance tests for skewness (Field, 2009). Skewness and kurtosis values were converted to z -scores to determine the extent of skewness and kurtosis. Skewness and kurtosis z -scores did not exceed the critical value of 2.58 (Field, 2009) for this sample size. Therefore, it was concluded that the data were not excessively skewed.

Data Analysis

This data was analyzed with IBM SPSS version 23 for Windows®. Participant responses were coded in Qualtrics. The first research question asked, what are the personal and educational characteristics of students enrolled in agriculture courses in Louisiana? Gender, race, and high school classification, were described using frequency and percent, which is appropriate for nominal and ordinal data. Age and number of agricultural classes taken were interval data and were described using means and standard deviations.

Research question number two asked if differences existed in leaf identification achievement between students who were taught with smartphones and those taught without smartphones. The pretest and post-test leaf identification examinations completed on Test Generator Web provided individual student test scores based on 100 points.

The data collected for inferential analysis in this study was a classic example of nested data (Raudenbush & Byrk, 1986). The treatment and comparison group were comprised of students nested within schools. Because the students were grouped within their natural school setting, the synergy between students in the same school makes them more alike than students in the other schools (Raudenbush & Byrk, 2002). As a result, the measurements of students pretest and post-

test achievement cannot be considered statistically independent (Raudenbush & Byrk, 2002). Traditional statistical approaches like ANOVA and linear regression are unsuitable for groups comprised of sub-groups of students collected from different regions (Peugh, 2010; Raudenbush & Byrk, 2002). Therefore, a two-level hierarchical linear model (HLM) with fixed effects was employed to determine if differences existed between the treatment and comparison groups. This statistical method has advantages over tests that assume independence of groups because it accounts for individual student variance in the dependent variable (DV) at the school level. The independent variable (IV) in the model that predicted achievement was group (i.e., treatment or control). The dependent variable (DV) was post-test score on the leaf identification test. The covariate was the pretest (centered). Grand mean centering is most often preferred when models will involve level one and level two predictors (Peugh, 2010; Wu & Wooldridge, 2005). Centering scores means rescaling them in a way that a researcher can determine if a relationship exists between the predictor and the outcome based on school level factors (Peugh, 2010; Wu, & Wooldridge, 2005). Therefore, grand mean centering was performed on the covariate in SPSS by subtracting the individual students pretest score from the sample mean ($X_{ij} - \bar{x}$).

It should be noted that not all nested data sets warrant HLM (Peugh, 2010). Several steps were taken to ensure HLM was the appropriate statistical procedure for the data set collected for this study. Intraclass correlation coefficients (ICC) were calculated to determine if sufficient variance existed across individual students within schools to warrant HLM (McGraw & Wong, 1996). In order to determine the ICC for the DV, an unconditional model (i.e. one-way random effects ANOVA) was utilized (Castro, 2001). An unconditional model for post-test by school was executed using the mixed model command in SPSS (Peugh & Enders, 2005). In all, school effects accounted for 9.4% of the variance in post-test scores.

Studies have supported that ICC values between five and 20% warrant social science research to utilize HLM (Muthén, 1994; Raudenbush & Bryk, 2002; Peugh, 2010). This variation across schools suggested post-test scores are not statistically independent and HLM is warranted to properly analyze the nested data.

After calculating the ICC from the unconditional model, the HLM technique had three steps. The first step produced the level one model which measured student differences in achievement at school level. The second step produced the full model which measured group level outcomes on the DV nested in schools while controlling for prior knowledge. The third step utilized likelihood ratio testing to determine if adding a school level variable improved the model. This model building process was necessary to determine if adding school level effects improved the model. Most importantly, step two (full model) specifically addressed research question number two.

The following equations pertain to building the models for research question number two. The independent variable was the group (i.e. treatment or control), the dependent variable was post-test.

$$\text{Level 1: } Y_{ij} = \beta_j + \beta_1 \text{ Pre}_{ij} + r_{ij}$$

Where Y_{ij} = post test score (Y) for student (i) nested in school (j), β_j = mean achievement score in school (j), β_1 = slope relating pretest to post-test [this value does not vary by school], Pre_{ij} is the score of student (i) in school (j) on the pretest, and r_{ij} = residual of for student (i) in school (j). The pretest scores were grand-mean centered for these analyses. The Level 2 model can be depicted as follows:

$$\text{Level 2: } \beta_j = \gamma_{00} + \gamma_1 Z_{1j} + u_j$$

Where β_j is the adjusted mean post-test in school (j), γ_{00} is the overall adjusted mean post-test for schools, Z_{1j} is an indicator variable [0=treatment school, 1=comparison school], γ_1 captures the difference in means for the treatment and control schools, and u_j is random error. The full model is as follows:

$$Y_{ij} = \gamma_{00} + \gamma_1 Z_{1j} + \beta_1 \text{Pre}_{ij} + r_{ij} + u$$

Research question number three asked what differences existed in student motivation (Attention, Relevance, Confidence, and Satisfaction) between students learning through smartphones and students learning with printed materials.

Motivation can be affected by perceived performance on an exam (Keller, 2010). Therefore, to ensure the students perceptions were directed solely at the motivation they received from the instructional methods, the CIS was taken by the students as a prerequisite to the leaf identification post-test. Both the treatment and comparison groups completed the CIS instrument on Qualtrics and the data was instantly reported to the researcher by the Qualtrics system. The independent variable was group (i.e., treatment or control). The dependent variables were the four constructs of the ARCS (Attention, Relevance, Confidence, and Satisfaction) as well as the overall Motivation score. Since the instrument was only completed one time at the end of the study, the HLM could not control for prior motivation. An unconditional model was executed and an ICC was calculated for each DV. The ICC revealed that all constructs in the scale warranted HLM.

After calculating the ICC from the unconditional model, the HLM technique had three steps. The first step produced the level one model which measured student differences in each DV at the school level. The second step produced the full model which measured group level

outcomes on the DV nested in schools. The third step utilized likelihood ratio testing to determine if adding a school level variable improved the level one model. This model building process was necessary to determine if adding school level effects improved the model. Most importantly, step two (full model) specifically addressed research question number three.

The following pertains to building the models for research question number three. The independent variable was group (treatment or control), the dependent variables were Attention, Relevance, Confidence, Satisfaction and Motivation.

$$\text{Level 1: } Y_{ij} = \beta_{ij} + r_{ij}$$

Where Y_{ij} is the construct score (Y) for individual student (i) nested in schools (j), β_{ij} is the mean construct score for a given school and r_{ij} is the residual of individual student difference in construct score around the school mean. School names were deleted and each school was given a school number to account for j in the analysis.

$$\text{Full Model: } \beta_{1j} = \gamma_{00} + (\text{GROUP})_{1j} + u_{1j}$$

Where β_{1j} is the mean construct score for treatment group schools, γ_{00} is the grand mean, $(\text{GROUP})_{1j}$ is the treatment group variable, u_{1j} is the treatment group schools deviation from the grand mean.

$$\text{Full Model: } \beta_{0j} = \gamma_{00} + (\text{GROUP})_{0j} + u_{0j}$$

Where β_{0j} is the mean construct score for comparison group schools, γ_{00} is the grand mean, $(\text{GROUP})_{0j}$ is the comparison group variable, u_{0j} is the comparison group schools deviation from the grand mean.

Summary of Findings

Research Question One

Concerning the treatment group demographic data, it was determined that more than two-third (67.7%) were male. Results also established that most were White/Caucasian (77.3%) and between the ages of 15 and 17 (82.8%). In terms of classification, 40.6% were in 10th grade and 32.3% were in 11th grade. Nearly one quarter (24.2%) were in their first agriculture class and over half (59.4%) were taking their second agricultural class of their high school career. In the comparison group, it was calculated that over three-quarter (79.3%) were male. Furthermore, 65.9% were White/Caucasian and 25.2% were African–American. The majority (84.4%) of comparison group students were between 14 and 16 years of age. In terms of classification, 36.3% were 9th graders, 28.9% were 10th graders and 28.1% were 11th graders. Nearly one-half (49.6%) were taking their first agriculture class and 34.8% were taking their second agriculture class of their high school career.

Research Question Two

The full hierarchical linear model analyzed Achievement between groups as a function of school while controlling for prior knowledge. No statistically significant difference ($p > .05$) was found between the treatment and comparison group in tree identification achievement. As a result, the researcher failed to reject the null hypothesis associated with research question two.

Research Question Three

The full hierarchical linear model analyzed Attention, Relevance, Confidence, Satisfaction and Motivation between groups as a function of school. No statistically significant differences ($p > .05$) were found between the treatment and comparison group in any

motivational construct. As a result, the researcher failed to reject the five null hypotheses associated with research question three.

Conclusions and Discussion

Student Personal and Educational Characteristics

Analysis of data concerning Louisiana agricultural education students concluded that the majority of participants were male, White/Caucasians, and were between 15 and 16 years old. The greatest number of students had completed one agricultural education course prior to the study.

Achievement Differences between Smartphones and Printed Materials

Analysis of data concerning students using smartphones to improve leaf identification achievement failed to provide a statistically significant difference when compared to students using printed materials as determined on a multilevel analysis of post test scores. Consequently, null hypothesis number one (H_{01}) was not rejected. The mean score on the post-test for the treatment group (46.0%) was slightly higher than the comparison group (42.8%). This finding refutes research that suggests when students use more advanced functions on their phones for learning, achievement gains are noticeable (Bennett, Maton & Kervin, 2008; Liu et al., 2015; Su & Cheng, 2015; Liu & Huang, 2015; Thomas & Muñoz, 2016). Furthermore, this finding is inconsistent with research that suggests formative assessment executed on mobile platforms increases knowledge (Sly, 1999; Buchanon, 2000; Wang, 2007; Lu, 2008; Aldon & Dempsey, 2016). Results from this study support the notion that smartphones are not superior to printed materials for learning in a student-centered approach (Chen et al., 2015; Traxler, 2007; Vacik et al., 2006; Yuping, Xibin, & Juan, 2015). This study supports the Theory of Learning for the Mobile Age (TLMA) which suggested that all ML factors are interconnected (Sharples & Taylor,

2007), and consequently neglecting some factors (i.e. Communication and Control) in ML may have negative effects on other factors (i.e. Objects, Tools, and Subjects). However, it is important to point out that smartphones did not diminish student achievement in a student-centered learning environment.

Motivational Differences between Smartphones and Printed Materials

Analysis of data concerning students using smartphones to improve learner motivation failed to provide a statistically significant difference when compared to students using printed materials as determined on a multilevel analysis of motivational constructs. Consequently, none of the null hypotheses aligned with research question three were rejected. Although not statistically significant, the comparison group reported higher ratings on all five motivational constructs (Attention, Relevance, Confidence, Satisfaction and overall Motivation). These results are inconsistent with findings that support the idea smartphones can increase learner motivation (Burns-Sardone, 2014; Hwang & Chang, 2011; Jiao, 2015; Su & Cheng, 2015; Lin-Siegler, Dweck & Cohen, 2016; Liu & Huang 2015; Traxler, 2007).

Implications

The results of this study indicate that using smartphones in the context of tree identification does not improve achievement or learner motivation. One important implication of this finding is that smartphones did not diminish achievement or learner motivation. Though not statistically significant, the comparison group reported slightly higher motivation scores on four out of five constructs measured by the researcher. Why did that happen? Perhaps the comparison group had a learning experience that was more dynamic than the treatment group. Is it possible that the learning methods used in the study were more engaging than what the comparison group students had experienced in past agricultural courses?

None of the treatment group schools were in their first year of BYOD, therefore, the novelty effect of using smartphones for learning was minimal. All of the treatment students were accustomed to using their phones in class from years of BYOD in their schools. Perhaps these digital natives (Prensky, 2001) were desensitized to the smartphone and its effectiveness as a motivator was negated. Were the learning curves for tree identification apps too much to overcome? Did the treatment group experience frustrations due to slow internet connection or some other common technological issue? Technology malfunction increases frustration and may hinder learning motivation (Keller, 2010). Comparison group students used printed books which may have been less frustrating to manipulate than smartphone applications. Perhaps it was more frustrating to use the technology but more user friendly to flip pages in a book. Students in the treatment group also lost learning time on the first day because they had to download the applications and familiarize themselves with the apps. Did this effect their attitude by making them feel like they were behind? Treatment group students were able to take formative tests 24 hours a day on their phones while the comparison group was limited to formative quizzes during agricultural class. Did the treatment group students access the apps outside of classroom time? Did the ubiquitous nature of the learning apps make the material boring for the treatment group? Did the treatment group take the material for granted since it was always easily accessible?

Teachers in the treatment group could have been faced with integration barriers such as student skill level, lack of time to plan, and technical support (Kotrlik et al., 2003; Coley et al., 2015) that decreased their perceived value of using the specific apps used in this study. If so, the teachers could have negatively impacted student motivation towards using the technology chosen for this study.

Though not statistically significant, the treatment group did score four percent higher on the post-test than the comparison group. Why was it not even higher? None of the students who completed this study demonstrated an extensive prior knowledge in forestry. The average pretest mean was approximately 16% for all participants. Only 65 students made a score on the post test that would be consider a C letter grade or higher. Why was that the case? Did they need more time? Did they perceive the pictures on the formative assessments were not sufficient enough to render a positive identification on the post-test? Did taking the tests on test generation software cause any anxiety? Answers to these questions could bring meaningfulness of the low post-test achievement scores.

The treatment group employed advanced smartphone functions instead of the basic core functions of their phones (Liu et al., 2015; Thomas & Muñoz, 2016) to solve problems of unidentified species of trees. Were these problems not meaningful enough (Leslie, 2014) to spark student interest (Padeste et al., 2015) and inspire them to inquire deeper understanding (Kuhlthau, Maniotes & Caspari, 2015)? The image sensing application Leafsnap allows students to practice the 21st century skill of creating (Thomas & Muñoz, 2016) their own virtual leaf collection inside the application (Su & Cheng 2015). Perhaps blending a virtual learning environment (Kuznekoff, Munz, & Titsworth, 2015) via social media based on sharing (Moskal, Dziuban, & Hartman, 2013) students' leaf collections could have increased the treatment groups leaf identification skills. Perhaps the students needed more interaction and communication with one another through their mobile devices (Kukulska-Hulme, 2010) to solidify what they were learning.

Students in both groups played formative assessment type games which were designed to give students as many repetitions identifying the leaf samples as possible. The only difference in

the games was paper index cards with names printed on them for the comparison group versus the touch screen of a smartphone for the treatment group. Both groups also received live samples from the researcher. Perhaps more than one study set should have been created by the researcher on Quizlet and more appropriately, perhaps the students would have higher achievement if they created their own study sets (Hwang & Chang, 2011; Jiao, 2015). Perhaps, the pictures were too small on the phone screens to determine identifying characteristics of the leaf pictures on Quizlet. Lastly, the teachers were facilitators of the groups but were not tree identification experts. The recruitment of teachers eliminated those who were experts at teaching tree identification. Were the students ready to teach themselves (Edelson, Gordin, & Pea, 1999)? Had the previous educational experiences of the treatment group students prepared them for a student-centered approach that focused on learning more than teaching (Kuhlthau, Maniotes, & Caspari, 2015)?

Recommendations

Recommendation for Research

Although this study did not provide a statistically significance differences in leaf identification achievement or motivation, optimism about the future of smartphones in secondary agricultural education exists. Because the study only consisted of one lesson (tree identification) and lasted 8 eight days, it should be replicated in a semester long time period that covers a more diverse agricultural curriculum. Longer duration of smartphone use spread across lessons in animal science, plant science, and agricultural mechanics may yield more substantial gains in achievement and motivation due to the treatment. A delayed post-test should also be administered to determine if either group retained leaf identification knowledge better than the other.

This research study analyzed data through the lens of the Theory of Learning for the Mobile Age (TLMA) and focused more abundantly on the interaction between Objects, Tools, Subjects, and Technology (Sharples & Taylor, 2007) and less on the factors Communication, Context, and Control. Sharples and Taylor (2007) and the Task Model (see Figure 3) clearly illustrate that all of the factors are interconnected. Also, this study operated in the technology layer. However, the theory offered an abstract domain called the semiotic layer that attempts to understand metacognition in ML research. Therefore, future studies in agricultural education that employ ML as a theoretical framework should investigate the interconnected factors in the Task Model and the more abstract constructs the semiotic layer offered by TLMA.

Recruitment efforts provided only a few potential treatment schools available for the study due to school board policy. This eliminated the opportunity to randomly assign groups to levels of the treatment. Consequently, teachers and students were sampled conveniently based on their parish policy towards phones in the classroom. As society continues to embrace smartphones as educational tools and school boards increasingly adopt bring your own device (BYOD) policies, the potential to introduce this study to a larger sample may become possible. If so, then teachers and students should be randomly assigned to the treatment to reduce the threats to external validity this study likely experienced.

Students in the treatment group had the opportunity to practice formative assessments on their smartphones 24 hours a day during the study. Smartphone applications like Leafsnap, V-tree, and Quizlet offered ubiquitous learning, but the question of whether or not the students used it ubiquitously was left unanswered. Future research should measure student learning attempts outside of formal class time to determine how much formative assessment repetition is related to achievement.

Future research should explore and compare various mobile operating systems and their usefulness for learning. Some smartphone applications are only available in the Apple store and some are exclusive to Android. Furthermore, assessments from web-based software like the one used in this study (Test Generator Web by Fain and company) warrants investigation of its own. Qualitative methods should be included to help determine what barriers agricultural education students and teachers perceived when using smartphones in an inquiry based learning approach to identify tree species.

The foremost challenge in information age schools is preparing students to thrive in a technologically saturated environment (Kuhlthau, Maniotes & Caspari, 2015). Future research in agricultural education should go beyond foundational knowledge achievement and incorporate smartphones applications used for 21st century skills such as creating electronic portfolios and posting demonstration videos online. Student collaboration was encouraged by the researcher but was not required nor measured in this study. In the future, a mobile collaborative element needs to be added to the research design that encourages students to discuss what is being taught outside of the formal classroom.

Recommendations for Practice

Although this research did not produce a statistically significant finding, it does support that using smartphones does not reduce achievement or motivation. Therefore, agricultural educators can implement smartphones in their teaching (as policy permits) with confidence that learning will not be impeded. In terms of preservice teacher education, university faculty should consider adding student-centered smartphone applications into methods coursework.

Modern students in America are digital natives (Prensky, 2001) who prefer a student-centered approach to self-directed learning that incorporates current technology (Jung, 2014).

Though millennial students may be perceived as superior to some of their teachers in terms of technological savvy, they still adopt their teachers' attitudes and mimic their actions (Thomas & Muñoz, 2016). Teachers should be mindful of this fact when discussing smartphones with their students; especially if their attitude is negative towards using smartphones. Guided inquiry success relies on a positive relationship between the guiding teacher and the exploring student (Kuhlthau, Maniotes & Caspari, 2015). This relationship could be difficult to establish if the teacher is negative towards smartphones. Research results support the concept that students most often adopt the same smartphone features their teachers use most frequently in the classroom (Obannon & Thomas, 2014). Therefore, agricultural educators who desire to incorporate smartphones should seek out training that enhances their practice of smartphones in classroom teaching.

Most teachers prefer to learn from others who have already mastered the nuances of an innovation (Rogers, 2003). The same holds true for agricultural educators and smartphone applications. Educational leaders should be strategic in creating opportunities for agricultural educators to learn about smartphone applications from one another. Best practices for agricultural teachers in Louisiana could be implemented at events that provide large gatherings of agricultural teachers. These events include FFA career development events, leadership camps, Louisiana Agriscience Teachers Association (L.A.T.A.) conference, State FFA convention, and National FFA convention.

Major Contributions of this Study

Contribution to Literature and Research

This pre-experimental study is the first of its kind in the agricultural education literature to determine whether smartphones affected achievement and motivation in the context of leaf

identification. Though no statistically significant differences were found in achievement and motivation, the findings suggest that smartphones do not decrease learning or motivation. Practicing and pre-service teachers should consider the smartphone a learning enabler and should consider implementing mobile learning into their pedagogy to increase variability in teaching (Rosenshine & Furst, 1971).

This study did not ignore the individual differences that existed between students who comprised the treatment and comparison group. Because the students were grouped within their natural school setting, the synergy between students in the same school made them more alike than students in the other schools (Raudenbush & Byrk, 2002). Furthermore, groups contained clusters of students nested in 13 schools from 13 diverse communities across a very diverse state, and therefore independence in test scores and self-selected motivational scores was not assumed. Individual differences were accounted for statistically through hierarchical linear modeling (HLM) (Raudenbush & Bryk, 2002). Failure to recognize the hierarchal nature of a nested data set in educational settings may result in unreliable analyzation of data and even misguided educational policy (Raudenbush & Byrk, 2002). Although no statistically significant difference was found in achievement or motivation between the groups, 2 Log likelihood ratios (2LL) were statistically significant ($p < .001$) between all level one and full models used in the data analysis. This suggests that HLM was the most salient analysis for this type of nested data, and future research in agricultural education should utilize HLM analysis when nested data exists. An independent samples t-test was conducted on the dependent variable achievement for the purpose of comparison to the results of the HLM procedure. No statistically significant differences existed between the treatment and comparison groups as a result of the t-test.

No teacher level factors were collected in this study. The only school level factor entered into this data analysis was an identification number for each school that allowed the model to adjust intercepts based on individual school mean scores. This aggregated the treatment as a function of school and thus accounted for the previously mentioned individual differences due to the nested data. However, if teacher level factors such as age, experience, certifications, etc. were collected they could be entered into the model as a predictor at level two and potentially increase the models accuracy to detect significant differences. Likewise, school level factors such as free and reduced lunch data, geographic location, rural/urban/suburban, teacher to student ratios, etc. could be assessed in future research and entered as a predictor at level two to more accurately detect significant gains as a function of treatment by school and teacher. These types of teacher level and school level factors added to a model allowed Raudenbush & Byrk (1986) to report in a groundbreaking study that achievement differences in private and public schools were not statistically significant. Had a traditional approach like ANOVA been used for that study, individual differences and school level effects would have been ignored and results could have been misleading. Lastly, when statistically significant differences are found with HLM, the analysis also has the ability to detect which percent of the variance is explained by each independent variable entered into the model. This positive aspect of HLM will allow future agricultural education researchers to pinpoint salient variables accurately and provide more meaningful recommendations which will positively impact the future of the profession.

Contribution to Practice

The findings of this study provide a very robust statistical analysis that failed to find significant differences in achievement and motivation between students who used smartphones and those who did not use smartphones. Most importantly, the findings suggest that smartphones

are a valid learning tool because they do not diminish learning or motivation. Agricultural educators should incorporate smartphones into their teaching practice without reservations of its effectiveness as a learning enabler.

Final Thoughts

The researcher's original recruitment attempt collected data from Louisiana agricultural educators pertaining to local school board policy towards smart phones. Unfortunately, only twenty teachers (representing seven parishes) reported policy allowing students to use smartphones in agricultural classrooms for educational purposes. The data suggests that parishes which allow smartphones lie in more cosmopolitan areas of the state. Only one rural parish reported allowing students to use smart phones in the classroom. This study provides evidence that smartphones do not diminish achievements gains nor decrease motivation to learn. It also does not suggest that smartphones are a great improvement over conventional learning materials in an inquiry based learning environment. Therefore, each school board in Louisiana should approach their policy on student smartphones with an open mind and base their decision towards banning phones on the needs of their particular student body. In terms of compatibility, students are starving for the adoption of smartphones in the classrooms (Coley et al., 2015). The stand to eliminate all cell phones eliminates the opportunity for well-managed classroom teachers to more effectively reach the students of today in a means they so readily accept.

Limitations

Finding from this study should not be generalized to any populations outside of the study sample. School selection procedures were based on volunteers and school board policy. Therefore, random assignment was not utilized to control effects of extraneous variables. Experimental mortality did exist in this study as one teacher had to stop for personal reasons after the pretest was administered. As a result, incomplete data existed.

REFERENCES

- Adas, D., & Bakir, A. (2013). Writing difficulties and new solutions: Blended learning as an approach to improve writing abilities. *International Journal of Humanities and Social Science*, 3(9), 254–266. Retrieved from <https://staff-old.najah.edu/sites/default/files/28.pdf>
- Adams, J. S. (1956). Inequity in social exchange. *Advances in experimental social psychology*, 2, 267–299. doi: 10.1016/S0065-2601(08)60108-2
- Aliaga, O., Kotamraju, P., & Stone, J. (2014). Understanding participation in secondary career and technical education in the 21st Century: Implications for policy and practice. *High School Journal*, 97(3), 128–158. doi: 10.1353/hsj.2014.0002
- Adlon, G., & Dempsey, M. (2016). Role of technology in promoting formative assessment practices in science classes. In *International Conference: New Perspectives in Science Education* (pp. 376–380). Pixel Libreria Universitaria.
- Anderson, J. R., Corbett, A. T., Koedinger, K. R., & Pelletier, R. (1995). Cognitive tutors: Lessons learned. *Journal of the Learning Sciences*, 4, 167–207.
- Anderson, M. (2015). Technology device ownership: 2015. *Pew Research Center*. Retrieved from <http://www.pewinternet.org/2015/10/29/technology-device-ownership-2015/>
- Arends, R. (2014). *Learning to teach*. New York, NY: McGraw-Hill Higher Education.
- Arikan, Y. D., & Ozen, S. O. (2015). A learning environment for English vocabulary using quick response codes. *Educational Sciences: Theory & Practice*, 15(2), 539–551. doi: 10.12738/estp.2015.2.2139
- Balscheid, M. A., & Thompson, G. W. (2002). Integrating science in agricultural education: Attitudes of Indiana agricultural science and business teachers. *Journal of Agricultural Education*, 43(2), 1–10. doi: 10.5032/jae.2002.02001
- Balmford, A., Clegg, L., Coulson, T., & Taylor, J. (2002). Why conservationists should heed Pokémon. *Science*, 295(5564), 2367b–2367. doi: 10.1126/science.295.5564.2367b
- Barkley, J. E., Lepp, A., & Salehi-Esfahani, S. (2015). College students' mobile telephone use is positively associated with sedentary behavior. *American Journal of Lifestyle Medicine*, 10(6), 437–441. doi: 10.1177/1559827615594338
- Bates, R., & Khasawneh, S. (2007). Self-efficacy and college students' perceptions and use of online learning systems. *Computers in Human Behavior*, 23(1), 175–191. doi: 10.1016/j.chb.2004.04.004

- Bebbington, A. (2005). The ability of A-level students to name plants. *Journal of Biological Education*, 39(2), 62–67. doi: 10.1080/00219266.2005.9655963
- Bell, B., & Cowie, B. (2001). The characteristics of formative assessment in science education. *Science Education*, 85, 536–553. doi: 10.1002/sce.1022.abs
- Bell, R. L., Smetana, L., & Binns, I. (2005). Simplifying inquiry instruction. *The Science Teacher*, 72(7), 30–33. Retrieved from https://www.mun.ca/educ/undergrad/scied/files/bell_simplifying-inquiry_2005.pdf
- Bennett, S., Maton, K., & Kervin, L. (2008). The ‘digital natives’ debate: A critical review of the evidence. *British Journal of Educational Technology*, 39(5), 775–786. doi: 10.1111/j.1467-8535.2007.00793
- Berk, L. E., & Winsler, A. (1995). *Scaffolding children’s learning: Vygotsky and early childhood education*. Washington, DC: National Association for the Education of Young Children.
- Berlyne, D. E. (1954). A theory of human curiosity. *British Journal of Psychology*, 45(3), 180–191. doi: 10.1111/j.2044-8295.1954.tb01243.x
- Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher Education*, 32(3), 347–364. doi: 10.1007/bf00138871
- Black, P., & William, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, 5(1), 7–74. doi: 10.1080/0969595980050102
- Bohlin, R. M. (1987). Motivation in instructional design: Comparison of an American and a Soviet model. *Journal of Instructional Development*, 10(2), 11–14. doi: 10.1007/bf02905786
- Brockman, C. F., & Merrilees, R. A. (1991). *Important forest trees of the eastern United States*. Washington D.C: Western Publishing Company.
- Bryson, D. (2012). Using flashcards to support your learning. *Journal of Visual Communication in Medicine*, 35(1), 25–29. doi: 10.3109/17453054.2012.655720
- Buchanan, T. (2000). The efficacy of a world-wide web mediated formative assessment. *Journal of Computer Assisted Learning*, 16, 193–200. doi: 10.1046/j.1365-2729.2000.00132.x
- Bunch, J. C., Robinson, J. S., Edwards, M. C., & Atonenk, P. D. (2014). How a serious digital game affected students’ animal science and mathematical competence in agricultural education. *Journal of Agricultural Education*, 55(3), 57–71. doi: 10.5032/jae.2014.03057
- Burns-Sardone, N. (2014). Making a case for BYOD instruction in teacher education. *Issues in Informing Science and Technology*, 11(1), 192–200. Retrieved from <http://iisit.org/Vol11/IISITv11p191-201Sardone0505.pdf>

- Burton, L. D. (2000). *Introduction to forestry science*. Albany, NY: Delmar Publishing.
- Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental design for research*. Chicago, IL: Rand McNally & Company.
- Candy, P. C. (1991). *Self-direction for lifelong learning: A comprehensive guide to theory and practice*. San Francisco, CA: Jossey-Bass.
- Carnevale, A. P., Smith, N., & Strohl, J. (2010). *Help wanted: Projections of jobs and education requirements through 2018*. Washington, DC: Center on Education and the Workforce, Georgetown University.
- Castro, S. (2002). Data analytic methods for the analysis of multilevel questions: A comparison of intraclass correlation coefficients, $r_{wg(j)}$, hierarchical linear modeling, within- and between-analysis, and random group resampling. *The Leadership Quarterly*, 13(1), 69–93. doi: 10.1016/S1048-9843(01)00105-9
- Cerutti, G., Tougne, L., Vacavant, A., & Coquin, D. (2011). *A parametric active polygon for leaf segmentation and shape estimation*. Proceedings of the 7th International Symposium on Visual Computing, Las Vegas, NV. Abstract retrieved from <https://hal.inria.fr/file/index/docid/622269/filename/667.pdf>
- Chen, Y., & Katz, J. E. (2009). Extending family to school life: College students' use of the mobile phone. *International Journal of Human Computer Studies*, 67(2), 179–191. doi: 10.1016/j.ijhcs.2008.09.002
- Chen, B., Seilhamer, R., Bennett, L., & Bauer, S. (2015). Students mobile learning practices in higher education: A multi-year study. Retrieved from <http://er.educause.edu/articles/2015/6/students-mobile-learning-practices-in-higher-education-a-multiyear-study>
- Coley, M. D., Warner, W. J., Stair, K. S., Flowers, J. L., & Croom, D.B. (2015) Technology usage of Tennessee agriculture teachers. *Journal of Agricultural Education* 56(3), 35–51. doi: 10.5032/jae.2015.03035
- Conroy, C. A., Dailey, A. L., & Shelley-Tolbert, C. A. (2000). The move to agriscience and its impact on teacher education in agriculture. *Journal of Agricultural Education*, 41(4), 51–61. doi: 10.5032/jae.2000.04051
- Chopra, M. (2016). *Tree ID: An image recognition system for plant species identification*. Retrieved from <http://manuchopra.in/rest/tree.pdf>
- Christin, G. N., Tamin, O. Z., Santosa, I., & Maharja, M. (2014). Adjustment of daily activities: The influence of smartphone adoption on the travel patten of mobile professionals in the greater Jakarta area. *Journal of Engineering and Technological Sciences*, 46(4), 394–409. doi: 10.5614/j.eng.technol.sci.2014.46.4

- Comer, J. C., & Wikle, T. A. (2008). Worldwide diffusion of the cellular telephone, 1995-2005. *Professional Geographer*, 60(2), 252–269. doi: 10.1080/00330120701836303
- Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York, NY: Harper and Row.
- Cullen, T. A., & Greene, B. A. (2011). Preservice teachers' beliefs, attitudes, and motivation about technology integration. *Journal of Educational Computing Research*, 45(1), 29–47. doi: 10.2190/ec.45.1.b
- Culp, K. M., Honey, M., & Mandinach, E. (2005). A retrospective on twenty years of educational technology policy. *Journal of Educational Computing Research*, 32(3), 279–307. doi: 10.2190/7w71-qvt2-pap2-udx7
- Cumming, D. R., Furber, S. B., & Paul, D. J. (2014). Beyond Moore's law. *Philosophical Transaction of the Royal Society*, 372, 20130376. doi: 10.1098/rsta.2013.0376
- Deci, E. L., & Ryan, R. M. (1975). *Intrinsic motivation*. New York, NY: Plenum Press.
- Dietz, S., & Henrich, C. (2014). Texting as a distraction to learning in college students. *Computers in Human Behavior*, 36, 163–167. doi: 10.1016/j.chb.2014.03.045
- Dollinger, S. J. (2000). Locus of control and incidental learning: An application to college student success. *College Student Journal*, 34(4), 537-540. Retrieved from <https://www.questia.com/library/journal/1G1-69750050/locus-of-control-and-incidental-learning-an-application>
- Downes, S. (2005). *An introduction to connective knowledge*. Retrieved from <http://www.downes.ca/post/33034>
- Dozier, H., & Mills, R. H. (2005). *Leaf key to common trees in Louisiana* (Publication No. 1669). Retrieved from LSU AgCenter website: <http://www.lsuagcenter.com/NR/rdonlyres/BA8FFA18-B7CD-4D98-88FF-AF234D5F9ACD/18437/pub1669LeafKey.pdf>
- DuCette, J., & Wolk, S. (1973). Cognitive and motivational correlates of generalized expectancies for control. *Journal of Personality and Social Psychology*, 26(3), 420–426. doi: 10.1037/h0034486
- Dunn, K. E., & Mulvenon, S. W. (2009). A critical review of research on formative assessment: The limited scientific evidence of the impact of formative assessment in education. *Practical Assessment, Research & Evaluation*, 14(7), 1–11. Retrieved from <http://pareonline.net/getvn.asp?v=14&n=7>

- Edelson, D. C., Gordin, D. N., & Pea, R. D. (1999). Addressing the challenges of inquiry-based learning through technology and curriculum design. *Journal of the Learning Sciences*, 8(3), 391–450. doi: 10.1207/s15327809jls0803&4_3
- Engeström, Y. (2009). The future of activity theory: A rough draft. In A. Sannino, H. Daniels, & K. D. Gutiérrez (Eds.), *Learning and expanding with activity theory* (pp. 303–328). Cambridge, UK: Cambridge University Press.
- Ericson, (2015). Ericson mobility report on the pulse of the networked society. Retrieved from: <http://www.ericsson.com/res/docs/2015/ericsson-mobility-report-feb-2015-interim.pdf>
- Fain, D. (2016). Test Generator [software]. Flagstaff, AR. Retrieved from: www.testshop.com
- Farnsworth, E. J., Chu, M., Kress, W. J., Neill, A. K., Best, J. H., Pickering, J., & Ellison, A. M. (2013). Next-generation field guides. *BioScience*, 63(11), 891–899. doi: 10.1525/bio.2013.63.11.8
- Festinger, L. (1957). *A theory of cognitive dissonance*. Stanford, CA: Stanford University Press.
- Foor, R. M., & Connors, J. (2010). Pioneers in an emerging field: Who eere the early agricultural educators? *Journal of Agricultural Education* (51) 3, 23–31. doi: 10.5032/jae.2010.03023
- Francis, R., & Shannon, S. J. (2013). Engaging with blended learning to improve students' learning outcomes. *European Journal of Engineering Education*, 38(4), 359–369. doi:10.1080/03043797.2013.766679
- Gagne, R.M. (1977). *The conditions of learning and theory of instruction*. New York, NY: Holt, Rinehart and Winston.
- Gallo, A., & Russel, A. (2016). Sobering stats: 110,000 homes worth \$20B in flood-affected areas in Baton Rouge region, analysis says. *The Advocate*. Retrieved from: http://www.theadvocate.com/louisiana_flood_2016/article_62b54a48-662a-11e6-aade-afd357ccc11f.html
- Geiwitz, J. P. (1966). Structure of boredom. *Journal of Personality and Social Psychology*, 3(5), 592–600. doi: 10.1037/h002302
- Gikas, J., & Grant, M. M. (2013). Mobile computing devises in higher education: Student perspectives on learning with cellphones, smartphones & social media. *Internet and Higher Education*, 19, 18–26. doi: 10.1016/j.iheduc.2013.06.002
- Glunn, S. M., Aultman, L. P., & Owens, A. M. (2005). Motivation to learn in general education programs. *The Journal of General Education*, 54(2), 150–170. doi: 10.1353/jge.2005.0021

- Gordon, H. R. (2003). *The history and growth of vocational education in America*. Long Grove, IL: Waveland Press, Inc.
- Henly, D. C. (2003). Use of web-based formative assessment to support student learning in a metabolism/nutrition unit. *European Journal of Dental Education*, 7(3), 116–122. doi: 10.1034/j.1600-0579.2003.003
- Hillison, J. (1996). The origins of agriscience: Or where did all that scientific agriculture come from? *Journal of Agricultural Education*, 37 (4), 8–13. doi: 10.5032/jae.1996.04008
- Hsin-Chih, L., Chun-Yen, C., Wen-Shiane, L., Yu-Lin, F., & Ying-Tien, W. (2013). The implementation of mobile learning in outdoor education: Application of QR codes. *British Journal of Educational Technology*, 44(2), E57–E62. doi:10.1111/j.1467-8535.2012.01343.x
- Hodges, J., Evans, D., & Garnett, L. (2015). *Louisiana trees*. Baton Rouge, LA: Louisiana Department of Agriculture and Forestry.
- Hwang, G., & Chang, H. (2011). A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students. *Computers & Education*, 56(4), 1023–1031. doi: 10.1016/j.compedu.2010.12
- Huett, J. B., Moller, L., Young, J., Bray, M., & Huett, K. C. (2008). Supporting the distant student: The effect of ARCS-based strategies on confidence and performance. *Quarterly Review of Distance Education*, 9(2), 113–126. Retrieved from <https://6100-group1.wikispaces.com/file/view/Supporting+the+Distant+Student.pdf>
- Iqbal, S., & Qureshi, I. A. (2012). M-learning adoption: A perspective from developing country. *The International Review of Research in Open and Distance Learning*, 13(3), 147–164. doi: 10.19173/irrodl.v13i3.1152
- Irby, T., & Strong, R. (2015). Instructional competencies needed to develop instructional strategies for mobile learning in fields of agricultural education. *Quarterly Review of Distance Education*, 16(3), 77–81. Retrieved from <http://search.proquest.com/openview/de21020b3d78b9cd5ba144101987a9ca/1?pq-origsite=gscholar&cbl=29705>
- ITU Telecom World, (2013). *The World in 2013, ICT Facts and Figures*. Geneva, Switzerland: International Telecommunication Union.
- Iwata, T., & Saitoh, T. (2013). Tree recognition based on leaf images. *Proceedings of IEEE (SICE) Annual Conference, 2013*, 2489–2494. Abstract retrieved from <http://ieeexplore.ieee.org/abstract/document/6736361/?reload=true>

- Jiao, H. (2015). Enhancing students' engagement in learning through a formative e-assessment tool that motivates students to take action on feedback. *Australasian Journal of Engineering Education*, 20(1), 9–18. doi:10.7158/D13-002.2015.20.1
- Johnson, D. M., Edgar, L. D., Cox, C. K. (2013). Student and faculty perceptions of ICT use in undergraduate agriculture courses. *Journal of Agricultural Education*, (54)3, 171–185. doi: 10.5032/jae.2013.03171
- Jung, H. J. (2014). Ubiquitous learning: Determinants impacting learners' satisfaction and performance with smartphones. *Language Learning & Technology*, 18(3), 97–119. Retrieved from: <http://llt.msu.edu/issues/october2014/jung.pdf>
- Kaku, M. (2011). *Physics of the future: How science will shape human destiny and our daily lives by the year 2100*. New York, NY: Anchor Books.
- Keane, T., & Keane, W. (2016). Achievements and challenges: Implementing a 1:1 program in a secondary school. *Education and Information Technologies*, 1–17. doi: 10.1007/s10639-016-9470-4
- Keller, J. M. (2010). *Motivational design for learning and performance: The ARCS model approach*. New York, NY: Springer.
- Keengwe, J., Schnellert, G., & Jonas, D. (2014). Mobile phones in education: Challenges and opportunities for learning. *Education and Information Technologies*, 19(2), 441–450. doi: 10.1007/s10639-012-9235-7
- Kim, J. (2015). A study of perceptual typologies on computer based assessment (CBA): Instructor and student perspectives. *Educational Technology and Society*, 18(2), 80–96. Retrieved from http://www.ifets.info/journals/18_2/7.pdf
- Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, 41(2), 75–86. Retrieved from: http://dx.doi.org/10.1207/s15326985ep4102_1
- Kotrlik, J. K., Redmann, D. H., & Douglas, B. B. (2003). Technology integration by agriscience teachers in the teaching/learning process. *Journal of Agricultural Education* 44(3), 78–90. doi: 10.5032/jae.2003.03078
- Kotrlik, J. K., & Redmann, D. H. (2009). A trend study: Technology adoption in the teaching-learning process by secondary agriscience teachers-2002 and 2007. *Journal of Agricultural Education*, 50(2), 62–74. doi: 10.5032/jae.2009.02062
- Kuhlthau, C., Maniotes, L., & Caspari, A. (2015). *Guided inquiry: Learning in the 21st Century*. Westport, CT: Libraries Unlimited, Inc.

- Kukulska-Hulme, A. (2010). Mobile learning as a catalyst for change. *Journal of Open Learning*, 25(3), 181–185. doi: 10.1080/02680513.2010.511945
- Kumar, N., Belhumeur, P. N., Biswas, A., Jacobs, D. W., Kress, W. J., Lopez, I. C., & Soares, J. V. (2012). Leafsnap: A computer vision system for automatic plant species identification. Lecture notes in *Computer Science*, 502–516. doi: 10.1007/978-3-642-33709-3_36
- Laskin, A. V., & Avena, J. (2015). Introduction of mobile media into formal classroom learning environments. *Journalism & Mass Communication Educator*, 70(3), 276–285. doi:10.1177/1077695815601170
- Lee, J. K. (2002). Digital history in the history/social studies classroom. *The History Teacher*, 35(4), 503–517. doi: 10.2307/1512472
- Leiner, B. M., Cerf, V. G., Clark, D. D., Kahn, R. E., Kleinrock, L., Lynch, D. C., ... & Wolff, S. (2009). A brief history of the Internet. *ACM SIGCOMM Computer Communication Review*, 39(5), 22–31. doi: 10.1145/1629607.1629613
- Leithner, A. (2009). Review of blended learning: Using technology in and beyond the language classroom. *Language Learning & Technology*, 13(1), 33–39. Retrieved from <http://llt.msu.edu/vol13num1/review3.pdf>
- Lenhart, A., Ling, R., Campbell, S., & Purcell, K. (2010). Teens and mobile phones. *Pew Research Center*. Retrieved from <http://pewinternet.org/Reports/2010/Teens-and-Mobile-Phones.aspx>
- Lepp, A., Barkley, J., & Karpinski, A. (2014). The relationship between cell phone use, academic performance, anxiety, and satisfaction with life in college students. *Computers in Human Behavior*, 31, 343–350. doi: 10.106/j.chb.2013.10.049
- Leslie, I. (2014). *Curious: The desire to know and why your future depends on it*. New York, NY: Basic Books.
- Levene, J., & Seabury, H. (2015). Evaluation of mobile learning: Current research and implications for instructional designers. *Techtrends*, 59(6), 46–52. doi:10.1007/s11528-015-0904-4
- Levinson, P. (2004). *Cellphone: The story of the world's most mobile medium and how it has transformed everything!* New York, NY: Palgrave Macmillan.
- Li, J., Lepp, A., & Barkley, J. E. (2015). Locus of control and cell phone use: Implications for sleep quality, academic performance, and subjective well-being. *Computers in Human Behavior*, 56, 450–457. doi:10.1016/j.chb.2015.06.021

- Lin-Siegler, X., Dweck, C. S., & Cohen, G. L. (2016). Instructional interventions that motivate classroom learning. *Journal of Educational Psychology*, 108(3), 295–299. doi:10.1037/edu0000124
- Liu, M., Scordino, R., Renata, G., Navarrete, C., Yujung, K., & Lim, M. (2015). A look at research on mobile learning in K-12 education from 2007 to the present. *Journal of Research on Technology in Education*, 46(4), 325–372. doi: 10.1080/15391523.2014.925681
- Liu, M. C., & Huang, Y. M. (2015). Collaborative experience sharing with the support of M-Learning 2.0: A fundamental framework, a case study and research issues. *International Journal of Mobile Learning and Organisation*, 9(1), 21–37. doi: 10.1504/ijmlo.2015.069711
- Louisiana Board of Elementary and Secondary Education (2016). *Policies and bulletins*. Retrieved from <http://bese.louisiana.gov>
- Louisiana Department of Education (2003). *Agriculture education content standards curriculum framework; Bulletin 106, Policies/Bulletins*. Retrieved from: <http://bese.louisiana.gov/documents-resources/policies-bulletins>
- Louisiana Department of Education (2003). *Forestry*. Retrieved from <http://www.la-ffa.org/download/lata/Forestry.pdf>
- Louisiana FFA (2016). Forestry career development event rules. Retrieved from: www.la-ffa.org/cde/forestry
- Lothridge, K., Fox, J., & Fynan, E. (2013). Blended learning: Efficient, timely and cost effective. *Australian Journal of Forensic Sciences*, 45(4), 407–416. doi:10.1080/00450618.2013.767375
- Lu, M. (2008). Effectiveness of vocabulary learning via mobile phone. *Journal of Computer Assisted Learning*, 24(6), 515–525. doi:10.1111/j.1365-2729.2008.00289.x
- Ma, W. (2009). Computer supported collaborative learning and higher order thinking skills: A case study of textile studies. *The Interdisciplinary Journal of E Learning and Learning Objects*, 5, 145–167. Retrieved from <http://repository.lib.eduhk.hk/jspui/handle/2260.2/9981>
- Madden, M., Lenhart, A., Duggan, M., Cortesi, S., & Gasser, U. (2013). Teens and technology 2013. *Pew Research Center*. Retrieved from <http://pewinternet.org/Reports/2013/Teens-and-Tech.aspx>
- Martinez, J. G., & Martinez, N. C. (1992). Re-examining repeated testing and teacher effects in a remedial mathematics course. *British Journal of Educational Psychology*, 62(3), 356–363. doi: 10.1111/j.2044-8279.1992.tb01028

- McGraw, K. O., & Wong, S. P. (1996). Forming inferences about some intraclass correlation coefficients. *Psychological Methods*, 1(1), 30–34. doi: 10.1037/1082-989x.1.1.30
- McCoy, B. (2013). Digital distractions in the classroom: Student classroom use of digital devices for non-class related purposes. *Journal of Media Education*, 4(4), 5–14. Retrieved from <http://digitalcommons.unl.edu/journalismfacpub/71/>
- Means, T., Jonassen, D., & Dwyer, F. (1997). Enhancing relevance: Embedded ARCS strategies vs. purpose. *Educational Technology Research and Development*, 45(1), 5–17. doi: 10.1007/bf02299610
- Montag, C., Błaskiewicz, K., Sariuska, R., Lachmann, B., Andone, I., Trendafilov, B., & ... Markowetz, A. (2015). Smartphone usage in the 21st century: Who is active on WhatsApp?. *BMC Research Notes*, 8(1), 1–6. doi:10.1186/s13104-015-1280-z
- Moskal, P., Dziuban, C., & Hartman, J. (2013). Blended learning: A dangerous idea? *Internet and Higher Education*, 18, 15–23. doi: 10.1016/j.iheduc.20.12.12.001
- Mueller, A.L., Knobloch, N.A., & Orvis, K.S. (2015). Exploring the effects of active learning on high school outcomes and teachers perceptions of biotechnology and genetics instruction. *Journal of Agricultural Education*, 56(2), 138–152. doi: 10.5032/jae.2015.02138
- Murdock, K. K. (2013). Texting while stressed: Implications for students' burnout, sleep, and well-being. *Psychology of Popular Media Culture*, 2(4), 207–221. doi: 10.1037/ppm0000012
- Murphrey, T. P., Miller, K. A., & Roberts, T. G. (2009). Agricultural science and technology teachers' perceptions of iPod and MP3 technology integration into curricular and cocurricular activities. *Journal of Agricultural Education*, 50(4), 110–119. doi:10.5032/jae.2009.04110
- Muthén, B. O. (1994). Multilevel covariance structure analysis. *Sociological Methods and Research*, 22(3), 376–398. doi: 10.1177/004912419022003006
- National Association of State Boards of Education. (2001). *Any time, any place, any path, any pace: Taking the lead on e-learning policy*. Alexandria, VA: Author. Retrieved from <http://www.nasbe.org/e-Learning.html>
- National Commission on Excellence in Education. (1983). A nation at risk: The imperative for educational reform. *The Elementary School Journal*, 84(2), 113–130. doi: 10.1086/461348
- National FFA Organization. (2013). *The National FFA organization national event winners news release*. Retrieved from https://www.ffa.org/SiteCollectionDocuments/convention_expo_210NewsRelease_f.pdf

- National FFA Organization. (2014). *The National FFA organization national event winners news release*. Retrieved from https://www.ffa.org/SiteCollectionDocuments/convention_expo_210NewsRelease_f.pdf
- National Research Council. (1988). *Understanding agriculture: New directions for education*. Danville, IL: Interstate.
- Neumark, D., Johnson, H., & Mejia, M. C. (2013). Future skill shortages in the US economy? *Economics of Education Review*, 32, 151–167. doi:10.1016/j.econedurev.2012.09.004
- Newburger, E. C. (2001). Home computers and internet use in the United States: August 2000. Washington, D.C.: United States Census Bureau. Retrieved from <https://www.census.gov/prod/2001pubs/p23-207.pdf>
- Norris, C., Hossain, A., & Soloway, E. (2011). Using smartphones as essential tools for learning: A call to place schools on the right side of the 21st century. *Educational Technology*, 51(3), 18–25. Retrieved from <http://cecs5580.pbworks.com/w/file/etch/50303907/ET%20article%20Norris%20Soloway.pdf>
- O'Bannon, B. W., & Thomas, K. (2014). Teacher perceptions of using mobile phones in the classroom: Age matters! *Computers & Education*, 74, 15–25. doi:10.1016/j.compedu.2014.01.006
- Obringer, S. J., & Coffey, K. (2007). Cell phones in American high schools: A national survey. *Journal of Technology Studies*, 33(1), 41–47. Retrieved from <https://eric.ed.gov/?id=EJ847358>
- Olapiriyakul, K., & Scher, J. M. (2006). A guide to establishing hybrid learning courses: Employing information technology to create a new learning experience, and a case study. *Internet & Higher Education*, 9(4), 287–301. doi:10.1016/j.iheduc.2006.08.001
- Oliva, A., & Torralba, A. (2001). Modeling the shape of the scene: A holistic representation of the spatial envelope. *International Journal of Computer Vision*, 42(3), 145–175. Retrieved from <http://cvcl.mit.edu/Papers/IJCV01-Oliva-Torralba.pdf>
- O'Malley, C., Vavoula, G., Glew, J. P., Taylor, J., Shaples, M., & Lefrere, P. (2003). Producing guidelines for learning, teaching and tutoring in a mobile environment. *Proceedings of the 2nd IEEE Internet Workshop on Wireless and Mobile Technologies in Education*. Retrieved from <http://www.mobilearn.org/download/results/guidelines.pdf>.
- Ozan, O. (2013). Scaffolding in connectivist mobile learning environment. *Turkish Online Journal of Distance Education*, 14 (2), 44–55. Retrieved from http://www.academia.edu/11366791/SCAFFOLDING_IN_CONNECTIVIST_MOBILE_LEARNING_ENVIRONMENT

- Ozdamli, F., & Uzunboylu, H. (2015). M-learning adequacy and perceptions of students and teachers in secondary schools. *British Journal of Educational Technology*, 46(1), 159–172. doi:10.1111/bjet.12136
- Park, Y. (2011). A pedagogical framework for mobile learning: Categorizing educational applications of mobile technologies into four types. *The International Review of Research in Open and Distributed Learning*, 12(2), 78–102. Retrieved from: <http://files.eric.ed.gov/fulltext/EJ920735.pdf>
- Pearcy, A. G. (2009). *Finding the perfect blend: A comparative study of online, face-to-face, and blended instruction* (Doctoral dissertation). University of North Texas, TX.
- Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S. A., Kamp, E. T., ... & Tsourlidaki, E. (2015). Phases of inquiry-based learning: Definitions and the inquiry cycle. *Educational research review*, 14, 47-61 Retrieved from: <http://www.sciencedirect.com/science/article/pii/S1747938X15000068>
- Pérez-Sanagustín, M., Muñoz-Merino, P. J., Alario-Hoyos, C., Soldani, X., & Delgado Kloos, C. (2015). Lessons learned from the design of situated learning environments to support collaborative knowledge construction. *Computers & Education*, 87, 70–82. doi:10.1016/j.compedu.2015.03.019
- Peters, K. (2007). M-Learning: Positioning educators for a mobile, connected future. *The International Review of Research in Open and Distance Learning* (8)2. doi: 10.19173/irrodl.v8i2.350
- Peugh, J. L. (2010). A practical guide to multilevel modeling. *Journal of School Psychology*, 48(1), 85–112. doi:10.1016/j.jsp.2009.09.002
- Pre Research Center. (2015) *Teens, social media and technology overview*. Washington, DC. Retrieved from http://www.pewinternet.org/2015/04/09/teens-social-media-technology-2015/pi_2015-04-09_teensandtech_06/
- Pew Research Center. (2017). *Who owns cell phones and smartphones?* Washington, DC. Retrieved from <http://www.pewinternet.org/chart/who-owns-cellphones-and-smartphones/>
- Phares, E. J. (1976). *Locus of control in personality*. Morristown, NJ: General Learning Press.
- Phipps, L. J., Osborne, E. W., Dyer, J. E., & Ball, A. (2008). *Handbook on agricultural education in public schools*. Clifton Park, NY: Thompson Delmar Learning.
- Pool, I. D. (1977). *The social impact of the telephone*. Cambridge, MA: MIT Press.
- Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon* 9(5), 1–6. doi: 10.1108/10748120110424816

- Peugh, J. L. (2010). A practical guide to multilevel modeling. *Journal of School Psychology, 48*(1), 85–112. doi: 10.1016/j.jsp.20.09.09.002
- Peugh, J. L., & Enders, C. K. (2005). Using the SPSS mixed procedure to fit cross-sectional and longitudinal multilevel models. *Educational and Psychological Measurement, 65*(5), 717–741. doi: 10.1177/0013164405278558
- Purcell, K., Heaps, A., Buchanan, J., & Freidrich, L. (2013). *How teachers are using technology at home and in their classrooms*. Retrieved from the Pew Research Center Internet and Tech <http://www.pewinternet.org/2013/02/28/how-teachers-are-using-technology-at-home-and-in-their-classrooms/>
- Quinn, C. (2000). M-learning: mobile, wireless and in your pocket learning. *Line Zine Magazine*. Retrieved from <http://www.linezine.com/2.1/features/cqmmwiyp.htm>
- Randler, C. (2008). Teaching species identification—a prerequisite for learning biodiversity and understanding ecology. *Eurasia Journal of Mathematics, Science and Technology Education, 4*(3), 223–231. Retrieved from http://www.ejmste.com/v4n3/EURASIA_v4n3_Randler.pdf
- Raudenbush, S., & Bryk, A. A. (1986). A hierarchical model for studying school effects. *Sociology of Education, 59*(1), 1–17. doi: 10.2307/2112482
- Raudenbush, S., & Bryk, A. (2002). *Hierarchical linear models: Applications and data analysis methods*. Chicago, IL: Sage Publications Ltd.
- Roberts, T. G., & Ball, A. L. (2009). Secondary agricultural science as content and context for teaching. *Journal of Agricultural Education, 50*(1), 81–91. doi: 10.5032/jae.2009.01081
- Romero, J. J. (2011). *NO. 1 Smartphones*. *IEEE Spectrum, 48*(1), 28–31.
- Rosen, L., Whaling, K., Carrier, L., Cheever, N., & Rokkum, J. (2013). The media and technology usage and attitudes scale: An empirical investigation. *Computers in Human Behavior, 29*(6), 2501–2511. doi:10.1016/j.chb.2013.06.006
- Rosenshine, B., & Furst, N. (1971). Research on teacher performance criteria. In B. O. Smith (Ed.), *Research in Teacher Education* (pp. 37–72). Englewood Cliffs, NJ: Prentice-Hall.
- Rotter, J. B. (1954). *Social learning theory and clinical psychology*. New York, NY: Prentice-Hall.
- Russell, M. (2006). *Technology and Assessment: The tale of two interpretations*. Greenwich, CT: Information Age Publishing.
- Robertson, C., & Green, T. (2012). Scanning the potential for using QR codes in the classroom. *Techtrends, 56*(2), 11–12. doi:10.1007/s11528-012-0558-4

- Rogers, E. M. (2003). *Diffusion of Innovations*. New York, NY: Free Press.
- Ruiz-Primo, M., & Furtak, E. M. (2006). Informal formative assessment and scientific inquiry: Exploring teachers' practices and student learning. *Educational Assessment*, 11(3-4), 237–263. Retrieved from: <http://www.tandfonline.com/doi/abs/10.1080/10627197.2006.9652991>
- Sarrab, M., Alalwan, N., Alfarraj, O. and Alzahran, A. (2015). An empirical study on cloud computing requirements for better mobile learning services. *International Journal of Mobile Learning and Organisation*, 9(1), 1–20. doi: 10.1504/ijmlo.2015.069709
- Schleifstein, .M (2016, August 17). Louisiana flood resulted in ‘1000-year’ rain in 2 days. *The Times-Picayune*. Retrieved from: http://www.nola.com/weather/index.ssf/2016/08/louisiana_flood_of_2016_result.html
- Schmidmaier, R., Ebersbach, R., Schiller, M., Hege, I., Holzer, M., & Fischer, M. R. (2011). Using electronic flashcards to promote learning in medical students: Retesting versus restudying. *Medical Education*, 45(11), 1101–1110. doi:10.1111/j.1365-2923.2011.04043.x.
- Schoffstall, A. M., & Gaddis, B. A. (2007). Incorporating guided-inquiry learning into the organic chemistry laboratory. *Journal of Chemical Education* 84(5), 848. doi: 10.1021/ed084p848
- Seneca, E. (2013). Analyzing the effects of context awareness mobile design principles on student performance in undergraduate kinesiology courses. (Doctoral dissertation). Retrieved from http://digitalcommons.lsu.edu/cgi/viewcontent.cgi?article=3053&context=gradschool_dissertations
- Shadish, W. R., Cook, T. D., & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Boston, MA: Houghton, Mifflin and Company.
- Sharma, P. (2013). Evolution of mobile wireless communication networks-1G to 5G as well as future prospective of next generation communication network. *International Journal of Computer Science and Mobile Computing*, 2(8), 47–53. Retrieved from <https://pdfs.semanticscholar.org/8e32/4078c7b0848c5e8c573861878cdbe417e89e.pdf>
- Sharples, M., Taylor, J., & Vavoula, G. (2007). A theory of learning for the mobile age. In R. Andrews & C. Haythornthwaite (Eds.), *The SAGE handbook of e-learning research* (pp. 221–247). London: Sage Publications Ltd.
- Shuler, C. (2009). *Pockets of potential: Using mobile technologies to promote children's learning*. New York, NY: The Joan Ganz Cooney Center at Sesame Workshop.

- Schunk, D. H. (1996). Goal and self-evaluative influences during children's cognitive skill learning. *American Educational Research Journal*, 33(2), 359–382. doi: 10.3102/00028312033002359
- Siemens, G. (2004). Connectivism: A learning theory for the digital age. *The International Journal of Instructional Technology and Distance Learning*, 2, 3–10. Retrieved from http://www.itdl.org/journal/jan_05/article01.htm
- Sly, L. (1999). Practice tests as formative assessment improve student performance on computer-managed learning assessments. *Assessment and Evaluation in Higher Education*, 24(3), 339–343. Retrieved from: <http://srhe.tandfonline.com/doi/abs/10.1080/0260293990240307>
- Small, G., & Vorgan, G. (2008). *iBrain: Surviving the technological alteration of the modern mind*. New York, NY: Harper Collins.
- Smith, A. (2011). *Americans and their cell phones*. Retrieved from <http://pewinternet.org/Reports/2011/Cell-Phones.aspx>
- Snedden, D. (1910). *The problem of vocational education*. Boston, MA: Houghton Mifflin.
- Sperber, D., & Wilson, D. (1986). *Relevance: communication and cognition*. Cambridge, MA: Harvard University Press.
- Stewart, J., Antonenko, P. D., Robinson, J. S., & Mwavita, M. (2013). Intrapersonal factors affecting technological pedagogical content knowledge of agricultural education teachers. *Journal of Agricultural Education*, 54(3), 157–170. doi: 10.5032/jae.2013.03157
- Stiggins, R. J. (2002). Assessment crisis: The absence of assessment for learning. *Phi Delta Kappan*, 83(10), 758–765. Retrieved from: <http://journals.sagepub.com/doi/pdf/10.1177/003172170208301010>
- Stimson, R. W. & Lathrop, F. W. (1942). *History of agriculture of less than college grade in the United States: A cooperative project of workers in vocation education in agriculture and in related fields*. Washington, D.C.: United States Office of Education.
- Stipek, D. J. (2002). *Motivation to learn: Integrating theory and practice*. Boston, MA: Allyn & Bacon.
- Su, C., & Cheng, C. (2015). A mobile gamification learning system for improving the learning motivation and achievements. *Journal of Computer Assisted Learning*, 31(3), 268–286. doi:10.1111/jcal.12088

- Tam, M. (2000). Constructivism, instructional design, and technology: Implications for transforming distance learning. *Educational Technology and Society*, 3(2), 50–60. Retrieved from http://www.ifets.info/journals/3_2/tam.html
- Taylor, J. Sharples, M., O'Malley, C., Vavoula, G., & Waycott, J. (2006). Towards a task model for mobile learning: A dialectical approach. *International Journal of Learning Technology*, 2(2-3), 138–158. doi: 10.1504/ijlt.2006.010616
- Thota, N. (2015). Connectivism and the use of technology/media in collaborative teaching and learning. *New Directions for Teaching & Learning*, 2015(142), 81–96. doi:10.1002/tl.20131
- Thomas, K., & O'Bannon, B. (2015). Looking across the new digital divide: A comparison of inservice and preservice teacher perceptions of mobile phone integration. *Journal of Technology and Teacher Education*, 23(4), 561–581. Retrieved from <http://www.learntechlib.org/p/149026>
- Thomas, K., & Muñoz, M. A. (2016). Hold the phone! High school students' perceptions of mobile phone integration in the classroom. *American Secondary Education*, 44(3), 19–37. Retrieved from <http://eds.b.ebscohost.com/eds/pdfviewer/pdfviewer?sid=bf89607f-cfa8-4db4-8dc6-2f894d47e42f%40sessionmgr120&vid=2&hid=114>
- Townsend, S., & Mulvey, B. (2016). Formative assessment via online quizzes in the EFL classroom: An ICT pilot teaching program. *Bulletin of Morioka Junior College Iwate Prefectural University*, 18, 41–46. Retrieved from: <http://simon.neted.com.au/wp-content/uploads/2016/05/An-ICT-pilot-teaching-program.pdf>
- Traxler, J. (2007). Defining, discussing and evaluating mobile learning: The moving finger writes and having written. *International Review of Research in Open and Distance Learning*, 8(2). doi: 10.19173/irrodl.v8i2.346
- True, A. C. (1929). *A history of agricultural education in the United States, 1785–1925*. Washington, D.C.: United States Department of Agriculture.
- Ullman, E. (2011). The new one-to-one. *Technology & Learning*, 31(7), 54. Retrieved from <http://www.techlearning.com/news/0002/school-cio-the-new-onetoone/60247>
- Uluyol, C., & Agca, R. K. (2012). Integrating mobile multimedia into textbooks: 2D barcodes. *Computers & Education*, 59(4), 1192–1198. doi:10.1016/j.compedu.2012.05.018
- Uricchio, C., Moore, G., & Coley, M. (2013). Corn Clubs: Building the Foundation for Agricultural and Extension Education. *Journal of Agricultural Education*, 54(3), 224–237.

- U.S. Department of Education. (2005). *Carl D. Perkins vocational and technical education act of 1998: Report to congress on state performance program year 2005-06* (USDE Contract No. ED-04-CO-0121/0001. Retrieved from <https://www2.ed.gov/about/offices/list/ovae/resource/perkinsrpt0506.pdf>
- U.S. Department of Education. (2010). *Transforming American education: Learning powered by technology*. Washington, D.C.: U.S. Government Printing Office.
- U.S. Department of Education. (2010) *Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies*. Washington, DC: USDE Office of Planning, Evaluation and Policy Development. Retrieved from <http://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf>
- U.S. Department of Labor. (1991). *What work requires of schools*. Washington, DC: U.S Dept. of Labor Secretary's Commission on Achieving Necessary Skills.
- Vacik, H., Wolfslehner, B., Spörk, J., & Kortschak, E. (2006). The use of COCOON in teaching silviculture. *Computers & Education*, 47(3), 245–259. doi:10.1016/j.compedu.2004.10.009
- Velan, G. M., Rakesh, K. K., Mark, D., & Wakefield, D. (2002). Web-based self-assessments in pathology with questionmark perception. *Pathology*, 34(3), 282–284. doi: 10.1080/00313020220131372
- Vosloo, S. (2012). *Mobile learning and policies: Key issues to consider*. Retrieved from <http://unesdoc.unesco.org/images/0021/002176/217638E.pdf>
- Vygotsky, L. S. (1986). *Language and thought*. Cambridge, MA: MIT Press.
- Wang, T. H. (2007). What strategies are effective for formative assessment in an e-learning environment? *Journal of Computer Assisted Learning*, 23, 171–186. doi: 10.1111/j.1365-2729.2006.00211.x
- Wasoh, F. (2016). Exploring the roles of blended learning as an approach to improve teaching and learning English. *Proceedings of the Multidisciplinary Academic Conference*, 165–171.
- Westra, J., & Frances, G. (2015). *Louisiana summary: Agriculture and natural resources 2014*. Baton Rouge, LA: LSU AgCenter. Retrieved from <http://www.lsuagcenter.com/~media/system/8/8/b/d/88bd7e96149b3ed6d765bffc3bdf3866/pub2382agsummary2014forweb.pdf>
- Whiting, B., Van Burgh, J. W., & Render, G. F. (1995). Mastery learning in the classroom. *Paper presented at the Annual Meeting of the American Educational Research Association*. San Francisco, CA. Retrieved from: <https://eric.ed.gov/?id=ED382688>

- Wiersma, W., & Jurs, S. G. (1990). *Educational measurement and testing*. Needham Heights, MA: Allyn and Bacon.
- Wingenbach, G. J. (2000). Agriculture students' computer skills and electronic exams. *Journal of Agricultural Education* 41(1), 69–78. doi: 10.5032/jae.2000.01069
- Wiliam, D. (2010). An integrative summary of the research literature and implications for a new theory of formative assessment. In H. L. Andrade, & G. J. Cizek (Eds.), *Handbook of formative assessment* (pp. 18–40). Abingdon: Routledge.
- Williams, M. R., Warner, W. J., Flowers, J. L., & Croom, D. B. (2014). Accessibility and usage of technology by North Carolina agriculture teachers. *Journal of Agricultural Education* (55)4, 191–205. doi: 10.5032/jae.2014.04191
- Williams, M. R., Warner, W. J., Flowers, J. L., & Croom, D. B. (2014). Teaching with technology: North Carolina agriculture teachers' knowledge acquisition, attitudes, and identified barriers. *Journal of Agriculture Education* (55)5, 1–15. doi: 10.5032/jae.2014.05001
- Wininger, S. R. (2005). Using your tests to teach: Formative summative assessment. *Teaching of Psychology*, 32(3), 164–166. doi: 10.1207/s15328023top3203_7
- Wu, Y. W. B., & Wooldridge, P. J. (2005). The impact of centering first-level predictors on individual and contextual effects in multilevel data analysis. *Nursing Research*, 54(3), 212–216. doi: 10.1097/00006199-200505000-00009
- Wlodkowski, R. J. (1978). *Motivation and teaching: A practical guide*.
- Wlodkowski, R. J. (1999). *Enhancing adult motivation to learn*. San Francisco, CA: Jossey-Bass.
- Yuping, W., Xibin, H., & Juan, Y. (2015). Revisiting the blended learning literature: Using a complex adaptive systems framework. *Journal of Educational Technology & Society*, 18(2), 380–393.

APPENDICES

Appendix A

ACTION ON PROTOCOL APPROVAL REQUEST



TO: Joey Blackburn
Agricultural & Extension Educ. & Evaluation

FROM: Dennis Landin
Chair, Institutional Review Board

DATE: August 12, 2016

RE: IRB# 3754

TITLE: Assessing the effects of mobile devices and apps as an instructional delivery system to the tree identification achievement and student motivation in Louisiana secondary agricultural students

New Protocol/Modification/Continuation: New Protocol

Review type: Full ☐ Expedited ☒ **Review date:** 8/12/2016

Risk Factor: Minimal ☒ Uncertain ☐ Greater Than Minimal ☐

Approved ☒ **Disapproved** ☐

Approval Date: 8/12/2016 **Approval Expiration Date:** 8/11/2017

Re-review frequency: (annual unless otherwise stated)

Number of subjects approved: 200

LSU Proposal Number (if applicable): _____

Protocol Matches Scope of Work in Grant proposal: (if applicable)

A handwritten signature in cursive script, appearing to read "D. Landin", is written over the signature line.

By: Dennis Landin, Chairman _____

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –

Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. SPECIAL NOTE: When emailing more than one recipient, make sure you use bcc.

*All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at <http://www.lsu.edu/irb>

Institutional Review Board Dr. Dennis Landin, Chair 130 David Boyd Hall Baton Rouge, LA 70803 P:
225.578.8692
F: 225.578.5983
irb@lsu.edu | lsu.edu/irb _____

Appendix B

Assessing the effects of mobile devices and apps as an instructional delivery system to the tree identification achievement and student motivation in Louisiana secondary agricultural students.

August 2016

_____ has agreed to participate in a research study being conducted by the Agricultural and Extension Education and Evaluation department at Louisiana State University (LSU). This teacher was purposefully selected because of school policy that allows students to use mobile devices for classroom learning. We ask that you sign this letter of consent indicating that you are informed about the study and support the teachers' participation in this project.

Background Information: The purpose of this study will be to assess the effect of using mobile devices (smartphone/tablets) in agricultural education on student ability to identify trees (achievement) and interest.

Procedures: The following requirements have been identified as crucial to this study.

The teacher will:

- Administer a pre-test designed to measure preexisting knowledge via an online testing software. This will require use of a computer lab.
- Facilitate the downloading and usage of mobile apps used to identify leaf samples of common Louisiana tree species, namely *leafsnap*®, *V-Tree*® and *Tree Book*®.

- Facilitate the students in downloading the *quizlet*© app and creating a *quizlet*© account which will allow them to join the tree identification class created by the researcher. Through this app the students will take formative assessments.
- Administer an instrument (survey) designed to measure student interest.
- Administer a post-test designed to measure student achievement in tree identification. This will require a computer lab.

Risks and Benefits:

There are no known risks associated with this study that would occur as a result of participation. Perceived benefits include the knowledge of how using mobile devices and apps effects students' acquisition of tree identification knowledge and motivation to learn.

Confidentiality:

Your school can be assured that the records of this study will be kept private and any information obtained relating to you or your students will be kept confidential. Any reports that are generated as a result of this study will remain confidential as well, and not include any identifiers to you or your students. Since this is classified as a voluntary study, your decision to participate will have no bearing on your current or future relationship with LSU.

Contact Information:

If you have any questions now or in the future regarding this study, please do not hesitate to contact myself or the others listed below.

Dr. Joey Blackburn
225-578-7892
jblackburn@lsu.edu

Eric Smith Ph.D
candidate
225-578-6149
Hsmit63@lsu.edu

For any general questions concerning this research study, please contact Joey Blackburn via email at: jjblackburn@lsu.edu or Eric Smith via email at hsmit63@lsu.edu. If you have questions about subjects' rights or other concerns, you may contact Dennis Landin, LSU Institutional Review Board, at (225) 578-8692, irb@lsu.edu, or www.lsu.edu/irb.

Please retain a copy of this form for your records

Statement of Consent:

I have read the above information and support the participation of the teacher in this study.

Printed Name

Signature

Date

Appendix C

Assessing the effects of mobile devices and apps as an instructional delivery system to the tree identification achievement and student motivation in Louisiana secondary agricultural students.

August 2016

_____ has agreed to participate in a research study being conducted by the Agricultural and Extension Education and Evaluation department at Louisiana State University (LSU). This teacher was purposefully selected because he/she has received professional development on how to teach tree identification using leaf keys and manuals. We ask that you sign this letter of consent indicating that you are informed about the study and support the teachers' participation in this project.

Background Information: The purpose of this study will be to assess the effect of using mobile devices (smartphone/tablets) in agricultural education on student ability to identify trees (achievement) and interest.

Procedures: The following requirements have been identified as crucial to this study.

The teacher will:

- Administer a pretest designed to measure preexisting knowledge via an online testing software. This will require use of a computer lab.
- Facilitate learning groups that utilize leaf manuals to identify 30 species of common Louisiana trees.
- Administer an instrument (survey) designed to measure student interest.
- Administer a post-test designed to measure student achievement in tree identification. This will require a computer lab.

Risks and Benefits:

There are no known risks associated with this study that would occur as a result of participation. Perceived benefits include determining the effectiveness of using leaf booklets for tree identification and serve to explain student interest in learning tree identification through the context of agriculture.

Confidentiality:

Your school can be assured that the records of this study will be kept private and any information obtained relating to you or your students will be kept confidential. Any reports that are generated as a result of this study will remain confidential as well, and not include any identifiers to you or your students. Since this is classified as a voluntary study, your decision to participate will have no bearing on your current or future relationship with LSU.

Contact Information:

If you have any questions now or in the future regarding this study, please do not hesitate to contact myself or the others listed below.

Dr. Joey Blackburn
225-578-7892
jblackburn@lsu.edu

Eric Smith Ph.D
candidate
225-578-6149
Hsmit63@lsu.edu

For any general questions concerning this research study, please contact Joey Blackburn via email at: jjblackburn@lsu.edu or Eric Smith via email at hsmit63@lsu.edu. If you have questions about subjects' rights or other concerns, you may contact Dennis Landin, LSU Institutional Review Board, at (225) 578-8692, irb@lsu.edu, or www.lsu.edu/irb.

Please retain a copy of this form for your records

Statement of Consent:

I have read the above information and support the participation of the teacher in this study.

Printed Name

Signature

Date

Appendix D

I, _____, agree to be in a study to see how effective the tree identification curriculum in my agriculture class is. I will have to take two special tests at the beginning and end of my agriculture class. I can decide to stop being in the study at any time without getting in trouble.

Child's Signature: _____ Age: _____
Date: _____

Witness* _____ Date: _____

* (N.B. Witness must be present for the assent process, not just the signature by the minor.)

Appendix E

Project Title: Assessing the effects of mobile devices and apps as an instructional delivery system to the tree identification achievement and student motivation in Louisiana secondary agricultural students.

Performance Site: _____ High School

Investigators: The following investigator is available for questions,

M-F, 8:00-4:30 pm

Dr. Joey Blackburn

Department of Agricultural and Extension

Education and Evaluation. LSU

(225)578-7892

M-W, 8:00-4:30 pm

Eric Smith

Department of Agricultural and Extension

Education and Evaluation. LSU

(225)578-6194

Purpose of the Study: The purpose of this study will be to assess the effect of using mobile devices (smartphone/tablets) in agricultural education on student ability to identify trees (achievement) and interest.

Inclusion Criteria: High school student enrolled in Agricultural Education courses that are NOT allowed by school policy to use mobile devices in the classroom.

Description of the Study: At the beginning of your student's agricultural education course, he or she will be given a test to determine any preexisting knowledge of tree identification. Your child will then learn tree identification by way of printed leaf booklets that have leaf and tree illustrations and pictures. At the end of the unit (approximately 5 days) your child will take a post test on tree identification to measure tree identification achievement. Finally, your child will complete a questionnaire pertaining to their interest in the course. Your child's test scores will remain anonymous to the researcher and only aggregated classroom data will be reported

Benefits: This study will help determine the effectiveness of using leaf booklets for tree identification and serve to explain the effectiveness of teaching tree identification through the context of agriculture.

Risks: There are no known risks.

Right to Refuse: Participation is voluntary, and a child will become part of the study only if both child and parent agree to the child's participation. At any time, either the subject may withdraw from the study or the subject's parent may withdraw the subject from the study without penalty or loss of any benefit to which they might otherwise be entitled.

Privacy: The school records of participants in this study may be reviewed by investigators. Results of the study may be published, but no names or identifying information will be included for publication. Subject identity will remain confidential unless disclosure is required by law.

Financial Information: There is no cost for participation in the study, nor is there any compensation to the subjects for participation.

Signatures:

The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigator. If I have questions about subjects' rights or other concerns, I can contact Dennis Landin, Chairman, Institutional Review Board, (225) 578-8692, irb@lsu.edu, www.lsu.edu/irb. I will allow my child to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

Parent's Signature: _____

Date:_____

The parent/guardian has indicated to me that he/she is unable to read. I certify that I have read this consent form to the parent/guardian and explained that by completing the signature line above he/she has given permission for the child to participate in the study.

Signature of Reader:_____

Date:_____

Appendix F

Dear friends,

I want to thank you for indicating an interest in participating in the research study I'll be conducting this fall. Your willingness to improve Louisiana agricultural education is something I admire. My ultimate goals are to improve student learning and help ag teachers find practical ways to facilitate learning. I promise you my best effort in meeting your individual needs as this project continues.

I would like to invite you to the "Jim Bowie Room" at the Vidalia Conference Center during L.A.T.A. on Tuesday July 26th at 9:30 a.m. for some initial training.

We will learn about the teachers role in this study, introduce the curriculum that has been created, and determine needs for further training. Participation in the workshop is vital to its success. If you are not attending the LATA conference, please make plans to attend the training.

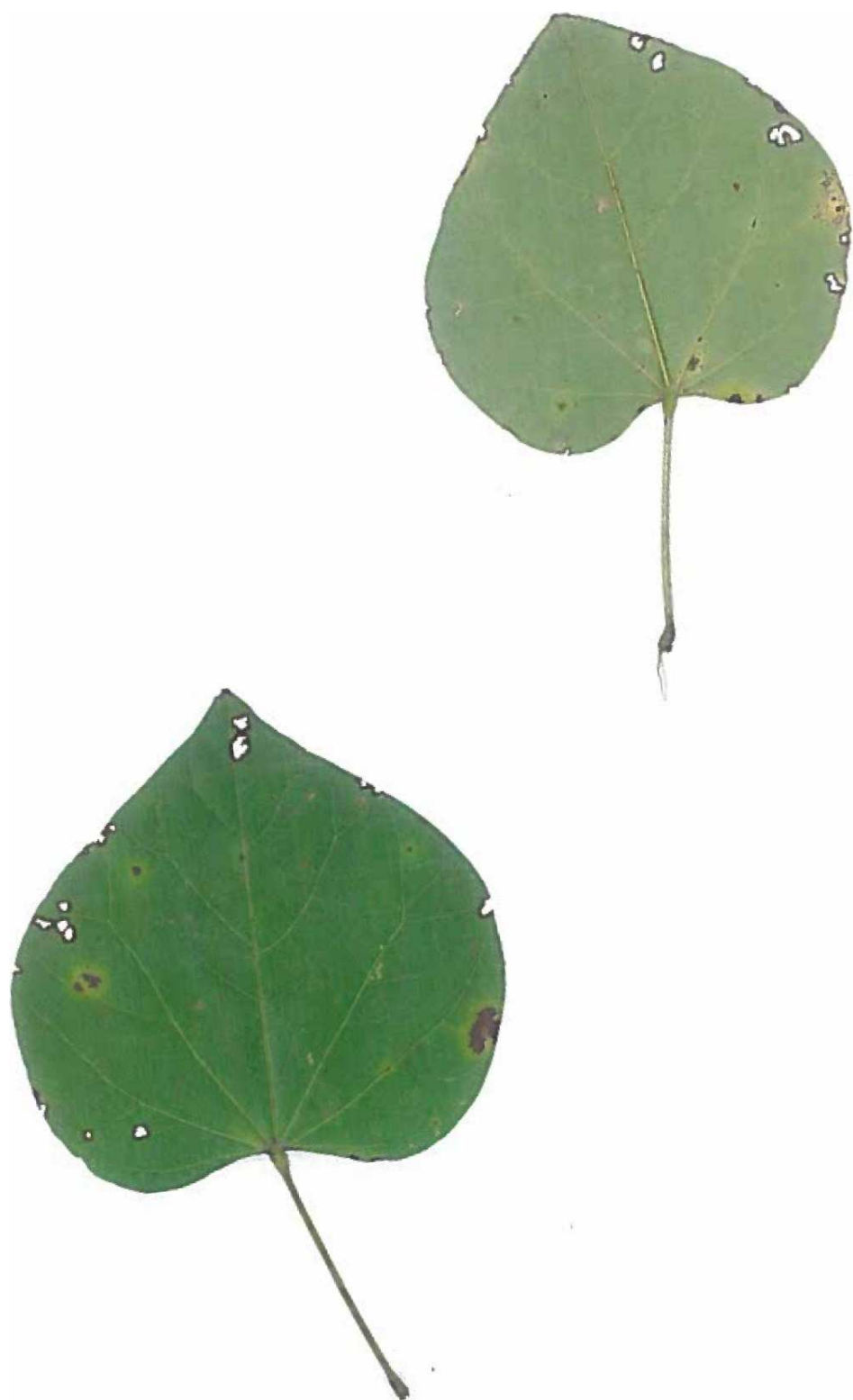
I am a realist and understand the life of agriculture teachers in late July. If you cannot attend this training, and want to still be included in the study, let me know via email and we will arrange a place and time to meet.

See you soon,

Eric Smith
225-578-6194
esmith@nat.k12.la.us
LSU Agricultural Education

Appendix G



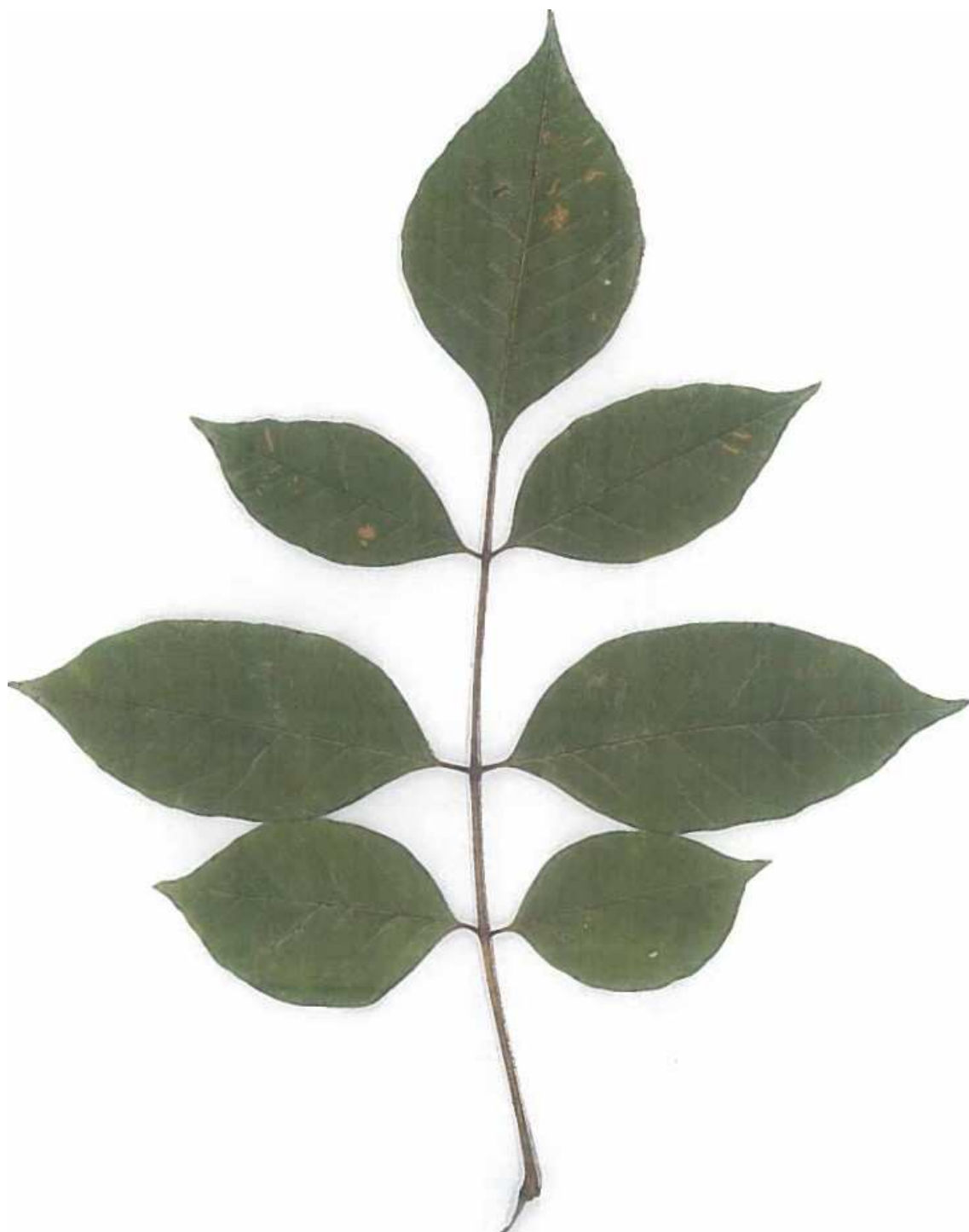


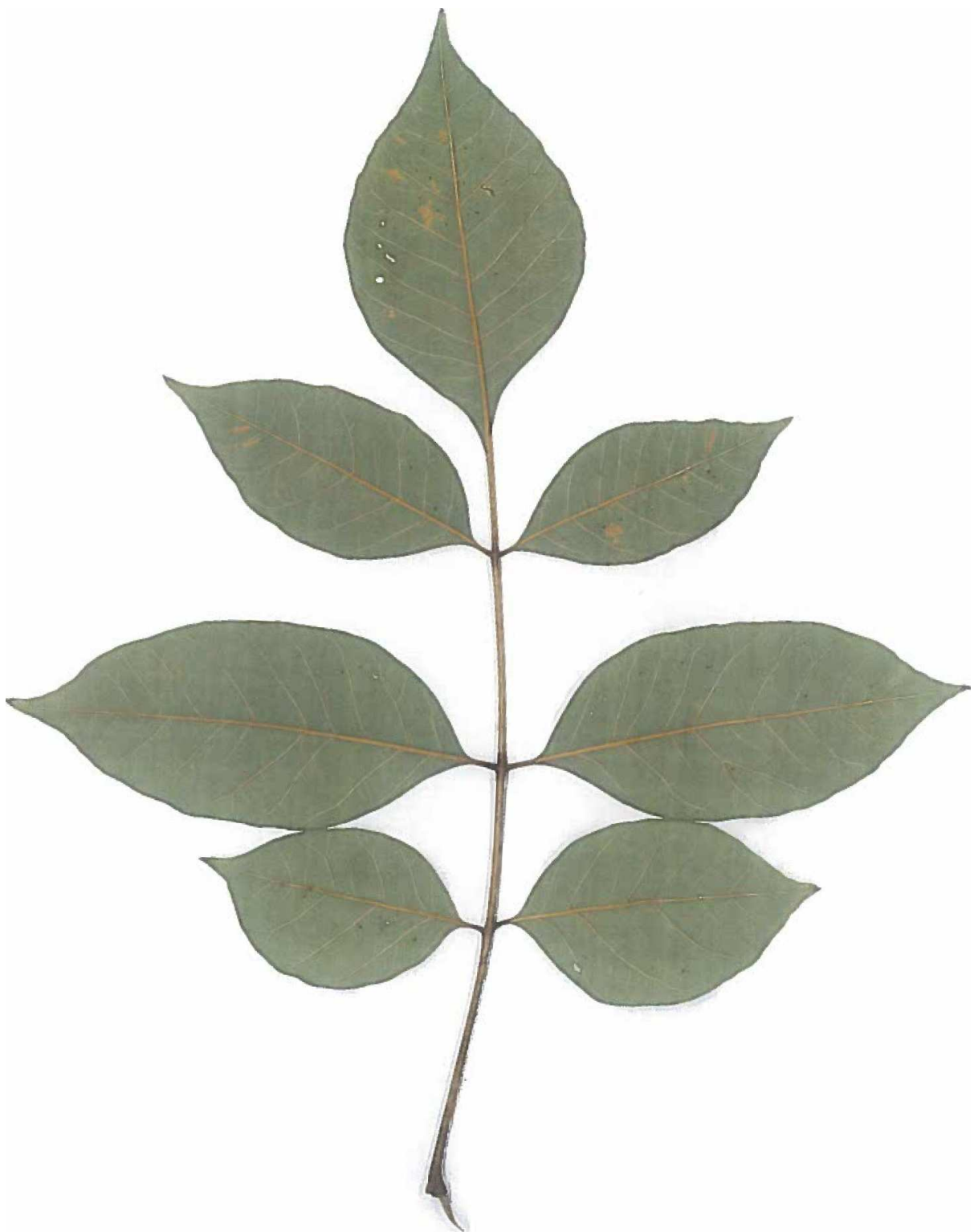










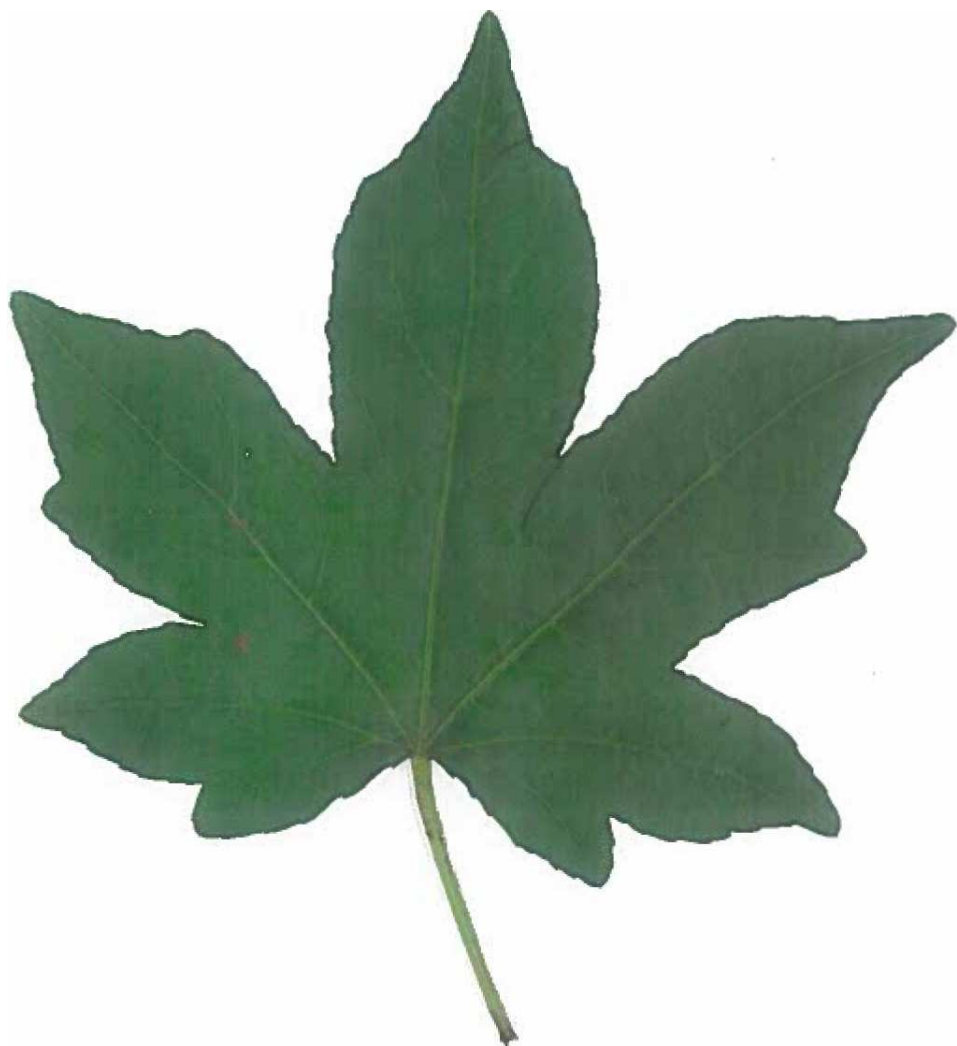


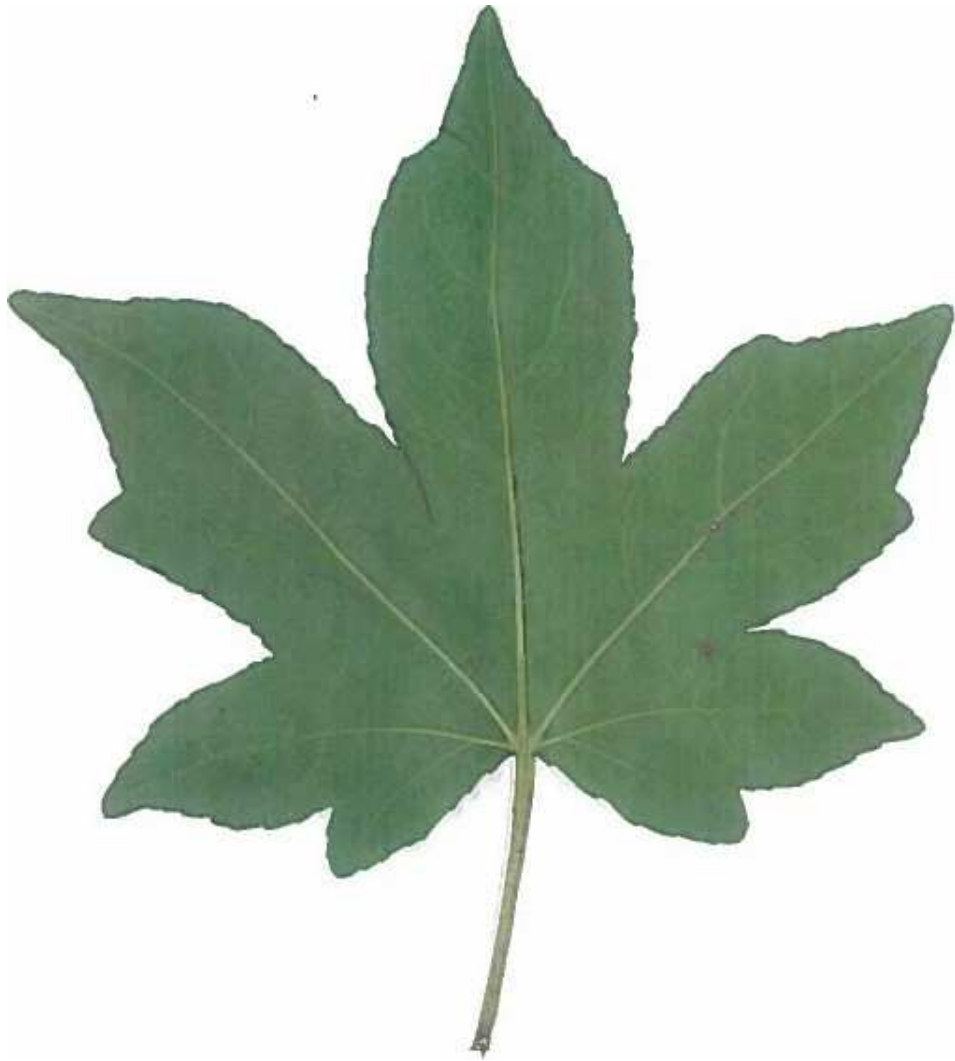


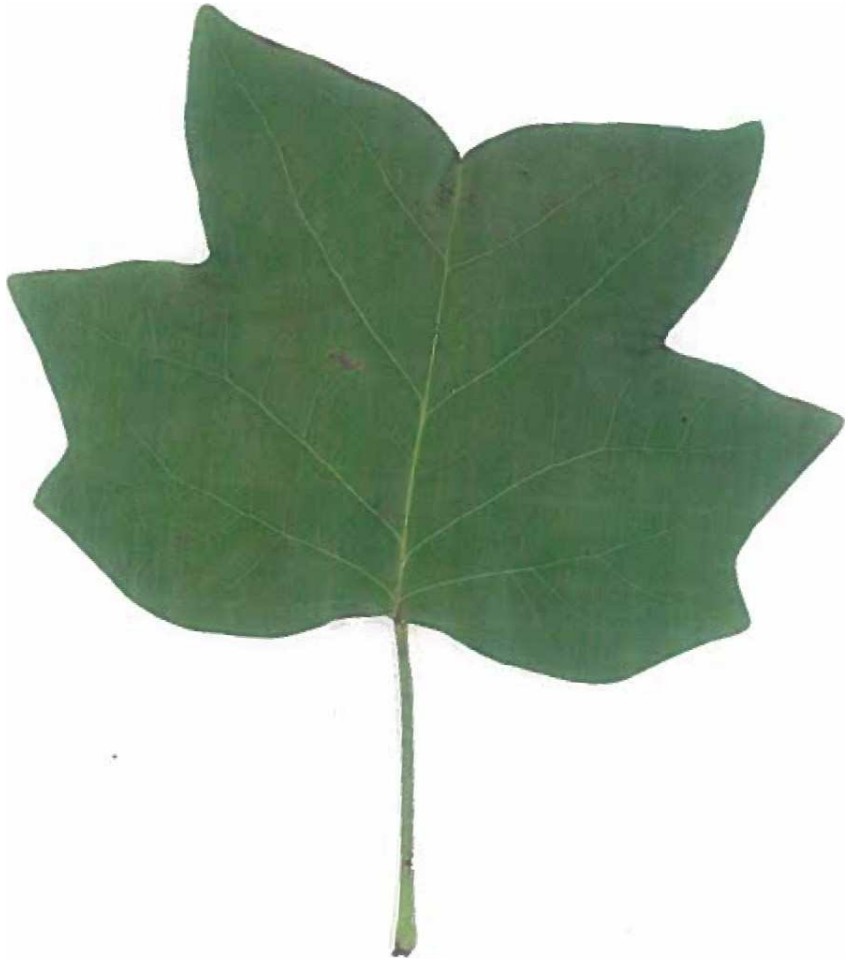




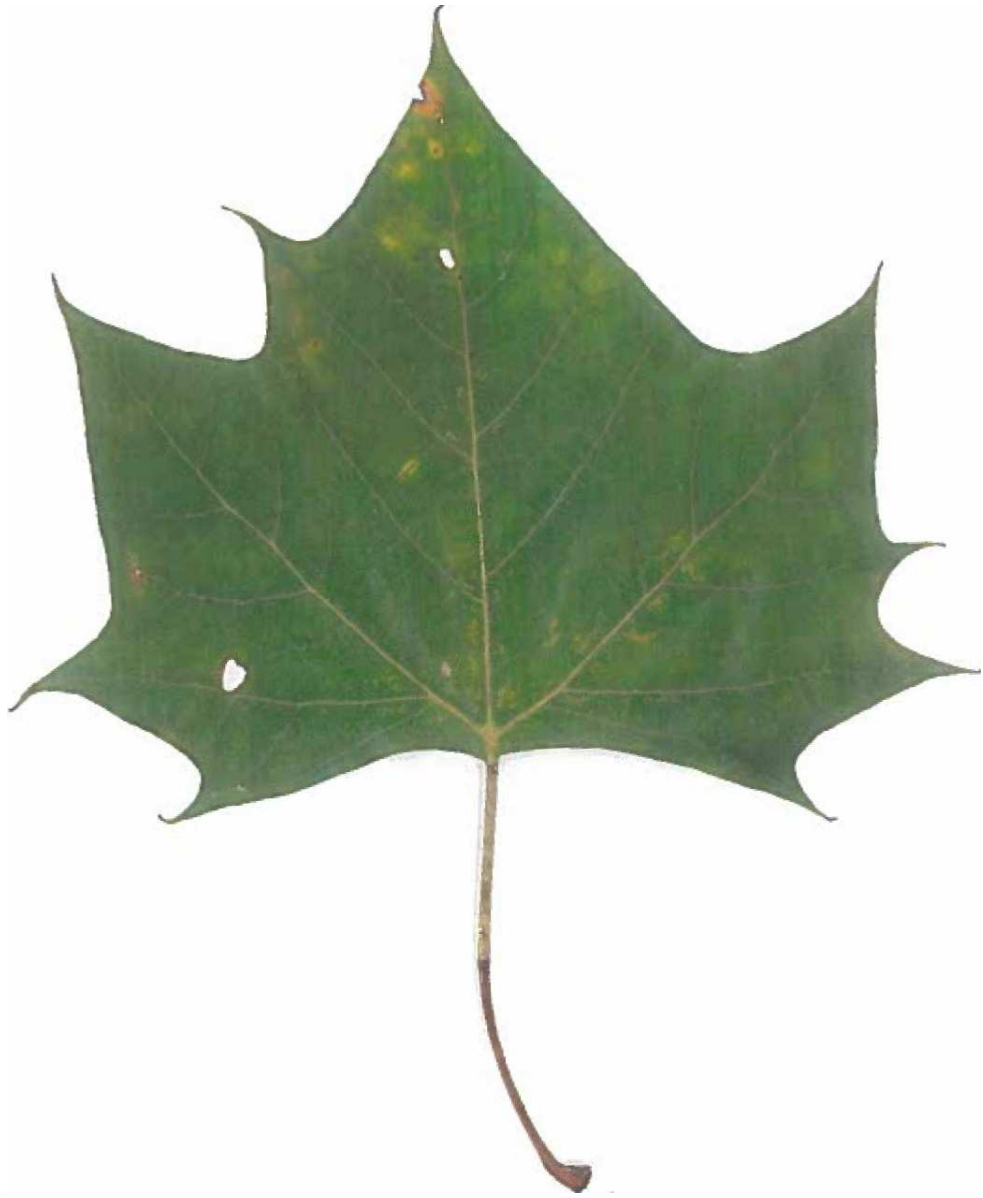
































































Test Generator

Pre test | Time Left: 00:27:34 | Question 2 of 30 | Time: 02:16:43 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Which one of the following trees is identified by this picture?

- A** ☐ Red Maple
- B** ☐ Eastern Redbud
- C** ☐ Flowering Dogwood
- D** ☐ Common Persimmon
- E** ☐ American Beech
- F** ☐ White Ash
- G** ☐ Honey Locust
- H** ☐ American Holly
- I** ☐ Eastern Redcedar
- J** ☐ Sweetgum



Test Generator

Pre test | Time Left: 00:27:09 | Question 3 of 30 | Time: 02:17:13 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Which one of the following trees is identified by this picture?

- ☐ A Red Maple
- ☐ B Eastern Redbud
- ☐ C Flowering Dogwood
- ☐ D Common Persimmon
- ☐ E American Beech
- ☐ F White Ash
- ☐ G Honey Locust
- ☐ H American Holly
- ☐ I Eastern Redcedar
- ☐ J Sweetgum



Test Generator

Pre test | Time Left: 00:26:07 | Question 4 of 30 | Time: 02:18:14 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Which one of the following trees is identified by this picture?

- A ☐ Red Maple
- B ☐ Eastern Redbud
- C ☐ Flowering Dogwood
- D ☐ Common Persimmon
- E ☐ American Beech
- F ☐ White Ash
- G ☐ Honey Locust
- H ☐ American Holly
- I ☐ Eastern Redcedar
- J ☐ Sweetgum



Test Generator

Pre test | Time Left: 00:25:42 | Question 5 of 30 | Time: 02:18:40 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Which one of the following trees is identified by this picture?

- A** ☐ Red Maple
- B** ☐ Eastern Redbud
- C** ☐ Flowering Dogwood
- D** ☐ Common Persimmon
- E** ☐ American Beech
- F** ☐ White Ash
- G** ☐ Honey Locust
- H** ☐ American Holly
- I** ☐ Eastern Redcedar
- J** ☐ Sweetgum



Test Generator

Pre test | Time Left: 00:25:19 | Question 6 of 30 | Time: 02:19:03 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Which one of the following trees is identified by this picture?

- A** ☐ Yellow poplar
- B** ☐ Black Tupelo (Blackgum)
- C** ☐ Loblolly Pine
- D** ☐ American Sycamore
- E** ☐ Eastern Cottonwood
- F** ☐ River Birch
- G** ☐ White Oak
- H** ☐ Southern Red Oak (Spanish Oak)
- I** ☐ Blackjack Oak
- J** ☐ Swamp Chestnut Oak (Cow Oak)



& TG Web copyright Fair & Company

Test Generator

Pre test | Time Left: 00:24:56 | Question 7 of 30 | Time: 02:19:25 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Which one of the following trees is identified by this picture?

- A** ☐ Yellow poplar
- B** ☐ Black Tupelo (Blackgum)
- C** ☐ Loblolly Pine
- D** ☐ American Sycamore
- E** ☐ Eastern Cottonwood
- F** ☐ River Birch
- G** ☐ White Oak
- H** ☐ Southern Red Oak (Spanish Oak)
- I** ☐ Blackjack Oak
- J** ☐ Swamp Chestnut Oak (Cow Oak)



& Company

Test Generator

Pre test | Time Left: 00:24:31 | Question 8 of 30 | Time: 02:19:52 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Which one of the following trees is identified by this picture?

- A ☐ Yellow poplar
- B ☐ Black Tupelo (Blackgum)
- C ☐ Loblolly Pine
- D ☐ American Sycamore
- E ☐ Eastern Cottonwood
- F ☐ River Birch
- G ☐ White Oak
- H ☐ Southern Red Oak (Spanish Oak)
- I ☐ Blackjack Oak
- J ☐ Swamp Chestnut Oak (Cow Oak)



Test Generator

Pre test | Time Left: 00:24:05 | Question 9 of 30 | Time: 02:20:15 pm | Date: 08/11/2016

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Which one of the following trees is identified by this picture?

- A** ☐ Yellow poplar
- B** ☐ Black Tupelo (Blackgum)
- C** ☐ Loblolly Pine
- D** ☐ American Sycamore
- E** ☐ Eastern Cottonwood
- F** ☐ River Birch
- G** ☐ White Oak
- H** ☐ Southern Red Oak (Spanish Oak)
- I** ☐ Blackjack Oak
- J** ☐ Swamp Chestnut Oak (Cow Oak)



Test Generator



Pre test | Time Left: 00:23:29 | Question 10 of 30 | Time: 02:20:48 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Which one of the following trees is identified by this picture?

- A** ☐ Yellow poplar
- B** ☐ Black Tupelo (Blackgum)
- C** ☐ Loblolly Pine
- D** ☐ American Sycamore
- E** ☐ Eastern Cottonwood
- F** ☐ River Birch
- G** ☐ White Oak
- H** ☐ Southern Red Oak (Spanish Oak)
- I** ☐ Blackjack Oak
- J** ☐ Swamp Chestnut Oak (Cow Oak)



Test Generator

Pre test | Time Left: 00:23:06 | Question 11 of 30 | Time: 02:21:18 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Which one of the following trees is identified by this picture?

- A ☐ Water Oak
- B ☐ Willow Oak
- C ☐ Shumard Oak
- D ☐ Post Oak
- E ☐ Live Oak
- F ☐ Black Locust
- G ☐ Black Willow
- H ☐ Sassafras
- I ☐ Winged Elm
- J ☐ American Elm



Test Generator

Pre test | Time Left: 00:22:36 | Question 12 of 30 | Time: 02:21:47 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Which one of the following trees is identified by this picture?

- A ☐ Water Oak
- B ☐ Willow Oak
- C ☐ Shumard Oak
- D ☐ Post Oak
- E ☐ Live Oak
- F ☐ Black Locust
- G ☐ Black Willow
- H ☐ Sassafras
- I ☐ Winged Elm
- J ☐ American Elm



Test Generator

Pre test | Time Left: 00:22:06 | Question 13 of 30 | Time: 02:22:18 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Which one of the following trees is identified by this picture?

- A ☐ Water Oak
- B ☐ Willow Oak
- C ☐ Shumard Oak
- D ☐ Post Oak
- E ☐ Live Oak
- F ☐ Black Locust
- G ☐ Black Willow
- H ☐ Sassafras
- I ☐ Winged Elm
- J ☐ American Elm



Test Generator

Pre test | Time Left: 00:21:46 | Question 14 of 30 | Time: 02:22:40 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Which one of the following trees is identified by this picture?

- A** ☐ Water Oak
- B** ☐ Willow Oak
- C** ☐ Shumard Oak
- D** ☐ Post Oak
- E** ☐ Live Oak
- F** ☐ Black Locust
- G** ☐ Black Willow
- H** ☐ Sassafras
- I** ☐ Winged Elm
- J** ☐ American Elm



in & Company

Test Generator

Pre test | Time Left: 00:21:12 | Question 15 of 30 | Time: 02:23:10 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Which one of the following trees is identified by this picture?

- A** ☐ Water Oak
- B** ☐ Willow Oak
- C** ☐ Shumard Oak
- D** ☐ Post Oak
- E** ☐ Live Oak
- F** ☐ Black Locust
- G** ☐ Black Willow
- H** ☐ Sassafras
- I** ☐ Winged Elm
- J** ☐ American Elm



Test Generator



Pre test | Time Left: 00:20:46 | Question 16 of 30 | Time: 02:23:35 pm | Date: 06/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Insert the number corresponding to the trees name from the scorecard provided.

This limb is from the [A](#) tree.



Test Generator



Pre test | Time Left: 00:20:21 | Question 17 of 30 | Time: 02:24:04 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Insert the number corresponding to the trees name from the scorecard provided.

This limb is from the [A](#) tree.

Test Generator & TG Web copyright Fain & Company



Test Generator

Pre test | Time Left: 00:19:22 | Question 19 of 30 | Time: 02:24:43 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Insert the number corresponding to the trees name from the scorecard provided.

This limb is from the [A](#) tree.

[Fain & Company](#)



Test Generator

Pre test | Time Left: 00:18:28 | Question 20 of 30 | Time: 02:25:35 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Insert the number corresponding to the trees name from the scorecard provided.

This limb is from the [A](#) tree.



Test Generator



Pre test | Time Left: 00:16:57 | Question 21 of 30 | Time: 02:27:25 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Insert the number corresponding to the trees name from the scorecard provided.

This limb is from the [A](#) tree.



Company

Test Generator



Pre test | Time Left: 00:16:25 | Question 22 of 30 | Time: 02:28:03 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Insert the number corresponding to the trees name from the scorecard provided.

This picture is of a branch.



Test Generator



Pre test | Time Left: 00:16:02 | Question 23 of 30 | Time: 02:28:28 pm | Date: 08/11/2016

professor5 (pro5)

<Back

Next>

Clear

Summary

Media

Flag Question



Insert the number corresponding to the trees name from the scorecard provided.

This picture is of a [A](#) branch.

Test Generator & TG Web copyright Fain & Company



Test Generator

Pre test | Time Left: 00:15:35 | Question 24 of 30 | Time: 02:28:54 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



Insert the number corresponding to the trees name from the scorecard provided.

This picture is of the [A](#) tree.

Test Generator & TQ Web copyright Eain & Company



Test Generator



Pre test | Time Left: 00:15:10 | Question 25 of 30 | Time: 02:29:20 pm | Date: 08/11/2016

professor5 (pro5)

<Back

Next>

Clear

Summary

Media

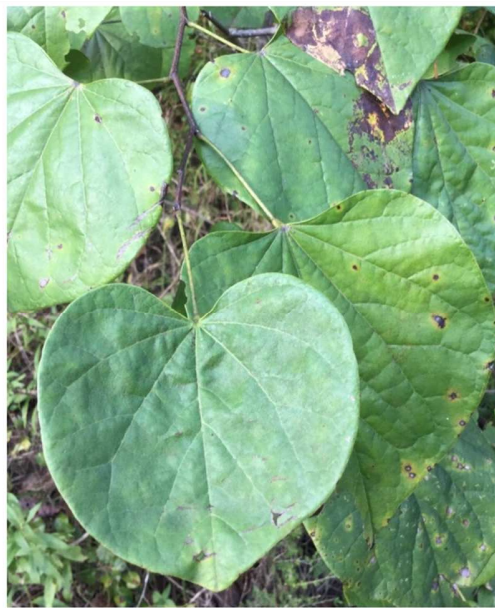
Flag Question



Insert the number corresponding to the trees name from the scorecard provided.

This picture is of the [A](#) _tree.

it Fain & Company



Test Generator



Pre test | Time Left: 00:14:35 | Question 26 of 30 | Time: 02:29:53 pm Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



This limb is from a black tupelo

- A ☐ True
B ☐ False

Test Generator & TG Web copyright Fain & Company



Test Generator



Pre test | Time Left: 00:14:10 | Question 27 of 30 | Time: 02:30:20 pm | Date: 08/11/2016

professor5 (pro5)

<Back

Next>

Clear

Summary

Media

Flag Question



This picture is of a river birch

A ☐ True

B ☐ False



Test Generator



Pre test | Time Left: 00:13:34 | Question 28 of 30 | Time: 02:30:58 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



This picture is from a southern red oak

- A ☐ True
B ☐ False



Fain & Company

Test Generator

Pre test | Time Left: 00:13:09 | Question 29 of 30 | Time: 02:31:23 pm | Date: 08/11/2016

professor5 (pro5)

[<Back](#) [Next>](#) [Clear](#) [Summary](#) [Media](#) [Flag Question](#)



This picture is of a post oak

- A ☐ True
B ☐ False



Test Generator

>>> ...

Pre test | Time Left: 00:12:45 | Question 30 of 30 | Time: 02:31:47 pm | Date: 08/1/2015

<Back


Next>

Clear

Summary


Media

Flag Question

 This limb is from a post oak

A ☐ True

B ☐ False




Test Generator

>>> ...


Pre test | Time Left: 00:12:01 | Question 18 of 30 | Time: 02:32:19 pm | Date: 08/11/2016

professor5 (pro5)

<Back | Next> | Clear | Summary | Media | Flag Question

 Insert the number corresponding to the tree limb shown in the image below.

This limb is from the [A](#) 3



Test Generator & TG Web copyright Eain & Company

Appendix I

Name _____ School _____

Directions: Write the correct tree number in the answer column.

Common Names

1 Red Maple

2 Eastern Redbud

3 Flowering Dogwood

4 Common Persimmon

5 American Beech

6 White Ash

7 Honey Locust

8 American Holly

9 Eastern Redcedar

10 Sweetgum

11 Yellow-Opplar

12 Blackgum

13 Loblolly Pine

14 American Sycamore

15 Eastern Cottonwood

16 River Birch

17 White Oak

18 Southern Red Oak (Spanish Oak)

19 Blackjack Oak

20 Swamp Chestnut Oak (Cow oak)

21 Water Oak

22 Willow Oak

23 Shumard Oak

24 Post Oak

25 Live Oak

26 Black Locust

27 Black Willow

28 Sassafras

29 Winged Elm

30 American Elm

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
Total	

16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
Total	

SCORE

Appendix J



The purpose of this questionnaire is to obtain information from students enrolled in agricultural courses that teach forestry in Louisiana. This questionnaire is designed to assess your perceived levels of motivation.

Your participation in this study is strictly voluntary and greatly appreciated. The information you provide will assist Louisiana State University in evaluating students' level of motivation in an agricultural course that teaches tree identification. Therefore, your responses are vital. However, you are not required to participate in this study. It is strictly voluntary. Should you decide to participate in this study, please complete the questionnaire.

Please type in your student number on question 1 of this questionnaire and not your name. Confidentiality is guaranteed and no names will be associated with this study or its findings

Thank you for participating in this important study.

Please enter your student number given by your teacher

What is your gender?

Male

Female

What is your age?

13

14

15

16

17

18

19

What is your current grade classification?

Ninth Grade-Freshmen

Tenth Grade-Sophomore

Eleventh Grade-Junior

Twelfth Grade – Senior

Which of the following ethnicity represents you best?

~~White~~/Caucasian

African-American

Asian

American Indian

Hispanic

Other

Including your current class, how many agriculture classes have you taken?

1

2

3

4

5

6

7

8

Appendix K

Instructions

1. There are 34 statements in this part of the questionnaire. Please think about each statement in relation to the instructional materials you have just studied, and indicate how true it is. Give the answer that truly applies to you, and not what you would like to be true, or what you think others want to hear.
2. Think about each statement by itself and indicate how true it is. Do not be influenced by your answers to other statements.
3. Record your responses by clicking the answer that truly applies to you.

1. The instructor knows how to make us feel enthusiastic about the subject matter of this course.

Not True

Slightly True

Moderately True

Mostly True

Very True

2. The things I am learning in this course will be useful to me.

Not True

Slightly True

Moderately True

Mostly True

Very True

3. I feel confident that I will do well in this course.

Not True

Slightly True

Moderately True

Mostly True

Very True

4. This class has very little in it that captures my attention

Not True

Slightly True

Moderately True

Mostly True

Very True

5. The instructor makes the subject matter of this course seem important.

Not True

Slightly True

Moderately True

Mostly True

Very True

6. You have to be lucky to get good grades in this course.

Not True

Slightly True

Moderately True

Mostly True

Very True

7. In this class I try to set and achieve high standards of excellence

Not True

Slightly True

Moderately True

Mostly True

Very True

8. I have to work too hard *to* succeed in this course.

Not True

Slightly True

Moderately True

Mostly True

Very True

9. I do NOT see how the content of this course relates to anything I already know.

Not True

Slightly True

Moderately True

Mostly True

Very True

10. Whether or not I succeed in this course is up to me.

Not True

Slightly True

Moderately True

Mostly True

Very True

11. The instructor creates suspense when building up to a point.

Not True

Slightly True

Moderately True

Mostly True

Very True

12. The subject matter of this course is just too difficult for me.

Not True

Slightly True

Moderately True

Mostly True

Very True

13. I feel that this course gives me a lot of satisfaction.

Not True

Slightly True

Moderately True

Mostly True

Very True

14. I feel that the grades or other recognition I receive are fair compared to other students.

Not True

Slightly True

Moderately True

Mostly True

Very True

15. The students in this class seem curious about the subject matter.

Not True

Slightly True

Moderately True

Mostly True

Very True

16. I enjoy working for this course.

Not True

Slightly True

Moderately True

Mostly True

Very True

17. It is difficult to predict what grade the instructor will give my assignments.

Not True

Slightly True

Moderately True

Mostly True

Very True

18. I am pleased with the instructor's evaluations of my work compared to how well I think I have done.

Not True

Slightly True

Moderately True

Mostly True

19. I feel satisfied with what I am getting from this course.

Not True

Slightly True

Moderately True

Mostly True

Very True

20. The content of this course relates to my expectations and goals.

Not True

Slightly True

Moderately True

Mostly True

Very True

21. The instructor does unusual or surprising things that are interesting.

Not True

Slightly True

Moderately True

Mostly True

Very True

22. The students actively participate in this class.

Not True

Slightly True

Moderately True

Mostly True

Very True

23. To accomplish my goals, it is important that I do well in this course.

Not True

Slightly True

Moderately True

Mostly True

Very True

24. The instructor uses an interesting variety of teaching techniques.

Not True

Slightly True

Moderately True

Mostly True

Very True

25. I do NOT think I will benefit much from this course.

Not True

Slightly True

Moderately True

Mostly True

Very True

26. I often daydream while in this class.

Not True

Slightly True

Moderately True

Mostly True

Very True

27. As I am taking this class, I believe that I can succeed if I try hard enough.

Not True

Slightly True

Moderately True

Mostly True

Very True

28. The personal benefits of this course are clear to me.

Not True

Slightly True

Moderately True

Mostly True

Very True

29. My curiosity is often stimulated by the questions asked or the problems given on the subject matter in this class.

Not True

Slightly True

Moderately True

Mostly True

Very True

30. I find the challenge level in this course to be about right: neither too easy not too hard.

Not True

Slightly True

Moderately True

Mostly True

Very True

31. I feel rather disappointed with this course.

Not True

Slightly True

Moderately True

Mostly True

Very True

32. I feel that I get enough recognition of my work in this course by means of grades, comments, or other feedback.

Not True

Slightly True

Moderately True

Mostly True

Very True

33. The amount of work I have to do is appropriate for this type of course.

Not True

Slightly True

Moderately True

Mostly True

Very True

34. I get enough feedback to know how well I am doing.

Not True

Slightly True

Moderately True

Mostly True

Very true

2/22/2017

The importance of Forestry and Leaf Characteristics

Information that will help you:

1. Understand why tree ID is important for you to learn
2. Communicate better when discussing leaf identification

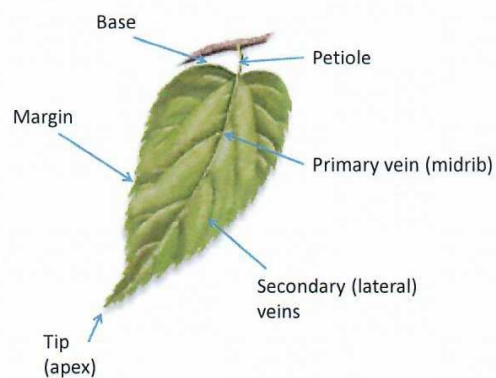
Why is Forestry important?

- Forestry is the #1 agricultural crop in LA
- Accounts for 25% of all ag commodities
- Louisiana's second largest manufacturing employer (only oil manufacturing employees more people)
- 50% of Louisiana acreage is forested (7 million acres)

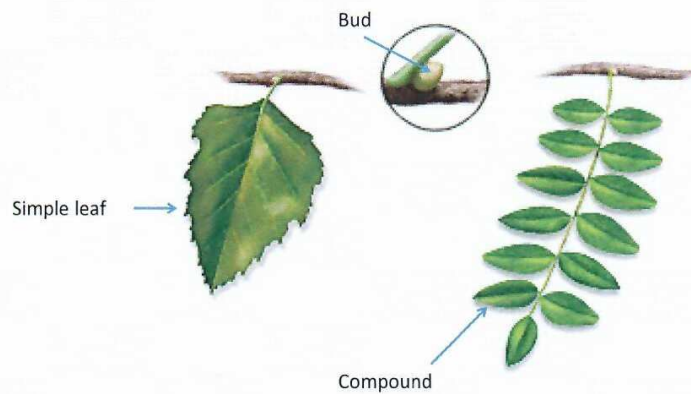
Leaf identification is the foundation

- Changes the way we view trees and forests when we know the names of the inhabitants.
- Essential for all employed in the timber processing industry and those who own land to know how to identify trees on the property.

Parts of a leaf



Simple vs. compound



Leaf shapes

Some common leaf shapes are round, egg-shaped (ovate), triangular (deltoid), or heart-shaped (cordate). It is important to note that within species and even individual plants you may see more than one typical leaf shape, and most plants will have several possible leaf shapes.

The shapes are generally determined by the location of the **widest** part of the leaf.



Deltoid



Oval



Cordate

Leaf margins

The margins of leaves (edges) may be toothed or without teeth (**entire**). A leaf margin is **serrate** if the teeth point forward towards the tip or **dentate** if the teeth point outwards. A leaf is **lobed** if it is broken into segments and has sinuses.



Serrated



Dentate



Entire



Lobed

Tips and Bases

Besides basic shape, leaves have a number of other physical characteristics that are useful for identification. For example, the tips of leaves may be rounded, acute, or long and tapering.



Some common leaf bases are rounded, wedge shaped and oblique



Leaf arrangement



Alternate



Opposite



Whorled

Part 1: A. Is a HIPAA Agreement Needed?

Are you obtaining any health information from a health care provider that contains any of the identifiers listed below?

A. Names

B. Address: street address, city, county, precinct, ZIP code, and their equivalent geocodes. Exception for Zip codes: the initial three digits of the ZIP Code may be used, if according to current publicly available data from the Bureau of the Census: (1) The geographic unit formed by combining all ZIP codes with the same three initial digits contains more than 20,000 people; and (2) the initial three digits of a ZIP code for all such geographic units containing 20,000 or fewer people is changed to '000'. (Note: The 17 currently restricted 3-digit ZIP codes to be replaced with '000' include: 036, 059, 063, 102, 203, 556, 692, 790, 921, 830, 831, 878, 879, 884, 890, and 893.)

C. Dates related to individuals

i. Birth date

ii. Admission date

iii. Discharge date

iv. Date of death

v. And all ages over 89 and all elements of dates (including year) indicative of such ago. Such ages and elements may be aggregated into a single category of age 90 or older.

D. Telephone numbers;

E. Fax numbers;

F. Electronic mail addresses;

G. Social security numbers;

H. Medical record numbers; (including prescription numbers and clinical trial numbers)

I. Health plan beneficiary numbers;

J. Account numbers;

K. Certificate/license numbers;

L. Vehicle identifiers and serial numbers including license plate numbers;

M. Device identifiers and serial numbers;

N. Web Universal Resource Locators (URLs);

O. Internet Protocol (IP) address numbers;

P. Biometric identifiers, including finger and voice prints;

Q. Full face photographic images and any comparable images; and

R. Any other unique identifying number, characteristic, or code; except a code used alone or in combination with other information to identify an individual who is the subject of the information.

- ☐ **YES** Your study falls under the HIPAA (Health Information Privacy and Accountability Act) and you must obtain either a limited data set use agreement or a HIPAA authorization agreement from the health care provider. This agreement must be submitted with your IRB protocol.
- ☒ **NO** You do not need a HIPAA agreement.

B. Are pregnant women specifically excluded from participation on the consent form?

☒ **YES** Skip to Part C.

☐ **NO** You need to document the following:

- ☐ 1. Is the purpose of the activity to meet the health needs of the mother and -
- ☐ a. Fetus will be placed at risk only to minimum to meet mothers needs.
- ☐ b. Fetus risk is minimal.
- ☐ 2. Have mother and father given informed consent including potential affects on the fetus?
- ☐ 3. Father's consent to be omitted when:
- ☐ a. Purpose of activity is to meet health needs of the mother
- ☐ b. His identity can not be ascertained
- ☐ c. He is not reasonably available
- ☐ d. Pregnancy is from rape

Continue on the next page

C. Are any of your participants incarcerated?

☐ **YES** - You must document the following information:

- ☐ 1. Is the study minimal risk? (it must be)
- ☐ 2. Research fits one of the allowed categories below
 - ☐ Causes or effects of incarceration
 - ☐ Study of prisons or prisoners
 - ☐ Conditions affecting prisoners as a class
 - ☐ Practices that may improve health or well-being of subjects
- ☐ 3. Are the risks commensurate with risks accepted by non-prisoners?
 - ☐ Selection of subjects is fair - controls random
 - ☐ Language is understandable
 - ☐ Study does not affect parole
 - ☐ If necessary, follow up care will be provided

☒ **NO**

D. Are children involved?

☒ **YES** - You need both parental consent form and a child assent form

- If the study has greater than minimal risk and no direct benefits, then you must show that the
- ☐ risk is only a minor increase above minimal, and it involves experiences that are commensurate with ordinary medical, psychological, social or educational situations

☐ **NO**

Part 2: Project Abstract - Provide a brief abstract of the project

☒ I have attached a project abstract to this application

Part 3: Research Protocol

A. Describe study procedures

Describe study procedures with emphasis on those procedures affecting subjects and safety measures. Also provide script for telephone surveys.

☒ I have attached a description of my study procedures to this application

B. Answer each of the following questions

1. Specify sites of data collection

Data collection sites will be high school agricultural education classes selected across Louisiana that have volunteered to implement teaching using mobile devices. Additionally, high school agriculture programs that will not use mobile technology to teach tree identification will be selected for comparative purposes. Schools that have volunteered are listed.

Treatment: Iberville MSA West, Zachary, Kaplan, Northwood Lena, Pineville, Rapides, South Lafourche, Union Parish

Control: Acadiana, Choudrant, Church Point, Comeaux, Eunice, Mangham, Northwest, Rayne

Continue on the next page

2. If surgical or invasive procedures are used, give name, address, and telephone number of supervising physician and the qualifications of the person(s) performing the procedures. Comparable information when qualified participation is required or appropriate.

3. Provide the names, dosage, and actions of any drugs or other materials administered to the subjects and the qualifications of the person(s) administering the drugs.

4. Detail all the physical, psychological, and social risks to which the subjects may be exposed.

no known risks

5. What steps will be taken to minimize risks to subjects?

Only aggregated data will be analyzed and reported.

Students in both the treatment and counter-factual groups will be taught by their normal teacher, in their normal educational setting.

Continue on the next page

6. Describe the recruitment pool (community, institution, group) and the criteria used to select and exclude subjects.

Student who enroll and complete courses in high school agricultural education programs that have policies in favor of using mobile technology in the classroom and have agreed to teach a unit in tree identification will serve as the recruitment pool for the treatment group. Students who are in high schools that have policies against student use of mobile devices in the classrooms will serve as the recruitment pool for the control group.

7. List any vulnerable population whose members are included in this project (e.g., children under the age of 18; mentally impaired persons; pregnant women; prisoners; the aged).

Children under the age of 18 enrolled in public high school agricultural education courses

8. Describe the process through which informed consent will be obtained. (Informed consent usually requires an oral explanation, discussion, and opportunity for questions before seeking consent form signature.)

A letter will be sent to high school agriculture teachers to distribute to parents/guardians in selected courses explaining the nature of the study. A consent form will be attached to the letter for parents/guardian to sign.

Child assent will be obtained by sending a letter to high school teachers to distribute to their students. An assent form will be attached for students to sign to agree to participate in the study.

Additionally, the school administrator and classroom teacher will provide informed, signed consent.

9. (A) Is this study anonymous or confidential? (Anonymous means that the identity of the subjects is never linked to the data, directly or indirectly through a code system.)

(B) If a confidential study, detail how the privacy of subjects and security of their data will be protected.

Confidential.

Students accounts will be created for a test generator software that will contain unidentifiable user names. Example: NWstudent1, NWstudent2, NWstudent3 etc. The classroom teacher will assign these user names to students and they will use these user names to take the pretest and post test on the web based software. The researcher will receive testing results through this software, however, the researcher will never know the identities. The testing account will be deleted once the data has been entered into SPSS.

Quizlet accounts are set up by students through the mobile app. They will be given a code to join the researchers quizlet class via email. The class will be private and no users can join without the code provided by the researcher.

The CIS instrument will require the students write in their test generator user name instead of their actual name.

Continue on the next page

Part 4: Consent Form (Including Assent Form and Parental Permission Form if minors are involved)

▷ **Please note:** The consent form must be written in non-technical language which can be understood by the subjects. It should be free of any exculpatory language through which the participant is made to waive, or appears to be made to waive any legal rights, including

▷ For example consent forms and a complete checklist of required items, please refer to our website, www.lsu.edu/irb. Remember, **IRB contact information must be included** on the consent form!

▷ To waive signed consent, **IRB must be provided with the consent script** that will present the informed consent information to human subjects regarding the study/research. Also, note that waiving signed consent requires full IRB approval, which may delay approval of your study.

I am requesting waiver of signed Informed Consent because:

☐ (a) Having a participant sign the consent form would create the **principal risk** of participating in the study.

or that

☐ (b) The research presents **no more than minimal risk** of harm to subjects and involves no procedures for which having signed consent is normally required.

Expedited reviews usually take one month. See our website for information about meeting dates. Carefully completed applications should be submitted three weeks before a meeting to ensure a prompt decision.

Institutional Review Board
Dr. Dennis Landin, Chair
130 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.5983
irb@lsu.edu | lsu.edu/irb

Appendix N

Eight Louisiana High Schools having policy which allows students and teachers to use mobile devices in the classroom will be purposefully selected to serve as the treatment group. Students will learn to identify leaf samples of 30 common species of trees found in Louisiana using different mobile applications. The following apps will be used to identify the leaf samples: *Leafsnap*®, *V-Tree*®, and *Tree book*®. Formative assessments will be taken using the *Quizlet*® app which utilizes interactive touch screen matching and flashcard games.

Additionally, eight schools having policy which does not allow students to use mobile devices in the classroom will be selected to serve as a control group. This group will use manuals containing illustration and pictures to identify the leaf samples. Formative assessments will be taken by matching index cards containing the tree names to the leaf samples.

Pretest-post-test control group will be the design for the proposed research (Campbell & Stanley, 1963). The pretest is one created by the researcher which will be taken online via Test Generator Web created by *Fain and Company*. The post test will be taken in the same manner. This software allows the researcher to upload authentic photographs of leafs, then have the students answer the identification problem with multiple choice, true/false, and fill-in-the-blank question formats. Test Generator will grade the exam and report the scores to the researcher. Students will also take a course interest survey (CIS) developed by Keller (2006) to measure motivation in an educational setting. Teachers will be encouraged to have students fill out the CIS one the first day, at the midway point, and on the final day of the study.

Appendix O

Hello teachers,

The devastation of the flooding event has affected all of Louisiana's citizens either directly or indirectly. Seeing the ag teachers mobilize and communicate with each other to focus on recovery efforts via the listserv has made me cautious about emailing anything pertaining to the research study I proposed to you all this summer. I have talked to enough people personally to safely say that *most* of the schools that can return to normal are beginning to get back to normal. Therefore, I am contacting all of you teachers who attended the workshop as the technology group about our plans moving forward with the study.

I turned in the application to the LSU review board for approval of our research studies' procedures the day before it started flooding. I thought it would take longer than it has to hear back from them, but I am glad to announce that the university has approved the methods of the study. This means I have the actual permission slips for your parents, administrators, and students approved by the university.

I am going to begin creating login usernames and passwords for your students. They will be generic in nature. For example I will create the username "Pineville1" with a password of 12345, then "Pineville2", pass 12345 etc. **I need an *estimated* number of students we will be collecting data from for each school. Please do not send any names, just a head count.** You may use more than one class for the study. If you have three sections of Agriculture II, you may teach the lesson in all three. You can teach the forestry lesson in any class where forestry makes sense. (Ag. I, Ag. II, Ag. III, woodworks, forestry, horticulture, etc.)

I'd like to get together to finish the training. I predict that it will last no more than two and a half hours. Wayne Oubre has agreed to host on **Saturday, September 17th at Acadiana High.** The address is 315 Rue du Belier Lafayette, LA 70506 We will begin at 10:00 a.m., lunch will be provided. If neither one of those dates fit your schedule, I will make arrangements to come to your school or meet you at a time that does fit and give you the materials and training necessary. Everyone has to receive the same amount of instruction for this to be considered sound research design.

My plan for the experiment is that I would like all schools to start with the pretest and preliminary survey on Monday, September 19th. We should begin the lessons that day or the following day, and take the post-test and final survey on Thursday, September 22nd.

If your principal needs more information about the study, give me their contact information (including email) and I will be glad to discuss it with them. Thank you all for sticking with me this far. I look forward to creating a dynamic experience for your students.

Have a great week,

Eric

Appendix P

School name _____

Day 1 Pretest

Monday September 19th, 2016

Directions: Please checkoff each item as it occurs during the instructional day. Feel free to make any notes on this agenda. As well, there are note pages for each instructional day at the end of this document.

☐ 1. Give each student a copy of the tree ID scorecard. They will need the tree numbers from the scorecard for the pretest fill in the blank items.

☐ 2. Student logins will be issued by the teacher (they should already be written on the student number log provided)

☐ 3. Pretest should be taken at <https://treeid.mytgweb.com>

Students will have a 30 minute time limit on the pretest.

The pretest will contain 30 pictures to be identified by either: multiple choice, fill in the blank, and true/false

If time permits introduce Powerpoint on the importance of forestry and leaf characteristics

Day 2

(Tuesday September 20th, 2016) Teaching the importance of forestry and leaf characteristics

☐ 1. Powerpoint on the importance of forestry and leaf characteristics (maximum 15 minutes)

☐ 2. Introduce 30 leaf samples and have students identify them on their own using the mobile tree identification apps: leafsnap, v-tree, treebook, or other preferred application. Confirm the students are identifying the species correctly and facilitate the proper use of the mobile apps.

☐ 3. If time permits have kids go to their course in quizlet and take a tree identification quiz of their choice.

Day 3

(Wednesday September 21st, 2016) Practice identifying leaf samples through formative quizzing

- ☐ 1. Have students take informal quizzes of their choice on quizlet
- ☐ 2. Allow students to finish identifying the samples using mobile apps
- ☐ 3. Confirm they have correctly identified the samples using the mobile apps
- ☐ 4. Take more informal tree identification quizzes on quizlet.

Day 4

(Thursday September 22nd, 2016) Practice identifying leaf samples through formative quizzing

- ☐ 1. Have students take informal quizzes on quizlet
- ☐ 2. Allow students to finish identifying the samples using mobile apps
- ☐ 3. Confirm they have correctly identified the samples using the mobile apps
- ☐ 4. Take more informal tree identification quizzes on quizlet

Day 5

(Friday September 23rd, 2016) Practice identifying leaf samples through formative quizzing

- ☐ 1. Have students take informal quizzes on quizlet
- ☐ 2. Allow students to finish identifying the samples using mobile apps
- ☐ 3. Confirm they have correctly identified the samples using the mobile apps
- ☐ 4. Take more informal tree identification quizzes on quizlet

Day 6

(Monday September 26th, 2016) Practice identifying leaf samples through formative quizzing

- ☐ 1. Have students take informal quizzes on quizlet
- ☐ 2. Allow students to finish identifying the samples using mobile apps
- ☐ 3. Confirm they have correctly identified the samples using the mobile apps
- ☐ 4. Take more informal tree identification quizzes on quizlet

Day 7-9

(Tuesday September 27th – Thursday September 29th, 2016) Survey and Post-test window

If you missed a day of instruction for whatever reason, you can make it up during this testing window. If you did not miss any instructional days, then please test on day 7. If you cannot finish the survey with enough time left in class to begin and finish the post-test, then complete the survey and post-test on consecutive days. Make any notes of any major changes or disruptions experienced during the instructional days on the last page of this document.

Once a student begins the post-test, they have to finish. They are not allowed any retakes or restarts unless there are technical reasons.

- ☐ 1. All students participating in the study should take the online survey **(this must be done before a student can take the post-test!!!!)** Access the survey at **bit.ly/2ccdyXC**
- ☐ 2. All students participating in the study should take the post-test (make sure students all have a copy of the scorecard before going to the computer lab)

Notes of any major changes, modifications or disruptions experienced

Monday 9-19-2016

Tuesday 9-20-2016

Wednesday 9-21-2016

Thursday 9-22-2016

Friday 9-23-2016

Monday 9-26-2016

Tuesday 9-27-2016

Wednesday 9-28-2016

Thursday 9-29-2016

Appendix Q

Master Tree List

Name _____

Directions: This list will help you narrow down choices of tree names as you identify common trees found in Louisiana using your mobile device. You may write notes on this list and highlight the names on this list as needed.

Number	Common Name	Botanical Name
1.	Red Maple	<i>Acer rubrum</i>
2.	Eastern Redbud	<i>Cercis canadensis</i>
3.	Flowering Dogwood	<i>Cornus florida</i>
4.	Common Persimmon	<i>Diospyros virginiana</i>
5.	American Beech	<i>Fagus grandifolia</i>
6.	White Ash	<i>Fraxinus americana.</i>
7.	Honeylocust	<i>Gleditsia triacanthos</i>
8.	American Holly	<i>Ilex opaca</i>
9.	Eastern Redcedar	<i>Juniperus virginiana</i>
10.	Sweetgum	<i>Liquidambar styraciflua</i>
11.	Yellow-poplar	<i>Liriodendron tulipifera</i>
12.	Blackgum (Black Tupelo)	<i>Nyssa sylvatica</i>
13.	Loblolly Pine	<i>Pinus taeda</i>
14.	American Sycamore	<i>Platanus occidentalis</i>

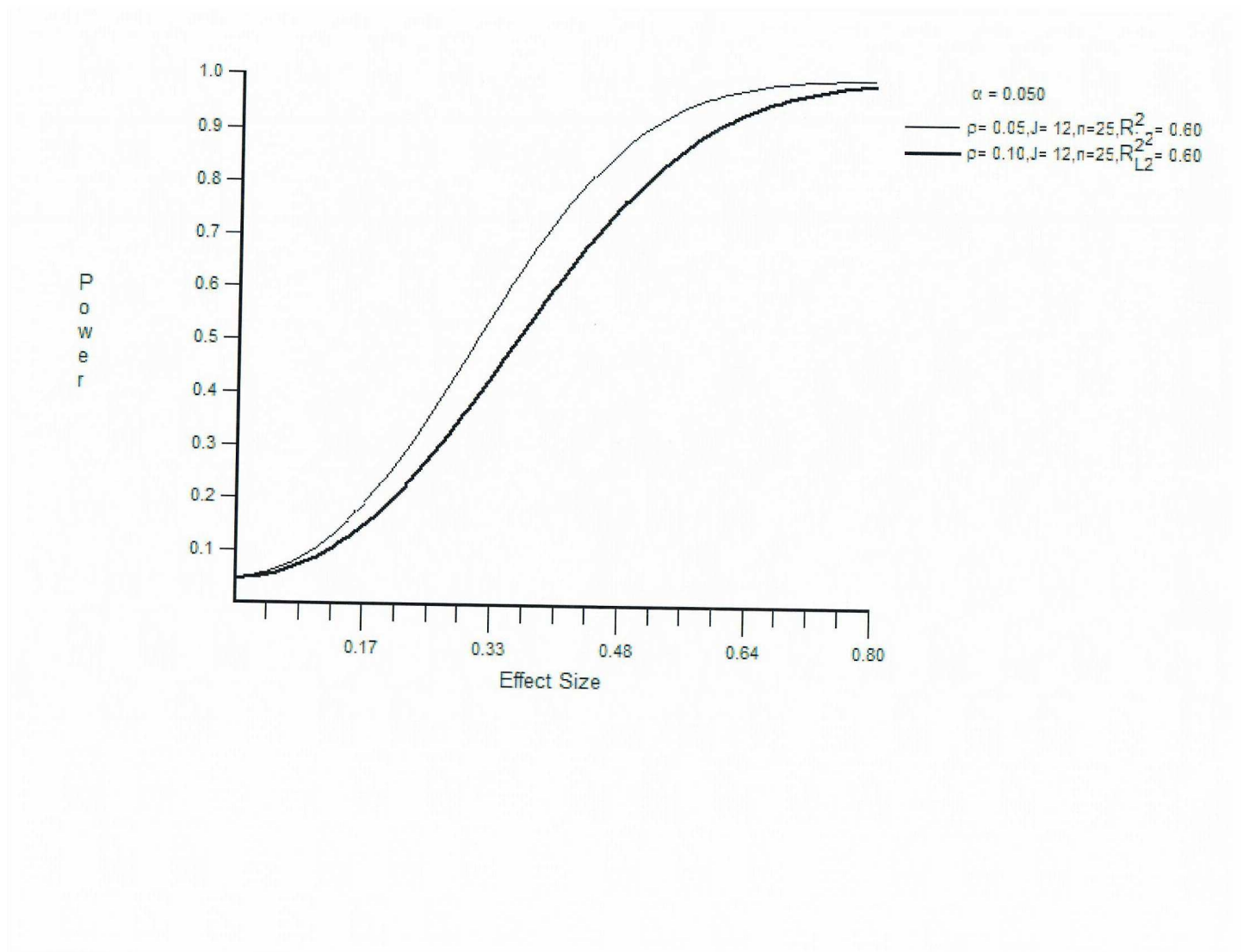
15.	Eastern Cottonwood	<i>Populus deltoides</i>
16.	River Birch	<i>Betula nigra</i>
17.	White Oak	<i>Quercus alba</i>
18.	Southern Red (Spanish Oak)	<i>Quercus falcata</i>
19.	Blackjack Oak	<i>Quercus marilandica</i>
20.	Swamp Chestnut (Cow Oak)	<i>Quercus michauxii</i>
21.	Water Oak	<i>Quercus nigra</i>
22.	Willow Oak	<i>Quercus phellos</i>
23.	Shumard Oak	<i>Quercus shumardii</i>
24.	Post Oak	<i>Quercus stellata</i>
25.	Live Oak	<i>Quercus virginiana</i>
26.	Black Locust	<i>Robinia pseudoacacia</i>
27.	Black Willow	<i>Salix nigra</i>
28.	Sassafras	<i>Sassafras albidum</i>
29.	Winged Elm	<i>Ulmus alata</i>
30.	American Elm	<i>Ulmus americana</i>

Teacher Key

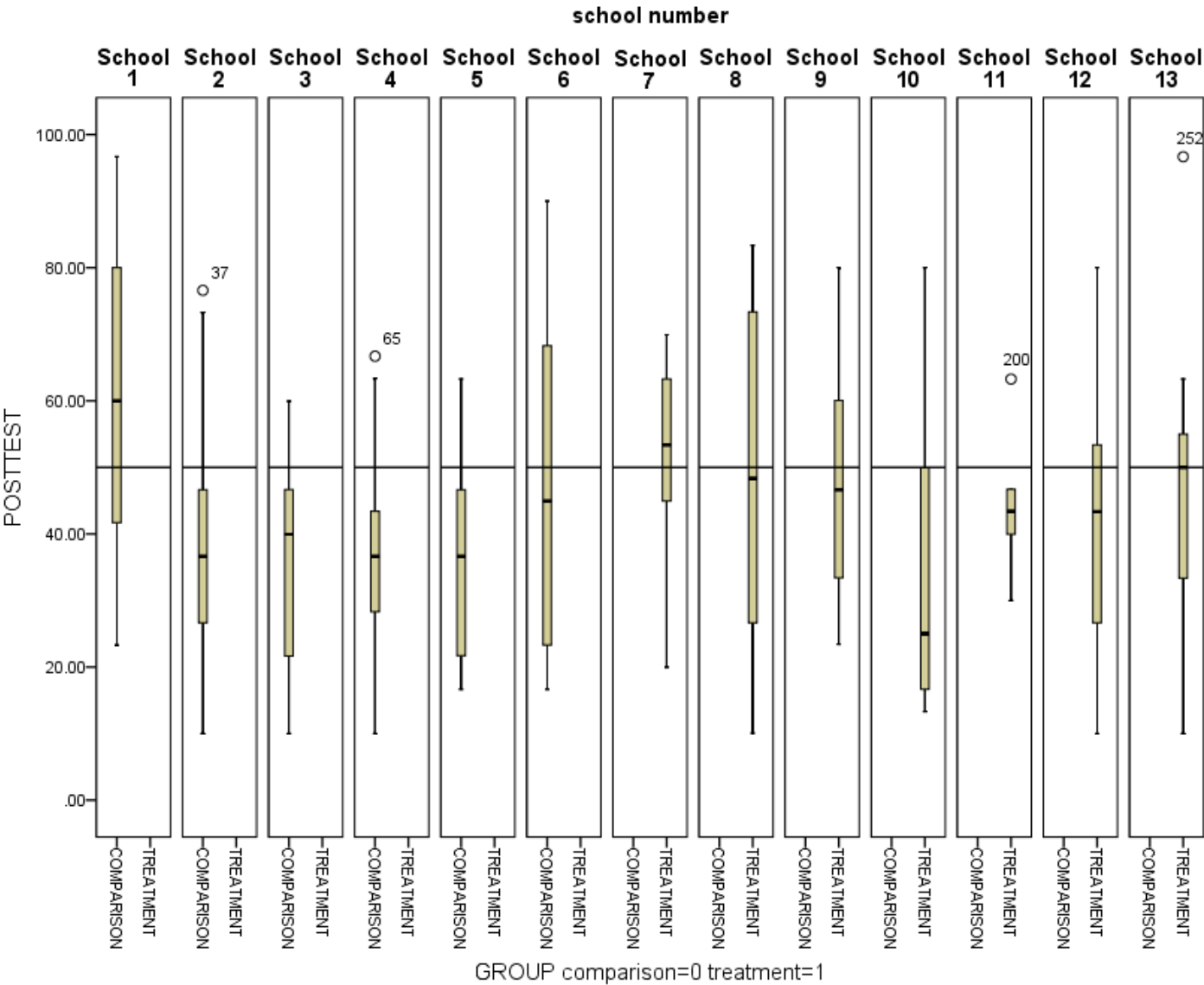
Number	Common Name	Botanical Name
16	Red Maple	<i>Acer rubrum</i>
12	Eastern Redbud	<i>Cercis canadensis</i>
4	Flowering Dogwood	<i>Cornus florida</i>
7	Common Persimmon	<i>Diospyros virginiana</i>
15	American Beech	<i>Fagus grandifolia</i>
20	White Ash	<i>Fraxinus americana.</i>
18	Honeylocust	<i>Gleditsia triacanthos</i>
17	American Holly	<i>Ilex opaca</i>
29	Eastern Redcedar	<i>Juniperus virginiana</i>
13	Sweetgum	<i>Liquidambar styraciflua</i>
19	Yellow-poplar	<i>Liriodendron tulipifera</i>
6	Blackgum (Black Tupelo)	<i>Nyssa sylvatica</i>
9	Loblolly Pine	<i>Pinus taeda</i>
3	American Sycamore	<i>Platanus occidentalis</i>

21	Eastern Cottonwood	<i>Populus deltoides</i>
30	River Birch	<i>Betula nigra</i>
2	White Oak	<i>Quercus alba</i>
11	Southern Red (Spanish Oak)	<i>Quercus falcata</i>
1	Blackjack Oak	<i>Quercus marilandica</i>
23	Swamp Chestnut (Cow Oak)	<i>Quercus michauxii</i>
5	Water Oak	<i>Quercus nigra</i>
26	Willow Oak	<i>Quercus phellos</i>
22	Shumard Oak	<i>Quercus shumardii</i>
10	Post Oak	<i>Quercus stellata</i>
24	Live Oak	<i>Quercus virginiana</i>
8	Black Locust	<i>Robinia pseudoacacia</i>
25	Black Willow	<i>Salix nigra</i>
27	Sassafras	<i>Sassafras albidum</i>
14	Winged Elm	<i>Ulmus alata</i>
28	American Elm	<i>Ulmus americana</i>

Appendix R



Appendix S



Appendix T

How the Eight Component of Establishing Criterion Referenced Reliability (Wiersma & Jurs, 1990) were Addressed by the Researcher

Component	How components were addressed
Homogeneous items	Photos were formatted to deliver the same size picture of each leaf sample from an equal distance perspective.
Discriminating items	Three types of questioning were used
Quantity of items	The test included 30 items
High quality test	Question format was given attention and designed to be easily understood. Multiple choice = Which of the following trees is identified by this picture? Fill in the blank = This limb is from a ___ tree. True/False = This picture is of a River Birch.
Clear directions	A student directions screen appears after students log in and had to be clicked on before students could begin the exam. Teachers also delivered verbal directions to the students.
Controlled environment	Students had to log in to the test with a secure name and password created by the researcher and administered by the teacher.

Participant motivation

Students were made aware of the purpose of the study and that research results could influence future policy.

Scorer directions

Tests were automatically scored and reported by the Test Generator Web® software. The key embedded in the program was determined 100% correct by the expert panel.

Appendix U

Table 5

Unconditional Models Estimates of Covariance Parameters for Attention, Relevance, Confidence, Satisfaction (ARCS) and Motivation (n = 263) and the Resulting ICC to Determine if Enough Variation Occurred Across Schools to Warrant HLM Analysis of Course Interest Survey (CIS) Data

DV	Parameter	Estimate	ICC
Attention	Residual (σ^2)	0.52	18.4%
	School variance (τ_{00})	0.12	
Relevance	Residual (σ^2)	0.62	9.2%
	School variance (τ_{00})	0.06	
Confidence	Residual (σ^2)	0.43	10.2%
	School variance (τ_{00})	0.05	
Satisfaction	Residual (σ^2)	0.58	15.0%
	School variance (τ_{00})	0.10	
Motivation	Residual (σ^2)	502.00	9.6%
	School variance (τ_{00})	87.00	

Appendix V

Table 8

Means and Standard Deviation for Attention, Relevance, Confidence, and Satisfaction in Treatment and Comparison Group (n = 263)

Group	Construct	Mean	SD	N
Treatment	Attention	3.24	.79	128
Comparison	Attention	3.42	.79	135
Treatment	Relevance	3.52	.85	128
Comparison	Relevance	3.60	.80	135
Treatment	Confidence	3.86	.69	128
Comparison	Confidence	3.93	.68	135
Treatment	Satisfaction	3.55	.82	128
Comparison	Satisfaction	3.61	.81	135

Note: mean scores ranged 1-5.

Table 9

Overall Motivation Summated Score and Standard Deviation in Treatment and Comparison Group (n = 263)

Group	Construct	Sum	SD	N
Treatment	Motivation	120.46	24.3	128
Comparison	Motivation	123.64	23.7	135

Note: Sum scores ranged 34-170.

VITA

Henry Eric Smith was born in 1980 and raised in the Black Lake community near Campti, Louisiana. He has taught agriculture at the same high school since 2003. He has a wife and two children. Eric is an avid woodsman and enjoys teaching tree identification to his students. In his career he has trained 13 teams that placed first in Louisiana in different Career Development Events (CDE) including forestry, agronomy, small engines, public speaking and nursery/landscaping. At the National FFA Convention in 2013 the forestry team he trained won national runner-up in the forestry CDE. Eric has taught countless students who are employed in the wood products industry including foresters, global information system analysts, logging equipment operators, mechanics, millwrights and production workers.

This page intentionally left blank.