THE EFFECTS OF A PAPERLESS CLASSROOM ON STUDENT ACHIEVEMENT IN THE MIDDLE SCHOOL SCIENCE CLASSROOM

by

Jason O. Hults

A professional paper submitted in partial fulfillment of the requirements for the degree of Master of Science in Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2015
DEDICATION

Dedicated to my wife Gina and my children: Steven, Jacob, Nicholas, and Kimberly. Never give up on your dreams; they can come true with patience and determination. I am proud of each of you and love you all.
# TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND ................................................................................. 1

2. CONCEPTUAL FRAMEWORK ............................................................................................... 5

3. METHODOLOGY .................................................................................................................... 9

4. DATA AND ANALYSIS .......................................................................................................... 14

5. INTERPRETATION AND CONCLUSION .............................................................................. 19

6. VALUE ................................................................................................................................... 21

REFERENCES CITED .................................................................................................................. 24

APPENDICES ................................................................................................................................ 26

  APPENDIX A Institutional Review Board Memorandum ....................................................... 27
  APPENDIX B Standard Format of Pre and Post Test ............................................................... 29
  APPENDIX C Hults Engagement and Attitude Survey (Post Treatment) ...................... 34
  APPENDIX D Hults Engagement and Attitude Survey (Pretreatment) ........................ 36
  APPENDIX E Hults Student Interview Questionnaire ...................................................... 38
LIST OF TABLES

1. Data Triangulation Matrix ................................................................. 14
LIST OF FIGURES

1. Average Percent Growth from Pretest to Posttest by Achievement Level Group .......................................................... 15

2. Average Percent Growth by Achievement Level Group ................................................................. 16

3. Average Normalized Gain by Achievement Level Group ................................................................. 16

4. Student Responses to “I felt more engaged in science during the paperless unit than I did in the traditional unit” on the Hults Engagement and Attitude Survey .............................................................................. 17

5. Comparison of Student Responses to Hults Engagement and Attitude Survey (Pretreatment versus Post Treatment) ................................................................. 18
ABSTRACT

The purpose of the study was to determine the effects of a paperless classroom on student achievement in the middle school science classroom. Two sections of eight grade life science students were used in the study. Each section of students was exposed to a paperless, online format of instruction and assessment for two chapters during a four-chapter unit and was required to do two chapters in the traditional paper orientated format. Student achievement was measured by pre and posttest assessments, with the treatment chapters compared to the non-treatment chapters to determine the overall effect of the paperless classroom on student achievement.
INTRODUCTION AND BACKGROUND

As a veteran teacher of 20 years, I have seen many initiatives come and go in the education world. From Differentiated Learning to Multiple Intelligences, it seems that as educators we have always looked for the next big idea that would solve all our problems and help our students be the best and brightest ever. Technology and its use and implementation in schools across the country have been no exception.

From my own experiences, I have seen technology use in the classroom grow by leaps and bounds. When I first started teaching in 1994, the school I taught at had a total of 12 computers in the entire building, and most of them were in administrator’s or their secretaries’ offices. As I moved to another district and the years went by, I observed computer labs becoming available for all teachers to access with their students, and funding appeared for technology based probes and software for use in my own classes. When I started at my current school district in 1999, the building had 1 computer lab with 20 computers and each teacher had a desktop computer in their room. Today my building has 2 computer classrooms with 25 computers in each room, every teacher has a laptop, every classroom has a Promethean Board, and the whole building has Wi-Fi. Our building also has 2 mobile laptop carts with 25 laptops in each one. The English department has 40 Kindles that they share between 2 classrooms. The school district’s Project Lead The Way teacher wrote a grant that allowed the school to buy 18 iPads. The availability and lower costs of technology has changed the way I and other teachers approach our classrooms.
The advance of technology use in our schools has paralleled the advance of technology in our society. From the first mobile brick phones to the current generation of smart phones, today’s students have seen technology become a larger part of their lives every day. In my own home, each of my children and my wife has smartphones and laptops. As a society, we have relied on technology more and more every day for communicating, keeping our calendars and schedules aligned, and for learning. As a senior in high school, my daughter had the option of taking online classes for the first time for dual high school and college credit, and she is entering college this fall with 18 credits already completed. My three sons in college have each had multiple classes taught in the online format. I have seen more and more of the classes I have taken to further my education over the past 20 years taught through distance learning and the online format similar to that which the Masters of Science in Science Education (MSSE) program follows. It seems like every day there are more and more online or distance learning opportunities available to not only our students but also to adults to further their education and careers.

As these technological advances have made their way into our schools, the students have changed as well. I have noticed it more in this past year in particular, because my current group of students could not survive without their phones. I was constantly fighting the battle to have them put their phones away until we were done with the lesson or activity of the day.

I teach in Villisca, IA, a small, rural community of 1252 people (2010 Census). Our district just finished the second year of a whole-grade sharing agreement with a
neighboring district approximately twice the population of our own. In the state of Iowa, whole-grading sharing allows school districts to share the expenses of educating their students, while offsetting costs and receiving financial incentives from the state. In the case of our two school systems, my building became the middle school, while their building became the high school. This means that all 6-8 grade students from both districts come to our middle school campus in Villisca while all 9-12 grade students go to the high school campus in Corning. After teaching high school for 19 years, 14 of them for the Villisca Community Schools, I now teach middle school for Southwest Valley Schools. Two years ago my building was a grade 6-12 building with approximately 165 students, and is now a grade 6-8 building with 144 students.

According to statistics from the Iowa Department of Education Website (2015), during the 2014 – 2015 school year the student population was 97.22% Caucasian, 0.69% Asian, and 2.08% Native American. The student body overall is 52% boys and 48% girls. The Free and Reduced Lunch program served 52.78% of the students, which reflects the lower socioeconomic backgrounds associated with the southern counties in Iowa. Our building has a Level 1 Behavioral Disorder Room (BD Room) and 4.5% of the student population was identified as BD students. A total of 15.28% of the overall student population had an Individualized Education Plan (IEP).

In the spring of the 2013-2014 school year, the school district conducted a technology survey of students, parents, and staff members using an online survey and data analysis website called Clarity. According to results of the survey (Southwest Valley Schools Technology Survey, May 2014), 90% of students reported having Internet
access at home as well as access to a device. The same students reported that 69% had to
share a device with others within their home. When asked about basic computing skills
such as sending emails or creating spreadsheets, 20% of the students reported finding
these tasks easy to perform.

I went from being the only high school science teacher, with six different preps a
day and approximately 100 students in my classes, to being the only middle school
science teacher with 3 different preps and 142 students a day. Last year I taught seven
sections out of an eight period day. I saw every student every day, with the exception of
2 boys who were in the BD room for all day instruction. The change from high school
students to middle school students has not been easy for me because they are so different.
I am looking forward to returning to the high school for the 2015-16 school year where
my teaching comfort level is. And one of their differences is the need for technology use.

I will admit that I am an old school teacher. When I student taught, it was with a
30 year veteran who stood in front of the classroom and lectured every day. I used to do
that, but I realized many years ago that I was not getting through to all of my students
using that teaching style. I still present to my classes on average three times a week, but
the presentations are more interactive, and technology has allowed me to do that. I use
the Promethean Board daily, and often have students come to the board and perform
some form of interactive activity that is part of the lesson. My classes often do research
using the schools laptops for major projects, such as researching alternative energies or
food chains in various ecosystems. But a few years ago, I began to wonder how the use
of technology was impacting the students? And I also started to question if we were
preparing them adequately for the digital word they would be living in? These were the seeds of my desire to move to a paperless classroom.

At the end of the 2012-2013 school year, the superintendent asked our district lead team, of which I was a member, to start to look into the 1-to-1 Laptop Initiative, because he was interested in moving our district in that direction. During our last discussion, the superintendent stated that we would not make the move to 1-to-1 laptops until the 2015-16 school year at the earliest. This allowed me the perfect window of opportunity to test how effective student integration with technology could be before the school district invests in 100 or more additional laptops.

My primary research question was, What are the effects of the paperless classroom on student achievement in the middle school science classroom? The sub-questions to my research study were as follows:

1) How does the paperless classroom affect student engagement?
2) How does the paperless classroom affect student attitudes toward science?

CONCEPTUAL FRAMEWORK

The idea of a paperless classroom has evolved side by side with the development of computer technology available to school systems. As Davis (2002) lamented

One day I’d be found alone in my office, still clutching my pen, rigor mortis having set in, buried under a mountain of papers, assignments, and projects. It was this frightening vision that ultimately prompted me to devise what I needed, a more efficient and effective method for responding to and filing paperwork.

(p. 162)
Although educators have always sought ways to be more efficient in handling the day-to-day organizational aspects of student assignments, this quest for efficiency is only one of many reasons that the paperless classroom concept has become more popular in schools around the world.

The driving force behind every education initiative of the last 100 years has been student achievement. Since the first computers made their way into schools, thousands of studies have been undertaken to determine what effect the use of technology has on student achievement outcomes. Many of these studies have yielded negative results. One review of selected literature suggested that the use of technology is actually detrimental to student achievement (Wenglinsky, 2006). Other studies suggest that it is how the technology is used in the classroom (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2011; Papanastasiou, Zembylas, & Vrasidas, 2003), how effectively the teachers are trained to use the technology (Bester & Brand, 2013), or the students’ attitudes towards the use of technology (Kay, 2011) that can negatively impact the overall effectiveness of technology implementation on student achievement in schools.

There are also numerous studies that have shown positive results on student achievement from the use of technology. Many of these studies have used the 1:1 laptop initiative as the technology implementation in their research. Zucker and Hug (2008) demonstrated that teachers needed to develop a new skill set that combined not only content knowledge and effective pedagogy for the content, but also the skills to effectively use technologies in the right way to maximize their potential. They called this new skill set *technological pedagogical content knowledge* or TPCK. Through the use of
TPCK, teachers can more effectively use the technology tools available to them to maximize the learning potential of their students. Survey results from this study suggested that the majority of students, teachers, and administrators all believed the use of 1:1 computers had a positive impact on student achievement (Zucker & Hug, 2008).

Other studies into the 1:1 laptop implementation have shown that student engagement and students’ overall attitude about school increase because of the access and use of technology (Zucker & Light, 2009). Another study concluded that the 1:1 laptop model produced positive effects on student engagement and student behavior, but a negative effect on student attendance (Shapley et al. 2011). Shapley proposes one reason for the lower attendance rate was the students’ frustration with lower technology use at school causing the students to stay home where they could utilize the laptops more often. A third study showed a positive effect on student achievement overall, but that a gender difference existed with males in the treatment group demonstrating larger gains than females (Dunleavy & Heinecke, 2008). In all the case studies surveyed, the researchers strongly suggested that more in-depth research with larger sample sizes is needed to validate their findings.

Having the availability of 1:1 laptops or iPads is an essential first step to creating a paperless classroom and having the software to support them is the second. Kay (2011) studied the effectiveness of web-based learning tools (WBLTs) in the science classroom. In her findings, she identified a number of criteria that support the use of WBLTs in the paperless classroom. First, all teachers, with minimal training or experience, can easily use WBLTs. Second, WBLTs have simply defined objectives, which can be easily
incorporated into lesson plans. Third, WBLTs are by their very nature accessible over the Internet, making it easy to use in a wireless setting or a computer lab. Fourth, the reusability of WBLTs makes them excellent tools to use in multiple classrooms from day to day and year to year. Finally, WBLTs allow the students to set the pace of their own learning, allowing for immediate feedback and eventual mastery of the concept. One of the conclusions from this study found that the use of WBLTs produced significant gains in student achievement, with some students showing increases of up to 40% on standardized assessments (Kay, 2011).

Other studies looked into the effects of information technologies such as email, web-based discussion boards, and teacher-developed websites on the performance of students in paperless classrooms. One study found that students developed more advanced organizational skills through the use of archival and retrieval tools, which helped increase their achievement levels (Waskowitz, 2001). Davis (2002) discovered that the implementation of a 60/40 model in his classrooms, where 60% of the course work is done in class with technology tools and 40% is completed outside of class time with web-based discussion boards, live chat, and emails increased the students’ efficiency in turning in work on time. This allowed for more immediate feedback on the instructor’s part, which in turn had a direct impact on the students’ achievement levels in the course.

An additional set of research looked at the effectiveness of electronic assessments on student achievement. The goal of the various electronic assessment tools is to provide immediate onsite evaluations and feedback to the student (Edward, 2007). Osuji (2012)
notes that the use of electronic assessment will provide the learners the ability to work at their own pace, anytime and anywhere that they choose, which can have a positive effect on the student’s learning. In the same study, Osuji stated, “due to the personalized nature of electronic assessments, their use can increase the validity of the assessment by decreasing cheating and plagiarism that can occur in more traditional paper testing scenarios” (p. 149).

The paperless classroom has other benefits to a school system. A few studies focused on the cost savings to a district that the paperless classroom provides. One study emphasized the impact on environmental awareness and education about sustainability that the paperless classroom affords the educator (De Bonis & De Bonis, 2011). Another study identified a 48% cost savings in paper usage for the science department from the year before the implementation year (Arney, Jones, & Wolf, n.d.). Although these considerations should be included when a school district decides to implement the paperless classroom concept, they should be less relevant than the potential impact on student achievement.

METHODOLOGY

The purpose of the study was to determine the effects of a paperless classroom on student achievement in the middle school science classroom. The treatment for this classroom research project included using two sections of eight-grade life science in a rotating treatment/non-treatment group approach. Each section received the treatment for two chapters during a four - chapter unit on ecosystems during March and April. The research methodology for this project received an exemption by Montana State
University’s Institutional Review Board and compliance for working with human subjects was maintained (Appendix A).

The eighth grade class contained 43 students divided into 2 sections of 19 and 24 students. The class overall contained 22 females, with 17 being 14 years old and the remaining 5 being 13 years old. The class also contained 21 males, with 16 being 14 years old and the remaining 5 being 13 years old. According to information obtained from school records by the secretary, all the students reported being of Caucasian decent and 42% were eligible for the Free and Reduced Lunch Program (T. Swenson, personal communication, April 10, 2015).

The treatment involved the use of school provided laptops for all instructional tools during the treatment period. Students used Google Docs, Google Drive, Adobe, Doc Hub, and Gmail to complete and submit assignments. The same worksheets provided in the curriculum materials were used for both sections. Assignments were scanned into the computer and converted into a pdf format using Adobe Pro software or converted to a Google Docs format and shared with the students through their school provided Gmail accounts. Each of the two sections received a shared folder through Google Drive into which assignments were placed. Students were able to use the school’s laptops during class time as well as during their study halls to work on the assignments using Google Docs, Adobe, or Doc Hub depending on which software package was on the laptop and their own personal preferences. Students could also access the assignments at home through their Gmail accounts using their home computers if they needed to. Assignments were then submitted electronically by the deadline to be graded. Students in
the non-treatment section received the worksheet in a traditional paper form and submitted it when completed in the designated turn in box for their respective class period.

Lectures and other presentation materials were presented to both sections using the Promethean Smart Boards in the classroom. During the treatment chapters, students were provided the notes in a Google Docs format for later review, while the students in the non-treatment class were required to take notes in their notebooks. Students were given a grade at the end of the unit for all notes taken during the unit based on teacher observations of participation.

Hands on lab activities were supplemented by using Google Sheets for recording, graphing, and analyzing data during the treatment chapters. The sections receiving the treatment chapters were provided the lab activity electronically. Students were allowed to use the laptops at their lab stations to read the lab directions and record any observations as they worked through the lab activity. Completion of the lab write-ups and turn in for grading was also completed electronically. The non-treatment sections performed the same lab activities, but were provided paper copies of the lab and completed any required graphing and analyzing of data by hand.

The primary research question, *What is the effect of a paperless classroom on student achievement*, was evaluated through the use of pre and post-tests during each chapter of the unit. Chapter pre and post-tests, provided in the curriculum materials, were conducted in the online format for assessments during the treatment chapters using Google Forms. The non-treatment section was given a traditional paper version for their
pre and post-tests. The same test format (Appendix B) was used for each chapter, so that student improvement could be determined by comparing the students’ pre and post-test scores. During the treatment and non-treatment chapters, raw score data from pre and posttest’s were recorded by class for simplicity. The differential between the pretest and posttest for each student during each chapter was then recorded and compiled into achievement level groups. The data was then further analyzed to find the Average Raw Score Differential for each achievement level group during both treatment and non-treatment chapters.

Standard normalized gain for each student was determined based on the raw score data. Once assigned into the achievement level groups, the average standard normalized gain was calculated for the treatment and non-treatment chapters for each student. Finally, the average normalized gain for each achievement level group was calculated for both treatment and non-treatment chapters within the classroom research project.

During the course of the classroom research project, I wanted to determine how the paperless classroom would affect different achievement level groups. I assigned the students to high, middle, and low achievement groups based on data acquired from Iowa Assessment scores and Measures of Academic Progress (MAP) test scores. Iowa Assessment scores used for the study were based on seventh grade results, as the Iowa Assessments were not administered until late April during the 2014 – 2015 school year. The Iowa Assessment had been given to the students in the winter of their seventh grade year, so I choose a National Grade Equivalent (NGE) score of 7.5 as a grade level reference point to divide the achievement level groups. Students were assigned to the
low achievement group if their NGE was one year below grade level (NGE < 6.5).

Students were assigned to the middle achievement group if their NGE was plus or minus one grade level (6.6 < NGE < 8.5), while students with a NGE greater than one grade level (NGE > 8.6) were assigned to the high achievement group. MAP testing was completed in the fall and spring semesters during the 2014 – 2015 school year, and the fall results were used. These assessments showed the yearly growth the students had made in science between seventh and eight grade. This data was used to validate the placement of students into the assigned achievement groups.

The first secondary question, *How does the paperless classroom affect student engagement*, was measured by teacher observations throughout the unit. These observations included monitoring on-task versus off-task behavior during class time. On-task behavior involved students working on science related assignments. Off-task behavior included students doing schoolwork other than science, or using the computer for non-science related tasks such as chat, YouTube, Facebook, or games. Tracking the number of late assignments during treatment and non-treatment units also provided data related to student engagement. The Hults Engagement and Attitude Survey (Post Treatment) (Appendix C) was used to measure the student’s perspective of their own engagement during both the treatment and non-treatment units. The online survey tool *SurveyMonkey* was used to create the student surveys. The students were asked at the beginning and end of the unit to access the survey through a link sent to their emails. Student responses to the Hults Engagement and Attitude Survey (Post Treatment) were analyzed using a five point Likert scale weighted average.
An additional secondary question, *How does the paperless classroom affect students’ attitudes toward science*, used the Hults Engagement and Attitude Survey (Pretreatment) (Appendix D) and Hults Engagement and Attitude Survey (Post Treatment) to determine the treatment’s effect on student attitudes. The Hults Engagement and Attitude Survey (Pretreatment) and (Post Treatment) used a five-point Likert scale to measure student responses. The weighted average of the pretreatment and post treatment survey questions were analyzed to determine how the attitudes of the students changed during their participation in the classroom research project. The Hults Student Interview Questionnaire was used to interview a random sample of 12 of the eighth grade students who participated in the classroom research project (Appendix E). Student responses to the Hults Student Interview Questionnaire were reviewed for common themes related to how the students’ attitudes changed during their participation in the classroom research project.

The triangulation matrix shown in Table 1 summarizes the sources of data for my research questions.

Table 1

<table>
<thead>
<tr>
<th>Focus Question</th>
<th>Data Source 1</th>
<th>Data Source 2</th>
<th>Data Source 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Question:</strong> What is the effect of the paperless classroom on student achievement?</td>
<td>Pre- &amp; Post Test Data</td>
<td>Iowa Assessments</td>
<td>MAP Scores</td>
</tr>
<tr>
<td><strong>Secondary Question:</strong> 2. How does the paperless classroom affect student engagement?</td>
<td>Hults Engagement and Attitude Survey (Pretreatment) and (Post Treatment)</td>
<td>Observation of on-task versus off-task behavior</td>
<td>Observation of the number of late assignments</td>
</tr>
</tbody>
</table>
### DATA AND ANALYSIS

The Low Achievement Level Group (LALG) showed a wide range of values when pretest to posttest data was compared ($n=17$). The average non-treatment percent growth ranged from a value of -5% to 16% on a 100-point scale, with a mean value of 3.29%. The average treatment percent growth for the LALG was higher, as indicated by a mean value of 5.82% within a range of -5% to 18%. The Middle Achievement Level Group (MALG) data reflected a similar pattern ($n=12$). Average non-treatment percent growth data for the MALG showed a range of values from -1.5% to 5% on a 100-point scale, with a mean value of 3.5%. The MALG showed a positive increase during the average treatment as the mean increased to 5.5% within a range of -2% to 8.5% on a 100-point scale. The High Achievement Level Group (HALG) also showed positive growth overall ($n=14$). Average non-treatment percent growth data for the HALG showed a range of values from -2% to 8% on a 100-point scale, with a mean value of 2.57%. The HALG showed a positive increase during the average treatment as the mean increased to 4.0% within a range of 0% to 8% on a 100-point scale (Figure 1).
Average percent growth from pretest to posttest by achievement level group, \((N=43)\).

\textit{Note.} Avg NT = Average of Non-Treatment Chapters, Avg T = Average of Treatment Chapters, HALG = High Achievement Level Group, \((n=14)\), MALG = Middle Achievement Level Group, \((n=12)\), LALG = Low Achievement Level Group, \((n=17)\).

In a final analysis of the pretest and posttest data, the average percent growth for each achievement level group was determined. Comparing the values for each achievement level group, a larger gain for all achievement level groups in the treatment chapters is evident (Figure 2).

\textit{Figure 2.} Average percent growth by achievement level group, \((N=43)\).

\textit{Note.} LALG = Low Achievement Group, \((n=17)\), MALG = Middle Achievement Group, \((n=12)\), HALG = High Achievement Group, \((n=14)\).
The average normalized gain during the treatment and non-treatment units was then calculated for each achievement level group (Figure 3).

![Chart showing average normalized gain by achievement level group]

*Figure 3. Average normalized gain by achievement level group, (N=36). Note. LALG = Low Achievement Group, (n=17), MALG = Middle Achievement Group, (n=12), HALG = High Achievement Group, (n=7).*

In observations made at the start of the treatment units, I observed students performing off task behaviors such as chat or YouTube approximately 25% of the time. As the treatment progressed, the number of students actively engaged increased, with the frequency of off task activities decreasing to less than five percent of the time. During the course of the classroom research project, a total of 17 assignments were given. This results in a total of 731 worksheets, labs, and activities that were handed in. During the non-treatment units, 42 assignments out of a total of 363 were turned in late, or 11.6% of the total assignments. Late assignments were reduced during the treatment units with only 14 late assignments out of 368 total, or 3.8% of all assignments. On the Hults Engagement and Attitude Survey (Posttest), 74% of students agreed or strongly agreed that they felt more engaged in science class during the paperless unit (Figure 4).
Student responses using weighted averages on a five point Likert scale were used to compare the pretreatment to post treatment survey responses on the Hults Attitude and Engagement Survey (N = 42). Five of the seven survey questions show positive gains ranging from 0.1 to 0.38 in the weighted average caused by an increase in positive students responses of agree or strongly agree of 9.5% to 16.7% of the students surveyed. The weighted average of one question decreased by one tenth due to a negative two point four percent shift in student responses caused by one student. The survey question, *Using technology in the classroom scares or intimidates me*, showed the largest positive gain in the weighted average of all the questions with a value of 0.43 caused by an 11.9% increase in agree or strongly agree responses (Figure 5).
Figure 5. Comparison of student responses to Hults Engagement and Attitude Survey (Pretreatment versus Post Treatment), \( (N=42) \). *Note:* Weighted averages on a 5 point Likert Scale where 1 = Strongly Disagree and 5 = Strongly Agree.

Student responses to the Hults Student Interview Questionnaire \( (N=12) \) showed a positive impact created by the paperless classroom treatment in almost every question and student interviewed. All 12 students interviewed expressed a desire to continue the paperless classroom, with the exception of one female student who said “except for labs, they would be easier without the computer getting in the way.” In responding to how the students enjoyed using computers during the unit, nine of the students responded that it made them more organized, and seven responded that they “didn’t have to worry about losing assignments because they were online.”
When asked about concerns or fears that the students had before participating in the paperless classroom, concerns about “how to turn in assignments” and “would the computers work when we needed them to” were expressed by half of the students interviewed. But 10 of the 12 students expressed a common theme that using the computers became easier as they became more familiar with the experience. When asked how their attitude changed toward science, 9 of the 12 students responded in some form that it made science easier and that their attitude improved. One male student replied “My attitude got better, and it felt like the computers were a good fit for science compared to other classes where it would have been harder.”

INTERPRETATION AND CONCLUSION

The primary research question, What are the effects of the paperless classroom on student achievement in the middle school science classroom, can be answered by looking at the percent growth from pretest to posttest and the change in average normalized gain. All three achievement level groups showed positive change in percent growth (Figure 2). Variation in the scores between groups can be attributed to multiple factors. The larger value of 2.52% for the Low Achievement Level Group (LALG) can be attributed to lower pretest scores before instruction being offset by large gains on posttest assessments. The smaller value of 1.44% for the High Achievement Level Group (HALG) can be attributed to the opposite effect. The HALG regularly scored higher on pretest assessments, which allowed for little, or in some cases zero growth resulting in an overall lower average percent growth. An additional contributing factor in the HALG is
that on six occasions students scored the maximum value on the pretest and then scored lower on the posttest, resulting in deflation of the average percent growth value.

The average normalized gain values also show a positive growth trend for all achievement level groups (Figure 3). However, the validity of the values comes into question for numerous reasons. First, the relative sample sizes for each achievement group are small, ranging from 12 to 17. Second, because only two chapters were used in both the treatment and non-treatment phases of the action research project, there is a limited data set to use in statistical calculations. Finally, in the HALG, six students scored lower on the posttest after scoring the highest maximum value on the pretest. This resulted in almost half of the data for the HALG being discarded because the average normalized gain could not be calculated for those students.

One set of factors that also could have affected all three achievement level groups but could not be tangibly measured includes the subject material and students prior knowledge and interest. The classroom research project was conducted during an ecosystem unit of a life science class using eighth grade students. The interest level of the students related to the actual subject matter was not quantitatively assessed during the study and may have played a role in the outcome of the action research. Teacher observations made during the unit of student engagement did show that the majority of students were involved and on task the majority of the time.

Looking at the results of the Hults Engagement and Attitude Survey, it appears that the paperless classroom had a positive impact on both student engagement and on student attitudes toward science (Figure 5). Five of the seven questions asked on both the
pretreatment and post treatment surveys showed a positive gain in the weighted average value as well as an increase in the total percentage of students responding agree or strongly agree. The decrease in value for the question *I think the use of technology in the classroom would make science more interesting* can be attributed to one student response changing from strongly agrees to strongly disagree. Due to the anonymity of the survey being conducted online, it was not possible to follow up with this one student to determine why his or her attitude changed so dramatically. The results of question *Using technology in the classroom scares or intimidates me*, which can be interpreted as a negative impact, could be in response to student frustrations caused by technology issues when the computers did not work as intended.

Student responses during the exit interviews conducted using the Hults Student Interview Questionnaire were overwhelmingly positive. When conducting the interviews, I observed all the students had a positive attitude about their experience and participation in the paperless classroom. Many of the other students who were not involved in the interviews also expressed positive comments and a desire to continue the paperless classroom experience.

Although the data suggests that the paperless classroom treatment used in the study was beneficial to the students by showing positive growth trends in both average percent growth and average normalized gain, as well as student engagement and overall attitude toward science, several questions can be raised. If the action research were completed over a longer period of time encompassing more units, producing a more reliable data set, would the results be similar? If a larger sample size of students were
used, would the outcome of the action research be the same? Finally, would similar results be obtained if the action research were competed with the students studying different content material?

VALUE

Conducting this classroom research project has impacted my teaching and my classroom in several ways. First, it has made me aware that I am not as technologically savvy as I thought I was. From my participation in a number of online courses and using computers for the last 30 years, I felt I would be able to handle any technology issues, which my students and I began to call “technology hurdles,” that would come up during the course of the project. I very quickly learned that I was not as proficient on many of the newer software programs that were available as I needed to be. I began to rely on my students and other faculty members to help us get over those hurdles.

I spent a large amount of time practicing and becoming familiar with Google Docs, Sheets, and Forms before I unleashed them on the students, and I still relied on many of the students to help get other students over the hurdles, somewhat in a peer tutoring style. Early in the projects planning stages, I relied heavily on other teachers in the building who had experience with online teaching or who had attended the Google Docs 101 class offered by our local Area Education Agency (AEA), which I wish I had attended before beginning this classroom research project. I hope that I can find opportunities to expand my technology knowledge so that I can incorporate more of it into my classroom in the future.
I also learned that many of the teaching strategies that I learned and have practiced for the last 20 years do not necessarily work with today’s students in a technology oriented paperless classroom. Lecturing three days a week and having the students do a group activity or lab the other two days was working for most of my students. After seeing them do research online and participate in more collaborative and performance based activities due to the use of technology; and seeing their engagement level and attitudes increase because of that has opened my eyes to the possibilities that a paperless classroom or 1:1 computer initiative can offer. I plan to implement many more of these types of activities into my classroom so that I can more effectively engage my students.

I do feel that my students also benefited from their participation in the paperless classroom in a few ways. The majority of the students enhanced their basic computer skills, from learning how to create formulas on a spreadsheet to creating and manipulating graphs using Google Sheets. They learned how to use drop boxes and create folders to help their organizational skills by using Google Drive. Some of them made slide show presentations for the first time in their school careers. All of these skills will be beneficial to them as they move on to high school, college, and eventually the work force.

As I reflect on the overall experience, it has made me want to continue to pursue a paperless classroom. Since I am transferring to the high school building next year and do not fully know the amount of technology resources available to me; I will have to be flexible as I try to plan for the coming school year. Due to my position on the district’s
Lead Team, I will be an advocate for our school district moving toward a 1:1 computer model. I will also use my position on the lead team to encourage technology focused Professional Development for my colleagues. Finally, I will encourage other teachers in my district to embrace the benefits that technology can bring to our students.
REFERENCES CITED


Southwest Valley Schools Technology Survey. (May 2014) Retrieved from https://clarity.brightbytes.net


APPENDICES
APPENDIX A

INSTITUTIONAL REVIEW BOARD MEMORANDUM
MEMORANDUM

TO: Jason Hults and John Graves

FROM: Mark Quinn, Chair

DATE: December 5, 2014

RE: “The Effects of a Paperless Classroom on Student Achievement in the Middle School Science Classroom” [JH120514-EX]

The above research, described in your submission of December 4, 2014, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of, or the comparison among instructional techniques, curricula, or classroom management methods.

- (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects’ responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

- (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

- (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

- (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

- (b) (6) Taste and food quality evaluation and consumer acceptance studies, if wholesome foods without additives are consumed, or if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.
APPENDIX B

STANDARD FORMAT OF PRE AND POST TEST
Ecosystems and Biomes

Multiple Choice
Write the letter of the correct answer on the line at the left.

1. Ecologists study feeding patterns to learn how energy flows within an
   a. species.
   b. population.
   c. ecosystem.

2. Organisms that use the sun's energy to turn water and carbon dioxide into food are called
   a. consumers.
   b. decomposers.
   c. producers.

3. A diagram that shows the amount of energy that moves from one feeding level to another in an ecosystem is called an
   a. food chain.
   b. energy pyramid.
   c. food web.

4. The carbon cycle is closely linked to the
   a. water cycle.
   b. nitrogen cycle.
   c. oxygen cycle.

5. The process by which a gas changes to a liquid is called
   a. evaporation.
   b. condensation.
   c. precipitation.

6. Wind, water, and living things are three ways of
   a. dispersal.
   b. succession.
   c. continental drift.

7. The type of biome that exists in an area is mostly determined by the area's
   a. climate.
   b. canopy.
   c. dispersal.
Ecosystems and Biomes

8. A rain forest found near the equator is called a
   a. tropical rain forest.
   b. temperate rain forest.
   c. boreal rain forest.

9. The biome that receives less than 25 centimeters of rain per
   year is the
   a. desert biome.
   b. deciduous forest biome.
   c. grassland biome.

10. An area where the fresh water of a river meets the salt water
    of the ocean is called a(an)
    a. savanna.
    b. tundra.
    c. estuary.

Completion
Read each word in the box. In each sentence below, fill in one of the words.
Not all words will be used.

| canopy    | evaporation | biogeography | carnivore | climate | neritic |

11. A(an) ________________ is a consumer that eats only
    animals.

12. The process by which liquid water changes into a gas is called
    ________________

13. The study of where organisms live is called
    ________________

14. In a tropical rain forest, tall trees form a leafy roof called a(an)
    ________________

15. The marine ecosystem in the shallow ocean area near the coast is
called the ________________ zone.
Ecosystems and Biomes

True or False
If a statement is true, write true. If it is false, write false.

16. Consumers get energy by eating wastes and dead organisms.

17. Water is recycled in ecosystems.

18. Species that have been carried into a new location by people are called exotic species.


20. A river is an example of a freshwater ecosystem.

Using Science Skills
Scientists who study biomes often use a graph like the one below. It shows both the monthly average temperatures and the monthly average rainfall per year in an area. Use the graph to answer questions 21, 22, and 23.

21. Interpreting Graphs: How many centimeters of rain does this area average in July?
   a. 17 cm
   b. 22 cm
   c. 24 cm

22. Interpreting Graphs: What is the area’s average temperature in October?
   a. 22°C
   b. 24°C
   c. 26°C

© Pearson Education, Inc., publishing as Pearson Prentice Hall. All rights reserved.
Ecosystems and Biomes

23. Drawing Conclusions. Look closely at the average temperatures and average rainfall of this area. Which of the following biomes could this graph represent?
   a. desert biome
   b. tropical rain forest biome
   c. tundra biome

Using Science Skills

The picture below shows the steps in a cycle of matter through an ecosystem. The steps in the cycle are numbered 1–9. Use the picture to answer questions 24 and 25.


24. Interpreting Diagrams. What cycle of matter does this picture show?
   a. water cycle
   b. nitrogen cycle
   c. carbon cycle

25. Drawing Conclusions. Step 2 is a very important step in the cycle because
   a. plants can only use nitrogen that is “fixed.”
   b. animal wastes can never be broken down.
   c. condensation occurs in underground water.
APPENDIX C

HULTS ENGAGEMENT AND ATTITUDE SURVEY

(POSTTREATMENT)
Participation in this survey is voluntary and participation or non-participation will not affect a student’s grade or standing in the class in any way.

Evaluate the following statements.

1) Science interests me:

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Disagree Nor Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

2) I enjoy science:

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Disagree Nor Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

3) I want to pursue a career in science

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Disagree Nor Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

4) I think science is challenging

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Disagree Nor Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

5) I think the use of technology in the classroom would make science more interesting

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Disagree Nor Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

6) Using technology in the classroom scares or intimidates me

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Disagree Nor Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

7) I prefer to use technology to do my schoolwork instead of paper

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Disagree Nor Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>

8) I felt more engaged in science during the paperless unit than I did in the traditional unit

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Disagree Nor Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
</table>
APPENDIX D

HULTS ENGAGEMENT AND ATTITUDE SURVEY

(PRETREATMENT)
Participation in this survey is voluntary and participation or non-participation will not affect a student’s grade or standing in the class in any way.

Evaluate the following statements.

1) Science interests me:
   - Strongly Disagree
   - Disagree
   - Neither Disagree Nor Agree
   - Agree
   - Strongly Agree

2) I enjoy science:
   - Strongly Disagree
   - Disagree
   - Neither Disagree Nor Agree
   - Agree
   - Strongly Agree

3) I want to pursue a career in science
   - Strongly Disagree
   - Disagree
   - Neither Disagree Nor Agree
   - Agree
   - Strongly Agree

4) I think science is challenging
   - Strongly Disagree
   - Disagree
   - Neither Disagree Nor Agree
   - Agree
   - Strongly Agree

5) I think the use of technology in the classroom would make science more interesting
   - Strongly Disagree
   - Disagree
   - Neither Disagree Nor Agree
   - Agree
   - Strongly Agree

6) Using technology in the classroom scares or intimidates me
   - Strongly Disagree
   - Disagree
   - Neither Disagree Nor Agree
   - Agree
   - Strongly Agree

7) I prefer to use technology to do my schoolwork instead of paper
   - Strongly Disagree
   - Disagree
   - Neither Disagree Nor Agree
   - Agree
   - Strongly Agree
APPENDIX E

HULTS STUDENT INTERVIEW QUESTIONNAIRE
Participation in this interview is voluntary and participation or non-participation will not affect a student’s grade or standing in the class in any way.

1. Did you have any concerns or reservations about the paperless classroom and using computers in the classroom for science before we did this unit?

2. How did you enjoy using computers during this unit?

3. Did your attitude about computer use and the paperless classroom for school related work change during this unit?

4. How did your attitude toward science change during this unit?

5. If given a choice, would you choose to continue to work in a paperless classroom using computers and other forms of technology or return to a more traditional classroom?

6. Is there any thing else you would like to share about your experience in the paperless classroom?