SMARTPHONES IN THE CLASSROOM: EVALUATING THE EFFECTS OF INCORPORATING SMARTPHONES TO AIDE IN STUDENT COMPREHENSION

by

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TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND 1

2. CONCEPTUAL FRAMEWORK 3

3. METHODOLOGY 7

4. DATA AND ANALYSIS 14

5. INTERPRETATION AND CONCLUSION 22

6. VALUE 23

REFERENCES CITED 25

APPENDICES 28

APPENDIX A: Survey Questions 29
APPENDIX B: Pre and Post Interview Questions 32
APPENDIX C: Evolution Test 34
APPENDIX D: DNA Test 38
APPENDIX E: Waves Test 41
APPENDIX F: Simple Machines Test 46
APPENDIX G: States of Matter Test 51
APPENDIX H: Energy Test 54
APPENDIX I: Population Test 57
APPENDIX J: Screen Shot 59
APPENDIX K: IRB Exemption Approval 62

LIST OF TABLES

1. Schedule for Treatment.....10

2. Data Triangulation Matrix 14

LIST OF FIGURES

1. Smartphone Use 15

2. Technology at School 16

3. Internet at Home 16

4. Teachers Who Allow Smartphones 17

5. Smartphone Success.....17

6. Learning with Technology.....18

7. What Apps you are Using.....19

8. Box Plot Treatment with Smartphone.....21

9. Box Plot Non-Treatment.....22

INTRODUCTION AND BACKGROUND

In my current teaching position I have two preps for biology, and physical science. I have been working at an alternative high school for two years, and have been teaching high school science in Jackson County North Carolina for ten years. Working with the alternative population has given me the opportunity to teach smaller classes and engage in more hands on activities. My classes consist of an average of 12 students per class. All of the students have been placed at my school because they have been unable to conform to a typical classroom setting or because of behavior or have a learning disability.

Jackson County Public School's vision statement is "All students will become responsible, functional and productive members of a culturally diverse, 21st century, global society." I take this to mean that our students need to be able to compete in a world that is technology dependent, and that our graduates need the skills to function in a technological setting. By having students use their smartphones in class, I will show them that there is another use for their devices besides communication.

At the alternative school I am the only science teacher, but I still keep in contact with people from the science department at the High School. One of which is going through the MSSE program at MSU. Rita Hubbs is a physics/chemistry teacher at the high school and is great resource. We have taken many of the same classes, and it is fun to look at things from a different perspective. I am lucky to have a good team helping me with new ideas and fresh eyes. Carol Patton is an English teacher across the hall. She helped proof read my papers. She finds things that I have overlooked from spelling to

grammar. My neighbor Katherine Mosses used to be an assistant principal at a local high school. She was involved with the state testing of all of the high school students. She has been a valuable asset when it comes to evaluating my students.

I work in a district that is considered a title one school district. This means that many of my students are on Medicaid, have free and reduced lunches, and come from a poor family. Somehow they can still can afford a smartphone. This has led to our school district to adopt a policy allowing students to BYOD (Bring Your Own Device) to school because the county does not have the money to buy more computers for our classrooms.

Over the past ten years I have seen the evolution of the cell phone taking place. I watched the demand for cells phones grow from a few students having them in my class to every student in my classes having a smart phone. You will see students taking selfies or checking Facebook on a regular basis. I set up rules requiring them to put their phones in a box at the beginning of class, but this only worked for a short amount of time. I decided to incorporate their phone use into my lessons with hopes that this would alleviate the constant war that has developed in my classroom. We used the smartphones to take tests on test banks that I made on Kahoot, and Quizlet.

My primary action research challenge was “How can I incorporate cell phones to aide in student comprehension.” I was curious to know whether my students would do better on tests if they used their smartphones to take them. My research questions were: 1) What effects will the use of smartphones have on test scores? 2) Does the use of smartphones change student attitudes towards taking tests? 3) Will the use of smartphones help student comprehension?

CONCEPTUAL FRAMEWORK

My plan was to find out what forms of technology other teachers are using so that I could try it in my classroom. I really wanted to find as much as I could to get my students "hooked" into the lesson. So many students are scattered within the formal classroom setting. If I could get them to focus on a lesson as much as they are focused on their cell phones there would be some serious learning going on.

My data collection and analysis has helped me with my action research plan and helped me understand what kind of technology is being used by both students and teachers. When I read the article about using smartphones to supplement classroom reading, I was very impressed that the teacher was using the smartphone to broaden the understanding of the reading. Taking the reading to a whole new level. "Reading more complex texts closely, independently, and proficiently may require students to have new ways to engage with authors, illustrators, and each other. Smartphones are a way to do this and supplement classroom reading as we inspire investigations, fuel curiosity, and invite deep and thoughtful reading" (Bromley, 2012,p. 344). This led me to the idea that it is okay to let my students use cell phones in class to do research, or take tests.

In a scholarly article by Marcia Blome, she talks about how to get students engaged through the use of technology immersion. "This leads me to the assumption that computers are part of not only their school life but technology continues on at home, and they feel comfortable with it" (2014, p. 33). Students are surrounded by technology all of the time. If we could make their learning fun through the use of technology we can have

them learn the concepts without thinking it is a lot of work. Blome used surveys to help understand how the students felt about the use of technology in her classroom.

Rachel Lee Zupke (July 2012) of Montana State University, also wrote a scholarly article about the need for technology in the classroom, and how it impacts student engagement. Information and Communication Technologies (ICT) are used to help the students understand the concepts that they are trying to learn. By interweaving modes of technology students already use outside of the school setting into the curriculum, I sought to open greater access to the information rather than having to get it directly from me, their instructor. Increasing student exposure to difficult conceptual ideas in ways suited for different learning styles, and at a student's own pace and repetition level, has been shown to improve student comprehension, overall academic performance, and attitudes toward learning, specifically in science. The author used a survey to find out what was working with the use of technology in the classroom.

All of the articles agree that technology in the classroom is key to having successful students. Utilizing the technology helps students learn and retain the information much longer than traditional teaching methods. Students can use their smart phones to do research and have access to the internet outside of the classroom to prepare for the next class.

The article" iPad Drops Off as Tablets Continue to Make Gains, Propelled by Education Spending" by David Nagel shows how much public schools are investing in tablet computers. Over the past couple of years, lower cost tablets made by Samsung have surpassed the Apple iPad formerly the first choice for most schools (2014). This is

good news for lower income schools because they will likely follow suit to stay competitive. An English teacher at my school has just received new tablets, and she enjoys the paperless work that the students are turning in. Paper has always been a large portion of our schools budget, and now that money can go somewhere else.

Another interesting read was the article "Technology in the Classroom Helpful or Harmful" by Samantha Cleaver. She talks about how the technology can help personalize a student's learning. "An interactive game is more engaging than a book, so technology often promotes more practice and review in areas requiring memorization, such as spelling, math and geography" (2014, p.1). "Just as Sesame Street helped transform television into a revolutionary tool for learning among young children four decades ago, advances in mobile technologies are showing enormous untapped educational potential for today's generation" (Shuler, 2009, p.4).

"Teaching Naked How Moving Technology Out of your College Classroom Will Improve Student Learning" written by Jose' Antonio Bowmen was an interesting look at how to engage students outside the classroom (2012). This approach was used to help better prepare students for a face-to-face class by using technology to prepare the students for class. The author brings up many interesting ideas about how to get students interested in the learning process through the use of technology. For example if your students are interested in video games then develop a video game that incorporates what you are trying to teach. This can be done through interactive virtual labs that students can do outside the classroom. "Our students and the world have changed. Success in the

future will depend on our ability to adapt and find new ways to connect with students" (Bowmen, 2012, p.288).

It is interesting that all of the articles that I read say that there is a real need for technology in the classroom. Teachers need to find ways for the students to become more engaged and thus empowered in their personalized learning. The use of technology as a hook gets the students interested in the lessons being taught.

By the end of 2015 it was estimated that 80% of all smartphone users will have access to the internet (Johnson et al., 2012), and 67% of all high school students will have smartphones with internet access (Project Tomorrow, 2010). The smartphones offer instructional tools that can become an important part of learning in our schools. There are a number of applications and features that could benefit the teacher and student in the classroom.

A recent article that researched smartphones in the classroom said that technology can improve students' engagement, motivation, and productivity (Roblyer & Doering, 2010). Smartphones are the Swiss army knife of today's technology. They have multiple useful tools that could be used in the classroom. Cameras to take pictures of notes, video for labs, audio for notes, and many applications that we are just discovering. For example identification apps for birds, flowers and trees for my biology class, might be some strong applications for the future.

In another study participating teachers were asked how cell phones could benefit student learning. More than half (59%) of the teachers felt that the use of smartphones would help with student engagement. A quarter of the teachers felt that the use of

smartphones would help with student motivation by allowing them access to this anytime anywhere source of information (Bolton, 2013). All of the research seems to indicate that this form of technology can benefit the students.

METHODOLOGY

I would like to provide a little background information into the development for my treatment. I teach at an alternative school that comes with its own set of challenges. Many of my students have criminal backgrounds, have learning disabilities, or come to school because their home life is out of control, and school helps give them some structure. I have found that all of my students are very connected to some form of technology. Almost all of the students in my classes have a smartphone or tablet, and I find it difficult to keep them off the electronic devices during class. I decided to do my research on technology in the classroom to help me incorporate more technology into my lessons. My thought is that instead of fighting the technology I could use it to benefit the success of my students.

Using technology in the classroom may affect student's progress in science and the successful completion of the EOC (End Of Course) state test. All state tests for science are now online, and a technology component for my class would be beneficial. Now more than ever technology has become an integral part of the science classroom. Following the STEM (Science Technology Engineering and Math) model at our school has opened up many possibilities for the integration of technology.

The purpose of this study was to find out what kinds of technology students are using so that I might apply these techniques in my own classroom. Students have become

addicted to technology to the point of no return. My goal was to get my students hooked on lessons through the use of their own technology. There are many applications available that helped me become a more effective teacher and more technological in my approach.

Another reason to develop a treatment based on technology is that the state of North Carolina has a standard six for a teacher's PDP (Personal Development Plan). This standard needs to show that your student test scores have improved over a period of time. If the student's scores have not shown improvement the teachers are held accountable. Last year my science classes did fairly well on the EOC for Biology, and I am hoping for improvement each semester. I want to improve my students learning with the use of technology. This research project has allowed me to apply and evaluate technology in an effort to accomplish this goal.

I have talked to many teachers that have concerns about student's low attention span. Many attribute this common concern to the use of technology in our student's lives. They are living in an "everything now" society. If they want to hear a song they search for it online and find it instantaneously. Information of any kind can be found with little effort. A lot of my students play video games for hours on end. My own children look forward to what we call "screen time." Many parents do not use the technology as a reward for good behavior. They just see it as something that is always there, or a chance to disconnect with their children. I have used the technology as a way to reconnect with my students, and use this research as a way to teach my students valuable information about my lesson and make it more interesting.

Treatment

For my study I gave my students the same test twice during a week for a period of four weeks to all of my classes. Each week I would switch out treatment and non-treatment tests to eliminate any bias for the second test. One test was on paper (non-treatment) the next was on the smartphone (treatment) to see if there was any improvement. This gave me the opportunity to compare test grades that were taken on paper, and on the smartphone. Test were reviewed by fellow teachers to insure validity and reliability of my instruments. I gave surveys to my students before treatment, and interviews were given to ten students after treatment. I also did in class observations and documented my findings in a journal. I engaged all of my 35 students from both biology and physical science classes for an intervention in the winter of 2016 to investigate my research questions.

Kahoot is an online test making website that is free to any user. These tests were my student's favorite because it is more interactive. They said that they enjoyed competing with the other students, and getting instant gratification with the answers they gave. Quizlet is an internet based test bank that teachers have to pay for. The Quizlet tests were more like worksheets on the phone, and students would work on their own without interaction. Quizlet is a bit limited in terms of its fun factor for students. They did not enjoy it as much as Kahoot because they were not interacting with each other using Quizlet.

One of the problems that arose was that my students did not understand why we were taking two of the same test. I let them know that it was for a project that I am

working on, and it would benefit them with good grades. Students became accustomed to the new weekly schedule and knew what to expect on a daily basis. This helped me with planning because I knew what to expect for my next day of classes. Instruction for each chapter during the first two days of the week was pretty traditional. I used a Smartboard with PowerPoints, classroom discussion, and an occasional video to get key points across to my students. See Table 1 below for the sequence of the treatment and non-treatment units with their respective curricular components.

Table 1: *Outline, Timeline, and Data Collection for the Action Research Treatment Schedule for Physical Science*

Activity	Topic	Dates
Unit 2 Chapter 7	Simple machines	02/01-02/05
Give and grade students treatment test on Quizlet		
Give and grade non-treatment test on paper		
Unit 2 Chapter 8	Waves	02/08-02/12
Give and grade non-treatment test on paper		
Give and grade students treatment test on Kahoot		
Unit 4 Chapter 10	States of Matter	02/15-02/19
Give and grade students treatment test on Quizlet		
Give and grade non-treatment test on paper		
Unit 3 Chapter 9	Energy	02/29-03/04
Give and grade non-treatment test on paper		
Give and grade students treatment test on Quizlet		

Treatment Schedule for Biology

Activity	Topic	Dates
Unit 3 Chapter 6	DNA	02/01-02/05

Give and grade students treatment test on Kahoot		
Give and grade non-treatment test on paper		
Unit 3 Chapter 7	Evolution	02/08-02/12
Give and grade non-treatment test on paper		
Give and grade students treatment test on Kahoot		
Unit 3 Chapter 8	Population	02/15-02/19
Give and grade students treatment test on Kahoot		
Give and grade non-treatment test on paper		
Unit 3 Chapter 9	Energy	02/29-03/4
Give and grade non-treatment test on paper		
Give and grade students treatment test on Kahoot		

Sample

Getting my students to do work can be very frustrating, but they seemed to enjoy using their smartphone for the lesson. This became the "hook" that I needed to collect the required data. Absences are also very high for our school so we try to offer incentive field trips for those students who can be at school consistently. Many of my students have an Individual Education Plan (IEP) and have special accommodations in place for taking the state exams. There are also many students who have emotional disorders and see counselors on a frequent basis.

There were 35 high school students in the study; 19 girls and 16 boys. Most of my students are academically below average with a handful of student's average or slightly above. Many of my students have been placed at the Alternative School because of learning disabilities, and behavioral issues that get them in trouble at school. The

ethnicity of my students is mostly white with 2 African American students, and 8 Cherokee. The academic environment is laidback with very limited student motivation. Our school qualified for a federal assistance program called the Community Eligibility Program. All 68 of our high school students receive a free lunch and breakfast on school days. Most of my students lack academic prowess and I would say that only 5% show any indications that they are interested in going into higher education.

Instruments

For my assessment I used a multiple choice tests that I gave to my students twice for eight chapters. One test was on paper (non-treatment) the other test was online (treatment) using student's smartphones for access. I wanted to see if there was any improvement on test scores by using their devices. The primary websites that I used were found by verbally surveying other teachers in the county. Both of the websites that I used are accessible through a smartphone or tablet. I used the online test making websites Kahoot, and Quizlet for my treatment. Kahoot is free, and Quizlet was paid for by my school, but my students did not seem to enjoy it as much as the Kahoot program.

I had the opportunity to present both programs to fellow teachers at a staff development session. This gave me the opportunity to demonstrate Kahoot and Quizlet to other teachers for peer feedback. Many teachers in the session had not heard of these programs and planned on using them for future classes. The peer feedback was very positive and solidified my plan to use them for this study.

All of my classes were run the same way for over a month. The first two days of the week were geared toward content. On Wednesdays my students were given an online test (treatment) or paper test (non-treatment) with the same multiple choice questions. Thursdays were review days, and on Friday's students were given the same test on paper (non-treatment) or the online test (treatment) to be taken on their smartphone. Each week I would switch out treatment and non-treatment tests to eliminate any bias for the second test. Summative assessments were gathered at the end of each testing session and written in my grade book for further investigation regarding an increase of student comprehension. To learn more about the students' attitudes toward using smartphones in class, every student in my class took Technology Survey before my study began (Appendix A). When the surveys were completed I looked over each one to highlight important points made by my students. A handful of students were interviewed by me based on the detail of their survey (Appendix B). I interviewed the students who I felt answered the survey questions honestly. By observing my students taking the survey I know that some of the students did not take the survey seriously, but many of them did. I also observed class participation during treatment and non-treatment to see if students were actively participating, and wrote my finding in my journal. I asked students to use their first name when signing on to a test for Kahoot. Some students would disappear from the game while others were taking the test. The excuse was technical error, but I think they just opted out to answer a text message. The research for this project received an exemption by Montana State University's Institutional Review Board and was in

compliance for working with human subjects (Appendix K). See Table 2 below for the triangulation matrix with my data sources.

Table 2 – *Data Triangulation Matrix*

Research Questions	Data Source		
	1	2	3
What effects will the use of smartphones have on test scores?	Treatment and Non-Treatment Test Scores	Summative assessments	Teacher observations, journal, peer review
Does the use of smartphones change student attitudes towards taking tests?	Student Survey	Interviews	Student Participation

DATA AND ANALYSIS

One observation that I made was that the students would always complain about taking a paper test. Whenever we used the smartphone students would light up and become excited to take a test. It was very rewarding to have my students look forward to taking a test. We primarily used the web based test bank Kahoot for taking test on the smartphones. The Quizlet program was a bit limited for what I was trying to do, and the students did not like it as much. The Technology Survey helped me establish a baseline idea of exactly how much my students use their smartphone. Consulting with other teachers gave me the idea of using a test- making website to see how I can incorporate the phones into my classroom. We use a program at my school called Home Base that is

used to maintain my student grades. This program provides a profile of student's progress over time. The surveys were handed out before treatment to understand how much my students used their phones for school and personal use.

Survey Questions

1. How much has your smartphone changed how you learn?

2. How often do you use your smartphone in class?

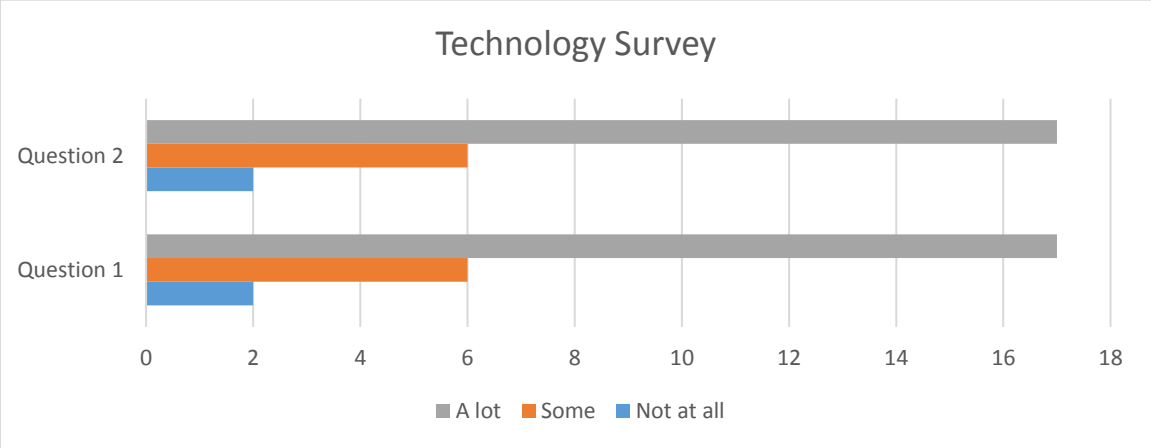

Figure 1: Smartphone use, (*N*=25).

These first two questions were to help me find out how much my students used their phones, and see if they thought it was a tool that helped them learn. Many of my students do use their phone for research and use them during class. During one of the interviews a student told me that his phone works faster than the outdated computers in my room. My interpretation of this was that the technology is growing faster than the school can keep up with. My students can go to the store and buy the newest technology right of the shelf, but the school needs to go through the budget process each year to see how much they can spend on technology with an ever growing student population.

3. What kind of technology do you use in school?

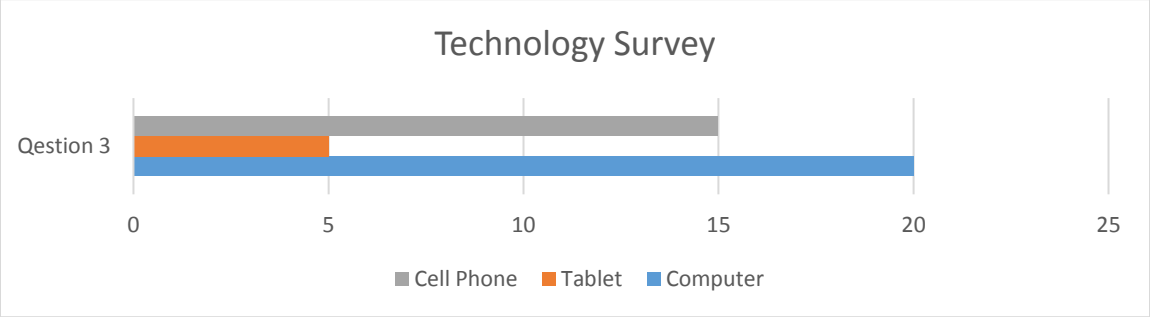

Figure 2: Technology at school, (*N*=25).

This question helped me understand what kinds of technology students would use on a typical day of school. It was interesting to see that a large number of students use their smartphones to do some sort of research. During the interviews some students said that they feel more comfortable using their phones for research than the computers. One student said they prefer the phone because they "can check messages and stuff", the school computers block social media sites.

4. How do you access the internet at home?

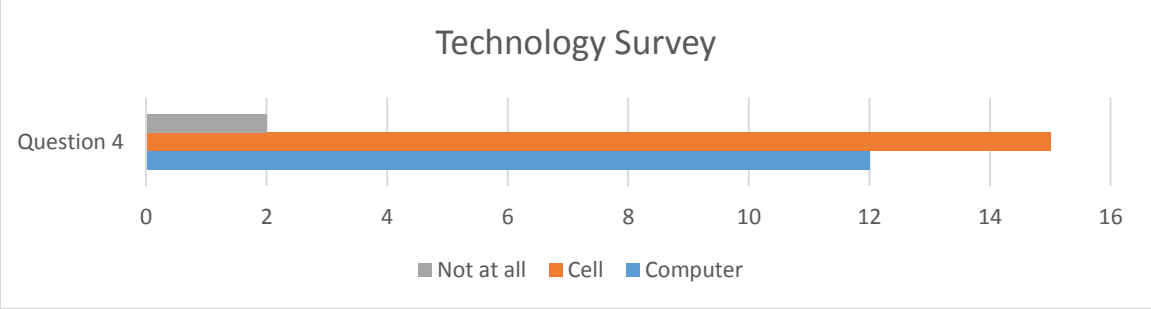

Figure 3: Internet at home, (*N*=25).

This graph shows that more students are using their phones at home to get on the internet. This gives them more practice using the smartphones as opposed to the

computer. This could also open up an opportunity for students to use phones to do homework assignments.

5. How many teachers have you had that let you use your smartphone in class?

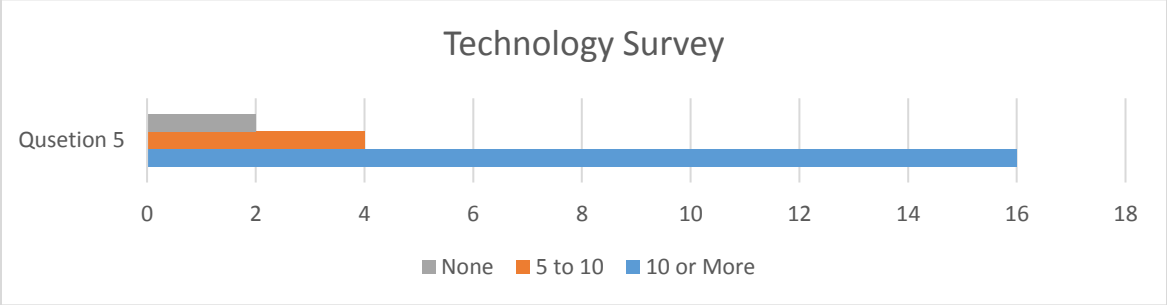

Figure 4: Teachers who allow smartphones, (*N*=25).

I was surprised to see how many teachers let their students use smartphones in class. After consulting with teachers who allow smartphones in their classroom most teachers said this was because of a lack of computers in the classroom. The "bring your own device" initiative has really hit home with some teachers and they feel that this can benefit the students. Some teachers use the smartphone as incentive to do assignments during class so students can use their phone at the end of the lesson.

6. How much has your smartphone helped you succeed in school?

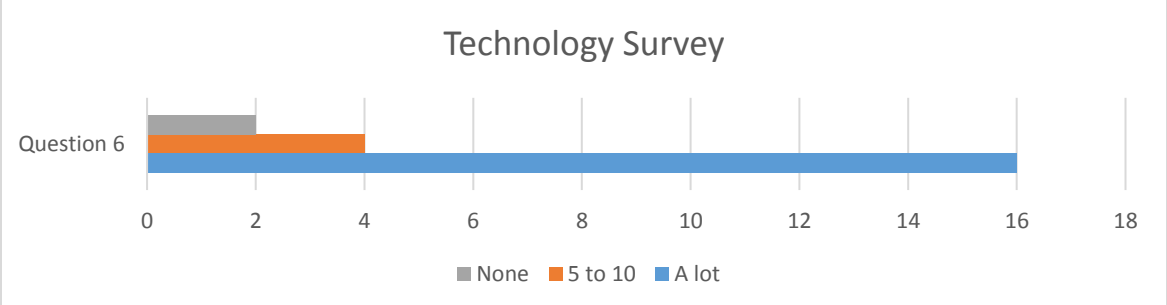

Figure 5: Smartphone success, (*N*=25).

A large number of students said that their use of a smartphone in class has helped them at school. Students said in the interview that the immediate access to the phone is more convenient than having to walk over to the computer turn it on and log in. The phone is right there and ready to go. During my interviews students said that they use their smartphones to research topics in class, and find definitions to terms that they do not understand. A few students said that they have a personal attachment to their phone, and know how to use it better than a school computer. One student said that the smartphone has become an "extension of themselves".

7. How much has technology helped you with learning?

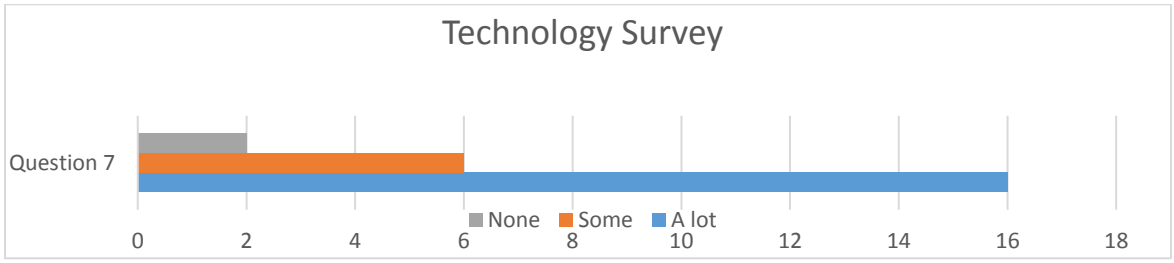

Figure 6: Learning with technology, (*N*=25).

Again students believe that the use of their phone in school has helped them learn. Many students said that they are so used to having the smartphone nearby so there is no need to use a computer. A few students said that they have become accustom to looking things up on their phone instead of using a computer for access to information.

8. What apps do you use the most on your phone? Which ones?

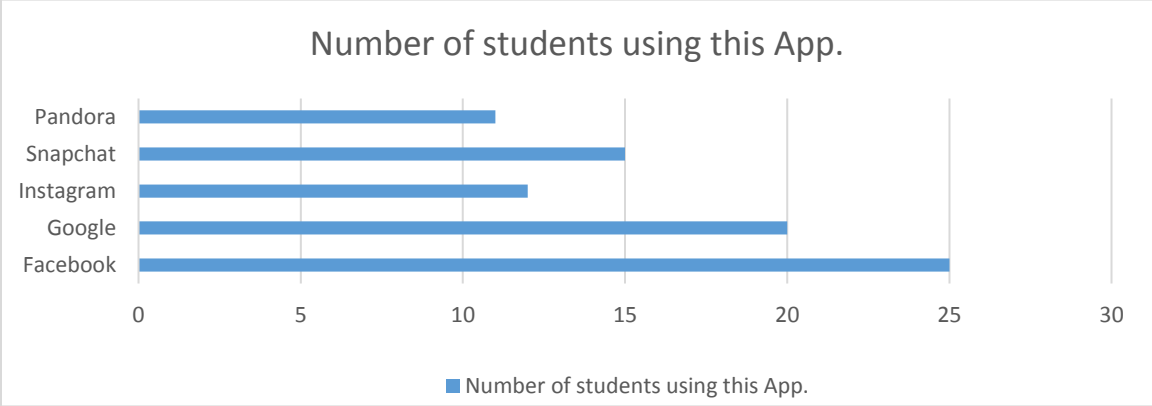

Figure 7: What apps you are using, (*N*=25).

I asked this question to see what kind of applications my students are using In hopes of finding something that we could use in class. I found it interesting that almost all of the apps were for communicating with each other not apps for learning.

After giving my treatment and non-treatment tests to my students on opposing days for a period of four weeks 100% of them did better taking the test online (N=35). I initially thought that my students would do better on the second test because they had already taken the test once with the same questions. The paper versions of the test my students consistently made a lower grade then the smartphone test. During my interviews I asked them what test they liked better 100% said that they liked the smartphone test (N=10). When I asked why, many of them said it was because they felt more connected to their phone then the paper test. A lot of students see a paper test and freeze up.

My students scored an average of ten points higher on the smartphone tests than the paper tests. On both tests there were students who did not do well on either test, and students who continually do well on test. This is a representation of how diverse my

classes are. I have some very high functioning students who scored in the upper 80's to 90's. Some very low functioning students who do not typically do well on test scoring below 70 to 55. Then the students who fall in between both categories scoring in the middle of the pack, but scoring higher on the treatment tests.

With the smartphones it made it more interesting to them. One student answered that "The smartphone made the test more like a game then a test." Another student said that the photos on Kahoot helped them answer the questions better because it gave them a visual to go by. At the end of each question on Kahoot my students can see how many of them answered one of the four questions. This also showed me what topics I may need to cover more. When I asked my students do you think that the smartphone would be a useful tool to use for the lesson 100% of them said yes (N=10). When asked why they said the phone was "easy to use" and they can "navigate it better" than a computer or book. Figure 8 shows how much better students did by using the smartphone for tests. Eight tests were given to my students over a period of 5 weeks. The average test score of smartphone test was 10 points higher than the test scores of the paper test. This proved to me that my students do better with technology based tests than papertest.

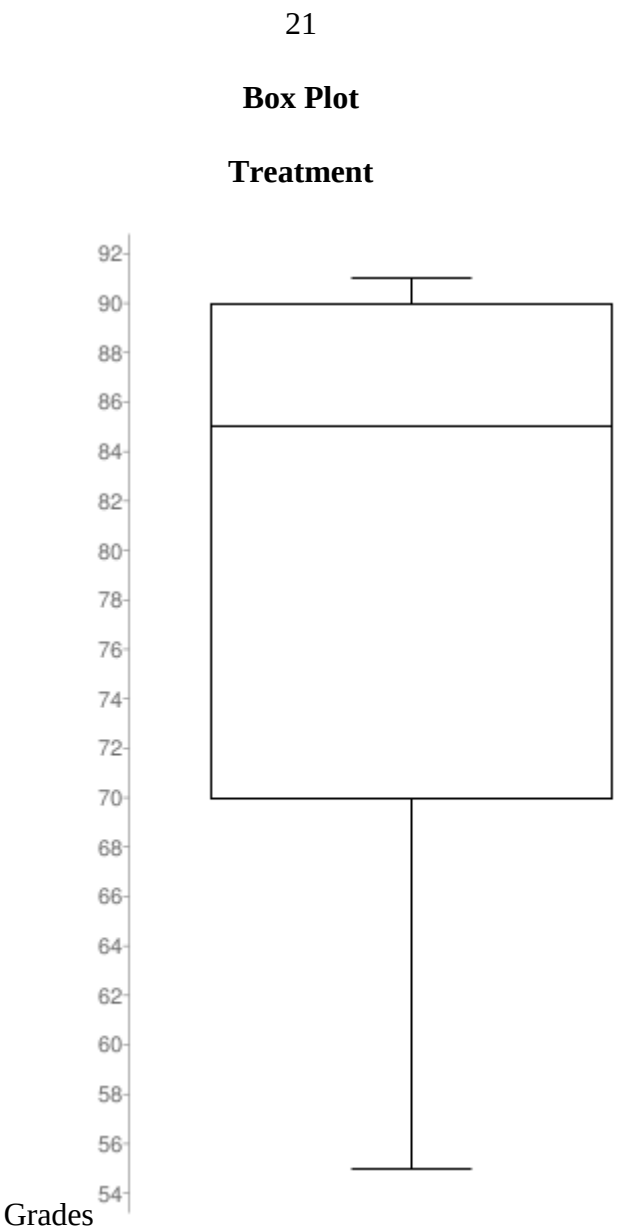

Figure 8: Class average smartphone test scores, (*N*=35).

Box Plot

Non-Treatment

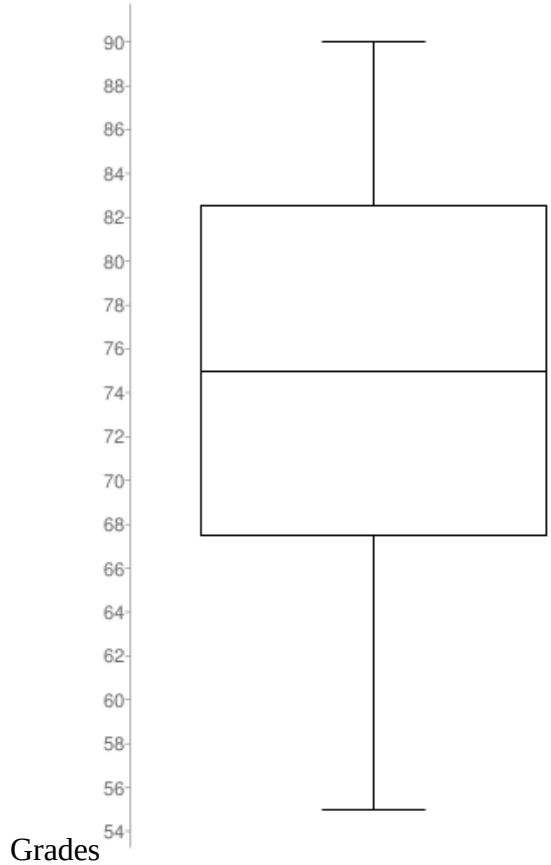

Figure 9: Class average paper test scores, (*N*=35).

INTERPRETATION AND CONCLUSION

My research focus on three major questions, 1) What effects will the use of smartphones have on test scores? 2) Does the use of smartphones change student attitudes towards taking tests? 3) Will the use of smartphones help student comprehension?

As to the first question I would have to say that the use of smartphones in class was a benefit to my students. They scored an average of ten points higher on the game

like tests than on the paper test. All of my students were involved with the test and actually looked forward to playing against each other. When I gave out a paper test the students would complain and shut down. They would say things like “I am not going to do it”. A lot of my students felt that the use of the smartphones made learning more fun than paper tests.

For my second question I observed that student’s attitudes did change while taking test online. They began to see these test as a video game, and enjoyed taking the online tests. The state test is online, so now they can look at that test as some sort of game. It is just another way to look at the high stakes, and not be so stressed out about it.

I also feel that my third question was answered about the use of smartphones helping student comprehension. There have been many times during class where I observed my students looking up an answer to a question on their smartphone. The phones have become the new hand held encyclopedia. All of the information that they need is all at their fingertips. I am hopeful that my students improve their comprehension skills on the state exam.

VALUE

This study has impacted my teaching in many ways. The most noticeable was the fact that my students and I can connect to the material on a whole new level using their smartphones. Before my research the smartphones were a constant battle. Now I have learned to embrace them as a study tool. My students have come up with new ways to show me how the smartphones can be useful in their education not only to take tests but

to do research, and connect with other students using social media. It opened my eyes to give the smartphones a fresh look and see them as a tool and not a distraction.

My future studies will investigate what type of activities students enjoy on their devices, and what apps I could use for my class that they are willing to download. One idea from a student was to have an Instagram account for the members of my class so they can share images

from any labs that we do. Another idea was to use Google docs for a place where students can see their work and work from other students. Even YouTube came up where we would make appropriate videos to post about the current curriculum of the class. The possibilities seem endless through the use of student's smartphones and the tech savvy, creative minds of my students.

With the lack of technology in Jackson County, and the fact that almost every student owns a smartphone I think that I have made headway into the next realm of teaching. My students enjoy using their smartphones so much that it would be anti-productive to not use them in class. This use of technology will also help them prepare for the state test which is an online exam. In all I think that using a student's device in class will benefit the student's and the teachers involved. My students seemed to be way more involved in the lesson while using their own device. I plan on continuing to use the Kahoot program because my students really enjoyed the competitive nature of this online tool. Quizlet was very remedial and my students did not enjoy the program as much. I do not plan on renewing my membership for this tool at the end of the year.

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APPENDICES

APPENDIX A
SURVEY QUESTIONS

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Survey

Technology survey

1. How much has technology changed how you learn?
   Not at all
   Some
   A lot
2. How often do you use your cell phone in class?
   Not at all
   Some
   A lot
3. What kind of technology do you use in school?
   Computers
   Tablets
   Cell phones
4. How do you access the internet at home?
   Computer
   Cell phone
   Not at all
5. How many teachers have you had that let you use your cell phone in class?
   1-5
   5-10
   None
6. How has your smartphone helped you succeed in school?
   Not at all
   Some
   A lot

7. How much has technology helped your with learning?

   Not at all

   Some

   A lot

8. What apps do you use the most on your phone? Which ones?

APPENDIX B

INTERVIEW QUESTIONS

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Interview questions:

1. Do you feel that the smartphones were a useful tool in class? How?
2. What test (paper on smartphone) did you feel worked the best? Why?
3. Where you able to stay on task? Why or Why not?
4. Where you more involved with the lesson by using your phone or using paper? Why?
5. How do you think that it went?

APPENDIX C

EVOLUTION TEST

Name:_____

1. What is mimicry?

A. an adaptation that allows mammals to breathe under water

B. allows species to blend with their surroundings

C. an adaptation that allows one species to resemble another

D. an adaptation that allows bacteria to resist penicillin

2. Which of these favors only one of the extreme variations of a trait?

A. directional selection

B. equilibrium selection

C. disruptive selection

D. stabilizing selection

3. A population that is _____ is not evolving.

A. in genetic equilibrium

B. in genetic drift

C. geographically isolated

D. part of the gene pool

4. What does this chart indicate about the evolution of the animal over time?

A. The species underwent divergent evolution.

B. The species underwent incomplete dominance.

C. The species underwent geographic isolation.

D. The species underwent disruptive selection.

5. Which of these statements about evolution is true?

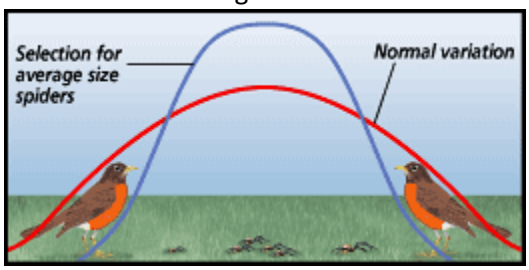
A. fossil finds are limited to the continents of Africa.

B. fossil record show evidence, but record not complete

C. Fossils are not an important source for scientists

D. Using anatomy studies to find evidence of evolution.

6. What does this figure illustrate?



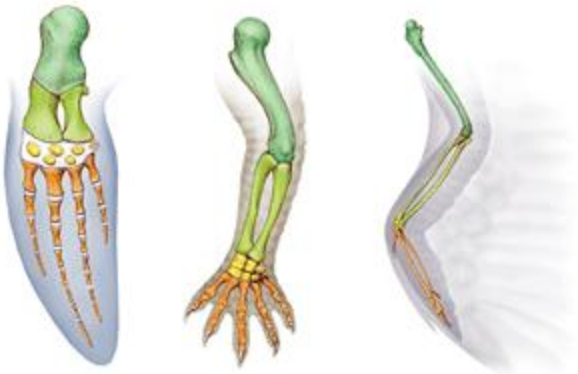
A. stabilizing selection

B. speciation

C. directional selection

D. disruptive selection

7. What can you infer about these structures?



A. they are vestigial structures

B. they are analogous

C. they are homologous

D. they have nothing to do with each other

8. Scientists theorize that the first forms of life may have been

A. maggots

B. formed through spontaneous generation

C. heterotrophs

D. complex eukaryotic cells

9. Some scientists hypothesize that the first life forms on Earth evolved from _____.

A. a protocell

B. archae bacteria

C. biogenesis

D. primordial soup

10. What type of rock are most fossils found in?

A. metamorphic

B. sedimentary

C. volcanic

D. igneous

APPENDIX D

DNA TEST

Name:_____

1. The process where enzymes make an RNA copy of a portion of a DNA strand is called _____.

A. acid creation

B. transcription

C. helix creation

D. replication

2. Which of these is a symptom of hemophilia?

A. cuts that take a long time to stop bleeding

B. inability to differentiate between shades of red and green

C. some degree of mental retardation

D. tissue damage from blocked blood flow

3. Which of these is NOT an example of a simple dominant trait?

A. a widow's peak hairline

B. a hitchhiker's thumb

C. cystic fibrosis

D. a cleft chin

4. People who have ancestors from which of these countries have a higher incidence rate of PKU?

A. England

B. South Africa

C. Sweden

D. Greece

5. _____ cause the phenotypes of both homozygotes to be produced in heterozygous individuals.

A. Codominant alleles

B. Environmental influences

C. Incomplete dominances

D. mutations

6. Which of these is usually NOT considered a mutagen?

A. nuclear radiation

B. low temperatures

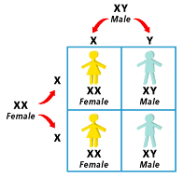
C. ultraviolet light

D. formaldehyde

7. According to this diagram, what is the chance that a human offspring will be male or female?

A. 50%

B. 75%



C. 100%

D. 25%

8. Traits that are controlled by genes found on the sex chromosomes are _____.

A. sex-linked traits

B. autosomes

C. polygenic inheritance

D. heterozygous

9. Thymine and cytosine are also called _____.

A. pyrimidines

B. isotopes

C. viruses

D. purines

10. Which of these DNA strands would the DNA strand A-T-G-C-C-G-T-T match to?

A. T-T-G-C-C-G-T-A

B. C-G-T-A-A-T-G-G

C. G-C-A-T-T-A-C-C

D. T-A-C-G-G-C-A-A

APPENDIX E

WAVES TEST

Name:_____

1. A _____ is a repeating disturbance that transfers energy through matter or open space.

A. conductor

B. frequency

C. wave

D. medium

2. Which of the following does a transverse wave have?

A. rarefactions

B. amplitude

C. compressions

D. ability to travel through space

3. The process in which two waves overlap and form a new wave is called _____ .

A. interference

B. diffraction

C. refraction

D. wave joining

4. If you stand next to a swimming pool and see an object under water, it will seem to be _____

A. bent in the middle

B. farther from the surface than it really is

C. closer to the surface than it really is

D. moving more than the water around it

5. Which of the following types of waves can travel through space?

A. transverse

B. light

C. compressional

D. mechanical

6. _____ is a wave pattern that forms when waves of equal wavelength and amplitude, but traveling in opposite directions, continuously interfere with each other.

A. Destructive interference

B. Reverberation

C. Constructive interference

D. A standing wave

7. What is the frequency of a wave if its wavelength is 5 m and wave velocity is 20 m/s?

A. 4 Hz

B. 0.25 Hz

C. 25 Hz

D. 100 Hz

8. _____ describes how fast a wave moves forward.

A. Wavelength

B. Wave velocity

C. Amplitude

D. Frequency

9. _____ is a measure of the energy in a wave.

A. Amplitude

B. Wavelength

C. Wave velocity

D. Frequency

10. _____ are a combination of compressional and transverse waves.

A. Seismic waves

B. Frequencies

C. Amplitudes

D. Ultrasonic waves

11. What is the wavelength of a wave traveling through a rope if the distance from one crest to the next is 1 m?

A. 1 m

B. 3 m

C. 2 m

D. 0.5 m

12. What is the less dense region of a compressional wave called?

A. rest position

B. crest

C. rarefaction

D. trough

13. _____ occurs when waves bend around a barrier.

A. Reflection

B. Interference

C. Refraction

D. Diffraction

14. What are the lowest points of a transverse wave called?

A. troughs

B. crests

C. valleys

D. depressions

15. Which of the following is a type of wave?

A. earthquake

B. trough

C. crest

D. frequency

16. As frequency increases, wavelength _____ .

A. becomes faster

B. remains constant

C. increases

D. decreases

17. Reflection occurs when a wave _____ .

A. causes ripples in a pool of water

B. strikes an object and bounces off of it

C. bends and changes speeds as it travels

D. compresses air particles as it travels

18. A _____ is a material through which a wave transfers energy.

A. frequency

B. medium

C. trough

D. substrate

19. The _____ of a wave is how many wavelengths pass a fixed point each second.

A. velocity

B. compression speed

C. amplitude

D. frequency

20. In _____ waves, matter in the medium moves back and forth in the same direction the wave travels.

A. compressional

B. transverse

C. radio

D. ocean

APPENDIX F

SIMPLE MACHINES

Name:_____

1. Which of the following tools is a wedge?

A. screw

B. bottle opener

C. wheelbarrow

D. knife

2. When work is done, there is always a(n) _____.

A. single movement involved

B. transfer of energy

C. increase in the mechanical advantage

D. constant rate

3. Which of the following equations should be used to calculate work done?

A. W = F/d

B. W = F X a

C. W = m X d

D. W = F X d

4. Which of the following equations should be used to calculate power?

A. P = W/t

B. P = W X t

C. P = F/t

D. P = m X a

5. Which of the following describes a first-class lever?

A. effort force located between the resistance force and fulcrum

B. resistance force located between the effort force and fulcrum

C. effort force and resistance force in same location

D. fulcrum located between the effort and resistance forces

6. _____is a modified wheel and axle that has two wheels of different sizes with interlocking teeth.

A. wheelbarrow

B. pulley

C. gear

D. screw

7. A lever is an example of a machine that?

A. increases the distance an object moves

B. decreases the work required to move an object

C. is complex and has many moving parts

D. increases the force applied to an object

8. A(n)_____ is a bar that is free to pivot about a fixed point.

A. screw

B. lever

C. pulley

D. inclined plane

9. _____is the rate at which work is done.

A. Force

B. Power

C. Efficiency

D. Effort

10. _____is a grooved wheel with a rope, chain or cable running along the groove.

A. pulley

B. screw

C. wedge

D. axle

11. To calculate the ideal mechanical advantage of a lever, _____.

A. divide the length of effort arm by length of resistance arm

B. divide the length of resistance arm by length of effort arm

C. add the lengths of the effort arm and the resistance arm

D. multiply the length of effort arm by length of resistance arm

12. A watt is equal to _____.

A. one meter per second

B. one newton per second

C. one joule per second

D. one newton-meter

13. Which of the following equations should be used to calculate power if work is not done.

A. Power cannot be measured if work is not done.

B. P = E/t

C. P = E X t

D. P = F/t

14. How does a ramp make it easier to move a heavy object a certain distance?

A. by decreasing the distance the object moves

B. by decreasing the amount of work required to move the object

C. by changing the direction in which the object moves

D. by decreasing the amount of force required to move the object

15. If you apply a force of 10 N to a box and push it 10 m in 10 s, how much power did you deliver?

A. 100W

B. 30W

C. 1000 W

D. 10W

16. Which of the following simple machines is an inclined plane wrapped around a post?

A. screw

B. wedge

C. lever

D. wheel

17. A(n)_____ is a simple machine that consists of two wheels that rotate together.

A. movable pulley

B. hand-operated can opener

C. wheel and axle

D. inclined plane

18. In which of the following situations do your arms do work on books?

A. holding a heavy stack of books while standing

B. carrying a heavy stack of books

C. picking up a pile of books from the floor

D. dropping a stack of books onto a table

19. _____is the transfer of energy that occurs when a force makes an object move.

A. Work

B. Power

C. Effort

D. Resistance

20. If a pulley is attached to something that doesn't move, what is it called?

A. moveable

B. stuck

C. fixed

D. block and tackle

APENDIX G

STATES OF MATTER TEST

Quizlet

NAME _____

18 Matching questions

1. [ ] The proportions of substances in a mixture _____ .
2. [ ] Which of the following is an example of physical weathering?
3. [ ] The ability of a metal to be drawn out into thin wires is a _____ .
4. [ ] If you have to use a microscope in order to see the substances in a mixture, that mixture is _____ .
5. [ ] Which of the following is a physical change?
6. [ ] A(n) _____ is a substance in which all the exact combinations of elements are always the same.
7. [ ] Which of the following is a solution?
8. [ ] Which of the following is a physical property?
9. [ ] A _____ is a heterogeneous mixture that never settles.
10. [ ] Which of the following is a chemical change?
11. [ ] A change in size, shape, or state of matter is a _____ .
12. [ ] Which of the following is a homogeneous mixture?

[a] water
[b] burning of a log
[c] iron turning white when heated
[d] heterogeneous
[e] chemical property
[f] smoke
[g] colloid
[h] solution
[i] magnetism
[j] cheese on a pizza
[k] compound
[l] physical property
[m] can vary among the substances
[n] salt water
[o] element
[p] physical change
[q] either an element or a compound
[r] formation of a canyon by a flowing stream

13. ( ) Which of the following is a compound?

14. ( ) A substance is _____ .

15. ( ) Which of the following is a colloid?

16. ( ) A mixture in which particles are so small they cannot be seen with a microscope is a _____ .

17. ( ) A _____ is a characteristic of a substance that indicates whether it can undergo a certain chemical change.

18. ( ) A(n) _____ is a substance in which all the atoms in it are alike.

APPENDIX H

ENERGY TEST

Quizlet

NAME _____

10 Multiple choice questions

1. is a thick, flammable liquid formed by decayed organisms.
   a. geothermal heat
   b. core
   c. Petroleum
   d. Coal

2. According to the law of conservation of energy, energy cannot be?
   a. renewable resource
   b. created or destroyed
   c. nonrenewable resource
   d. geothermal heat

3. Heat generated within Earth by the decay of radioactive elements is called?
   a. geothermal heat
   b. Petroleum
   c. Coal
   d. core

4. In what part of a nuclear reactor does fission occur?
   a. geothermal heat
   b. core
   c. Petroleum
   d. Coal

5. is the joining together of small nuclei at high temperatures.
   a. Thermonuclear fusion
   b. hydroelectricity
   c. Petroleum
   d. renewable resource

6. What rock type resource is a fossil fuel?
   a. geothermal heat
   b. Petroleum
   c. Coal
   d. core

APPENDIX I

POPULATION TEST

Name:_____

1. An environment's __ is the number of organisms of a certain species can support indefinitely.

A. stability

B. density

C. carrying capacity

D. exponential growth

2. _____ is a density-dependent factor.

A. Competition

B. Temperature

C. Floods

D. Drought

3. Which of these equations represents zero population growth?

A. Birthrate - Death rate > 0

B. Birthrate - Death rate = 0

C. Birthrate + Death rate = 0

D. Birthrate + Death rate < 0

4. Which of these is NOT a characteristic of a rapid life-history organism?

A. long life span

B. small body size

C. early reproduction age

D. rapid period of time until maturation

5. Which of these is NOT a limiting factor to the growth of a population?

A. long-term abundance of space

B. introduction of disease

C. availability of food

D. increasing population of predators

6. An elephant has a slow life-history pattern. Which of these would be matched to an elephant?

A. long lifespan

B. mature quickly

C. unstable environment

D. reproduce early

7. What does the dotted line represent on this graph?

A. predation

B. birth rate

C. carrying capacity

D. death rate

8. Which of these is the study of human population size and the factors that influence it?

A. meteorology

B. botany

C. demography

D. ecology

9. Which of the colonies was least affected by temperature as a limiting factor?

A. 4

B. 1

C. 2

D. 3

10. What does the red line on the graph represent?

A. primary succession

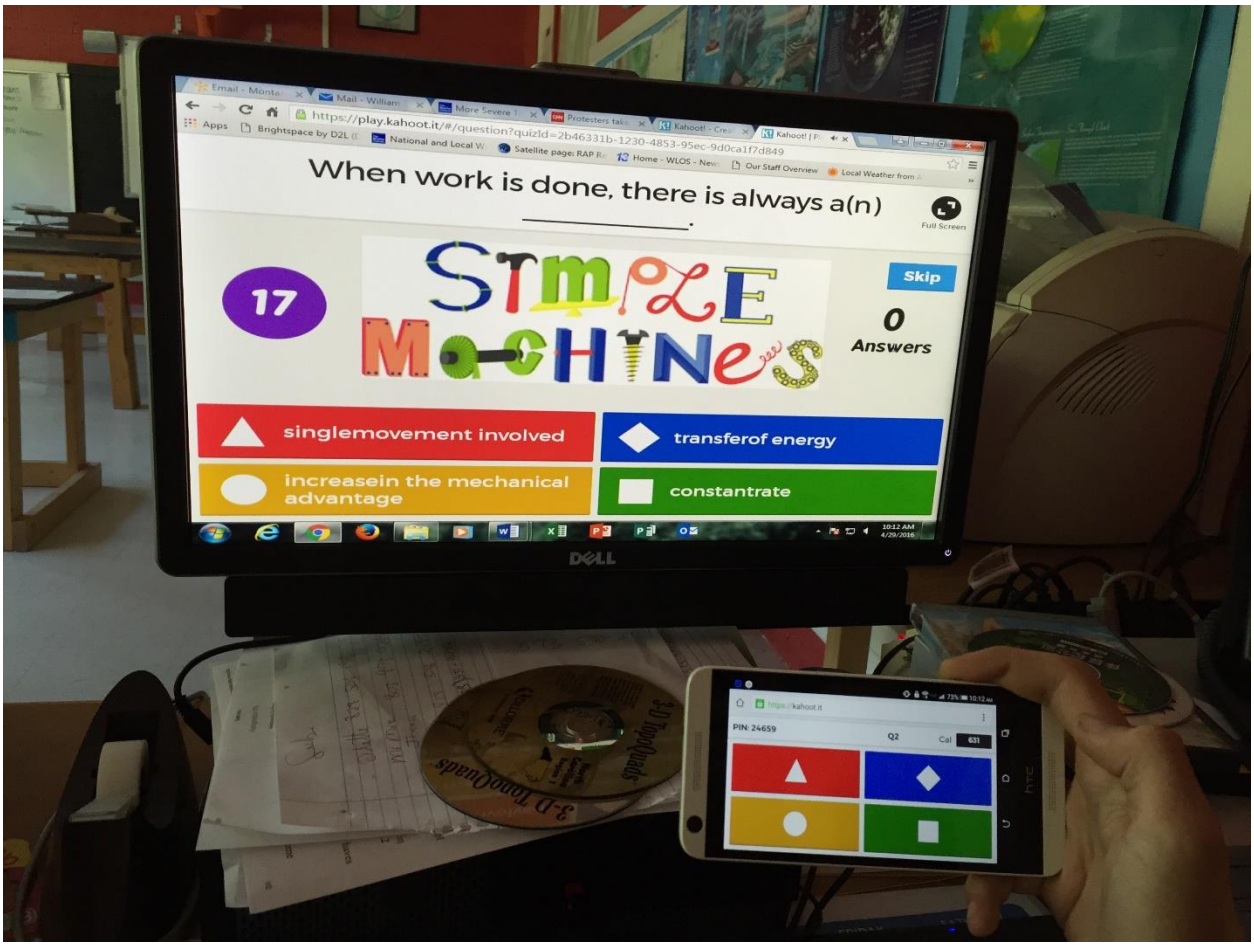
B. a limiting factor

C. a climax community

D. secondary succession

APPENDIX J

SCREEN SHOT


When work is done, there is always a(n) _____.
17
SIMPLE MACHINES
Skip
0
Answers
singlemovement involved
transferof energy
increasein the mechanical advantage
constantrate
DELL

APPENDIX K

IRB EXEMPTION APPROVAL

MONTANA
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MEMORANDUM

TO: William Sparks and Walter Woolbaugh

FROM: Mark Quinn, Chair Mark Quinn Chy

DATE: November 20, 2015

RE: *"The Effects of Using Cell Phones in the Classroom to Benefit Student Performance" [WS112015-EX]*

The above research, described in your submission of November 20, 2015, 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:

_X_ (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.

_X_ (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, (i) if wholesome foods without additives are consumed, or (ii) 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.