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# Integrated technology: does it affect learner outcomes?

Adam Ross Barrett
*Louisiana State University and Agricultural and Mechanical College*

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# INTEGRATED TECHNOLOGY: DOES IT AFFECT LEARNER OUTCOMES?

A Thesis
Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Master of Natural Sciences

in

The Interdepartmental Program in Natural Sciences

by
Adam Ross Barrett
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# ABSTRACT

Because technology has become prevalent in classrooms, this study was undertaken to test whether the use of integrated technology, specifically computers and online activities, affects learner outcomes in a classroom setting. The outcomes from classes taught using integrated technology were compared to classes taught with traditional teaching strategies such as notes, discussions and book work. Students in a 7$^{th}$ grade life-science class were given pre-tests and post-tests to determine their learning gains on the topics of genetics and photosynthesis. Each class was assigned different activities based on the subject. Each unit was covered in four 90 minute periods. When one set of classes was using integrated technology for a topic, the other set was using traditional methods of learning.

The integrated technology had no detectable effect on learner outcomes. There were no significant differences between mean learning gain and the different variables tested: class size, gender and teaching styles. However, there was a positive effect on the students' behavior and attitude for learning the material. The technology-based methods did not detract from student learning. Over a more extended time frame, implementation of technology-based methods in the classroom may increase learning gains and/or foster increases in engagement and class attendance.

# INTRODUCTION

## Integrated Technology and its Role in the Classroom

Integrating technology tools such as computers, Microsoft PowerPoint presentations, videos, etc., into the curriculum is becoming an inseparable part of teaching (Pierson, 2001). Integrating technology into a classroom setting can be challenging, because the success of implementing different technologies may be affected by both the learner and the adult educator (Redmann & Kotrlik, 2004). Many different obstacles of implementation have been identified, which include funding and cost, lack of training or expertise, lack of time, access to technology, resistance to change, and teachers' attitude (Black, 1998; Budin, 1999; Frabry & Higgs, 1997; George, 2000; Ginsburg & Elmore, 2000; Glenn, 1997; Jaffee, 2001; King, 1999; OTA, 1993; Smerdon et al., 2000; as cited in Redmann & Kotrlik, 2004). While these are real and potentially difficult obstacles, many educators have successfully incorporated technology into their classrooms.

Recently, there has been a move to promote the use of technology in teaching and learning (Zandvliet & Straker, 2001). Technological innovations have created a new set of tools for science students to explore. But, while there are new developments in scientific technology, research on the use of this technology is limited. Instructional technology has progressed from a time when early computer software was limited in its use and served only as a tool for drill and practice, to new interactive technologies that allow a student to become a virtual scientist and conduct experiments, collect and analyze data, and communicate and collaborate with other students and educators around the world (Jones et al., 2003). There have been many efforts to incorporate these new tools into science standards in America, particularly innovative pedagogical approaches to make learning in the classrooms more meaningful and allow students to participate in actual scientific practices (Krajcik et al., 2007).

As technology development has progressed in the educational setting, connecting academic learning with modern technology can help students gain more opportunities and help raise interest in exploring content (Wright, 2001). Again, in order for this to happen, teachers must be able and willing to use technology, and use it effectively in their teaching in order to realize the benefits of the technology. While the use of email is growing amongst educators, most computer use by students in classes consists primarily of report and presentation generation or accessing materials. It is critical to prepare teachers to use technology effectively in the classroom because developments in technology have rapidly increased in the field of education more than almost any other field (Becker, 2007).

Although there has been a push for technology in classrooms there have also been educators who question the use of technology as a primary teaching tool. However, when successfully integrated, technology has been shown to have a positive impact on a child's development without minimizing or reducing the engagement with traditional essential learning experiences (Clements & Nastasi, 1993). Technology may contribute to a child's cognitive development in three ways: first, by allowing teachers to easily create a learning environment that is hands-on. Second, it helps students visualize concepts that may be difficult to grasp or understand (Bransford et al., 2000) and last, it allows for the reinforcement of traditional developmentally appropriate activities (Clements & Nastasi, 1993). For example, children in the third-grade who used manipulatives and computer programs had a greater understanding in the areas of classification and logical thinking when compared to children who used manipulatives as their only source of learning (Clements and Nastasi, 1993). This suggests that to create a successful learning environment, a teacher must find a balance between traditional teaching methods and integrating technology into their lessons.

**Technology Use in Schools**

Computers are beginning to gain recognition as an effective learning tool to improve the quality of education for students (dot-com alliance, 2006). The use of this technology has been a great aid to teachers and students in the pursuit of knowledge. This trend needs to continue, but at the same time, become more focused on content rather than learning how to run a computer program or how the program works. Time is wasted when students have to spend time learning how to load a program or download software. According to the American Institute of Physics Panel on Using Technology for Education

(American Institute of Physics, 1997), educational technology should do the following: focus on the child learning with technology, not having to learn about it; emphasize content and not hardware associated with the computer; provide students with achievable goals in order to connect prior knowledge with the new ideas they are learning; ensure the social context of learning supports the process of building on the ideas of other intellectuals; and create learners who can pursue different careers with the new skills and knowledge they attain.

Several studies have examined whether the use of technology in the teaching-learning process improved learner outcomes. Some studies have shown marked improvement in learner outcomes (Khalili & Shashoani, 1994; Moore & Kearsley, 1996), while others have not found any differences between technologically based and traditional based approaches in instruction (Moore & Kearsley, 1996; Timmermann, 1998). Bower (1998) states that even if there is a lack of data showing that technology improves student performance, teachers should employ technology because its use continues to increase in educational, workplace and personal environments. Whether the use of technology shows a marked improvement in learner outcomes, the use of technology in society will continue to grow. In order to create and maintain a society that is competent in the use of technology, the task will rely heavily on the shoulders of educators.

**Rationale for This Study**

Students seem to excel in classrooms where integrated activities are utilized to enhance their learning. Tüzün et al. (2009) showed that students made significant learning gains when participating in computer game-based activities. The way children learn has changed and an effective teacher must adapt the curriculum to this. With the digital age, students are more inclined to want to use technology in any way, shape or form. At a middle school in Ohio, students were polled and the three most popular technology uses at the school were using Microsoft Word for composing reports, using the internet to search for information, and emailing (Lei & Zhao, 2007). Whether constructing a word document, searching for a computer simulation or e-mailing friends, students want to be entertained and surrounded by technology. For this to occur, teachers must be open to using and exploring the use of technology in their classrooms.

Because of the wide interest and implementation of technology in the classroom it is prudent to ask whether these technologies improve learning outcomes. The present study was undertaken to test whether the use of classroom technology improved learning outcomes on two specific biological topics which from personal experience, seventh graders find difficult, often because of preconceptions. In this study, students' learning outcomes were assessed by calculating learning gains using pre- and post-tests (Hake, 1998).

## MATERIALS AND METHODS

### Designing the Pre- and Post-Tests

To assess student learning, pre- and post-tests for both genetics and photosynthesis were developed (Appendices A, B, C, D). The photosynthesis pre-test was composed of eight questions (Appendix A). Five of the questions were basic knowledge while the other three were application-type questions based on Bloom's Taxonomy (Bloom *et al.,* 1956). The genetics pre-test consisted of nine questions, seven knowledge based and two application-based (Appendix B). The questions were reviewed and revised by a committee of science teachers several times and were tested to determine if they were valid. Both pre-tests were given to students in a non-major's biology laboratory, BIOL 1005, at Louisiana State University. The laboratory students were good candidates for taking the pre-test because in order to be in BIOL 1005, they must have taken the lecture course BIOL 1001 where both topics, photosynthesis and genetics, were taught. The students did well on this test probably because they were familiar with the material and the questions presented to them were on a seventh grade level. It was thought that if they could answer the questions with little difficulty, the questions were straightforward and non-biased.

### Definition of the Study Population

A total of 104 participants in the photosynthesis pre- and post-test and a total of 94 participants in the genetics pre- and post-test. The ages of the students who participated ranged from twelve to fourteen. The students who participated in the study were representative of the population of the whole school (Table 1). While these numbers do represent the whole school, $6^{th}$ through $8^{th}$ grade, the students participating were all in the $7^{th}$ grade. The school's population was 828 in 2007. Of those students, 541, or 65.3%, are offered either free or reduced lunches. This school is classified as a Title 1 school and in a high needs district.

*Table 1*. Number of students in each population in each class that participated in the study (eSchoolPlus+).

| Ethnicity for Woodlawn Middle School in Baton Rouge, La | | |
|---|---|---|
| | School Population | Study Population |
| Black | 61.3% | 67.35% |
| White | 30.6% | 26.53% |
| Asian | 2.93% | 0% |
| Hispanic | 3.83% | 4.08% |
| Other | 1.44% | 2.04% |

**Administering the Tests**

All students agreed to participate by having a parent or guardian sign a letter of consent (Appendix E). The parental consent and this research project were approved by the Institutional Review Board at Louisiana State University.

Before each topic was taught in the seventh grade life science class, the pre-test was administered to the students. To ensure each student applied him/herself fully, students would receive bonus on his/her next class work assignment for each question answered correctly on each pre-test. In an effort to keep the students from memorizing the questions, the pre-tests were not handed back and were not reviewed with the students. The photosynthesis test was given first and a total of 104 students participated. Of these students, 51 of them were administered the traditional teaching style and the other 53 were taught using the integrated learning methods (Table 2). The genetics pre-test was given approximately four weeks later and the total number of students to take that test was 94. Of those 94 students, 44 were given the traditional teaching style treatment while the other 50 were taught using the integrated learning methods (Table 2). After each set of pre- and post-tests were given, the scores were recorded and Hake's (1998) formula (Appendix F) was used to calculate learning gains for both tests.

**“A” and “B” Days**

The science classes taught in this study were broken down into “A” day classes and “B” day classes. “A” days had 3 classes; 1A, 3A and 4A. “B” days were the same, 1B, 3B and 4B. Each class was given the pre- and post-test but “A” day and “B” day classes were taught in different ways. This study took two class periods for each topic; thus, “A” and “B” day class times were equal. In all, eight class days were devoted to this study over the span of eight weeks. For photosynthesis, “A” day classes were taught using integrated technology (IT) (Table 2), web based activities and short videos on the computer. On “B” day (Table 2), the lessons were taught a traditional (T) way with a combination of book work, notes and lecture material, while every class got the same treatment. For the lesson on genetics (Table 3), the same treatment was applied and was replicated exactly the same, except that the delivery was changed on “A” day and “B” day. Assignments from the book and notes and lectures were given to the “A” day and “B” day classes that used T methods and IT classes were assigned internet-based activities and short video segments on the computer. IT students were allowed to work freely and at their own pace. The students were encouraged to think and learn the information themselves in the IT portion of the study. The teacher was nearby in order to help provide assistance for students with regards to the topics of study or methods of navigating the web pages.

*Table 2*. Number of students in each class that took the photosynthesis pre- and post-tests.

| Class Period | Number of Students | Teaching Method |
|---|---|---|
| 1A | 15 | T |
| 3A | 23 | T |
| 4A | 12 | T |
| 1B | 15 | IT |
| 3B | 27 | IT |
| 4B | 12 | IT |

*Table 3.* Number of students in each class that took the genetics pre- and post-tests.

| Class Period | Number of Students | Teaching Method |
|---|---|---|
| 1A | 16 | IT |
| 3A | 17 | IT |
| 4A | 11 | IT |
| 1B | 15 | T |
| 3B | 26 | T |
| 4B | 9 | T |

**Traditional Teaching Methods**

For the groups taught by traditional teaching methods, the students were given different assignments than the integrated technology groups. Many of the assignments allowed the students to read sections from the textbook and discuss the material. Students were given vocabulary from the textbook and required to define the words. The vocabulary was reviewed and discussed, if there were any questions about a certain word or idea that the students did not understand. The students were encouraged to ask questions and ask for explanations from the teacher about any area they were unsure of on the topics of photosynthesis and genetics. Written notes were also placed on the whiteboard and the students were required to record them in their journals or notebooks. The students were also given end of the section reviews from the textbook in order to enhance their understanding of what they read. The questions were reviewed at the end of the class, and students were again allowed to ask the teacher questions about the chosen topics.

**Integrated Activities: Genetics**

A series of three web-based activities was used in order for the students to be able to work on their own and in pairs (Table 4). Several pre-made sites were used in the design of this activity. The first site, http://nobelprize.org/educational_games/medicine/dna_double_helix/about.html, allowed students to play a game and match base pairs and compete against each other in order to see how many correct base pairs they could make. The more errors the students made, the more mutations they had and the fewer points they could accumulate. This site was used in order to have the students use their knowledge about base pairs, which they gained when reading the introduction to the activity, and apply it to the game situation.

The second site that enabled students to interact with the computers while learning about genetics was http://www.thetech.org/genetics/index.php. This site allowed students to view actual pictures of genetic structures under different magnifications of a microscope. The site also allowed the students to create or design a child and find out what color eyes he/she would have using a program that would determine offspring’s eye colors based on the parents of the offspring. The website offered many different ways in which students could explore the world of genetics and find out how genetics, and the study of genetics, could affect their everyday lives. The site also allowed them to research and learn different ideas and concepts about genetics such as learning about genes and how they affect a person's health and well-being. Students can also learn the basics of genetics, how genes are inherited, genetic testing, ethics, new therapies, genetic inheritance and food engineering.

*Table 4*. Overview and description of activities from genetics websites.

| **Activity Topics Used in Genetics Lesson** | **Description of Activity** |
|---|---|
| Base Pairing | Matching base pairs game |
| Phenotypes/Genotypes | Determining eye color of offspring |
| Blood Type | How to determine blood type |
| DNA Structure | Microscope slides of DNA structures |
| Genetic Inheritance | Determining sex of offspring |
| Modified Foods | How foods are modified for us to eat |
| Punnett Squares | How to use a Punnett square |
| Dominant and Recessive Genes | What are dominant and recessive genes? |
| Mendelian Genetics | Mendel's study |
| Codominance | What is codominance? |

The third and final site that the students used was http://www.cccoe.net/genetics/index.html; this site allowed students to explore genetic topics such as genetics and heredity, Mendel's experiments, dominant and recessive genes, Punnett squares, codominant genes, blood types and heredity. This site was a preferred site due to its user friendliness and availability for a variety of activities. It also allowed students to work at his/her own pace.

**Integrated Activities: Photosynthesis**

The photosynthesis integrated technology activities (Table 5) were intended to make students learn and think independently. As with the genetics activities, the photosynthesis activities involved online activities and video clips. The first site, http://sites.ext.vt.edu/virtualforest/, allowed students to follow a guided website and use simulations in order to better understand the process of photosynthesis and the components involved in carrying out that process. This site was exceptionally well put together and user friendly. The students were excited to work with this web site because it allowed them to choose different topics on plants and photosynthesis in particular. The site guided them through different interactive activities where the students were able to click on different icons to answer questions and at the end of one of the activities; the students actually had to compose their own photosynthesis flow chart. If they were incorrect, they had the opportunity to change the different ingredients until the equation was correct.

*Table 5.* Overview of description activities form photosynthesis websites

| **Activity Topics Used in Photosynthesis Lesson** | **Description of Activity** |
|---|---|
| How plants make food | Written summary of how plants make food |
| Chemical Formula | Interactive chart for composing formula |
| Components Used | Composing flow chart |
| Overview of Photosynthesis | Review of process |

The second site used in the study, http://www.newtonsapple.tv/video.php?id=915, consisted of a brief written summary of photosynthesis and the materials needed in order for photosynthesis to occur. The students were required to read this. On this site, there was also a short video that the students could rewind and play on their own. The students could play back any parts of the video that they did not understand or failed to hear33. This allowed the students to watch the video all over again if necessary. At the end of the activities, the students were verbally quizzed about information regarding what they learned in class.

### Analysis of the Pre- and Post-Tests

Using Hake's (1998) formula, learning gain was calculated for both IT and T methods of teaching. Hake defined learning gain as: learning gain = (post-test score – pre-test score) ÷ (100 – pre-test score). For example, a score of 8 or 80% on a pre-test that consisted of 10 questions combined with a post-test score of 9 or 90% would give a learning gain of 0.5 (0.5 = [90– 80] ÷ [100 – 80]). Thus, the student learned 50% of what could have been learned as measured by the test. If the student had gotten all the answers correct on the post-test, the learning gain would be 1.0. The learning gain metric has a ceiling effect if a student had a perfect score. When this occurred, a score of 99 was recorded for that test. This allowed a learning gain to be calculated instead of having to divide by zero if a 100 was scored on the pre-test.

The effects of three separate variables on learning gain were analyzed: teaching strategy, class size and gender. The Mann-Whitney Test in GraphPad InStat for Windows version 3.1 was used to determine statistical significance. First, the mean learning gain versus class size was compared.

# RESULTS

## Test Scores

The performance of the classes on the pre- and post-tests varied widely, with values ranging from 0 to 100% (Table 6). There were some negative mean learning gains in this study because several students scored higher on the pre-test than on the post-test (Appendix G). This was not a problem unless the student achieves a perfect score on the pre-test and then a much lower score on the post test. For example, one student scored a 100% on the pre-test and then scored 62.5% on the post-test. This brought the student's learning gain to a very low -36.5. This large negative number caused the rest of the positive learning gains to be cancelled out.

*Table 6.* Pre- and post-test results for both photosynthesis and genetics that show range, mean, and standard error.

| Pre- and Post-Test Results | | | | |
|---|---|---|---|---|
| | Photosynthesis | | Genetics | |
| | Pre-Test | Post-Test | Pre-Test | Post-Test |
| Range | 12.5% - 100% | 0.0% - 100% | 11.1% - 100% | 0.0% - 100% |
| Mean | 51.41% | 62.37% | 47.03% | 64.76% |
| Standard Error | 1.987 | 2.030 | 1.726 | 1.920 |

## Mean Learning Gain and Class Size

The learning gains of students taught by the two teaching strategies were compared by class size (Figure 1). The mean learning gain for students in the large genetics classes that used integrated technology ( IT, $0.286 \pm 0.055$) was not different from the mean learning gain of students in small classes that used IT ($0.377 \pm 0.081$, Table 7). The mean learning gain for students in small genetics classes that used traditional teaching methods (T, $0.190 \pm 0.084$) was different from the learning gain of the students in large classes which used T methods ($0.533 \pm 0.051$, Table 7). Students in the smaller classes performed better. The mean learning gain for students in large IT classes in the photosynthesis lessons (-0.958 ± 0.871) did not differ ($P = 0.586$) from the gain of the students in small IT classes (-1.197 ± 1.472). The mean learning gain for students in large traditional classes in the photosynthesis lessons (0 = 0.168, ± 0.084) was not significantly different ($P = 0.312$) from the gains of the students in small T classes (0.286 ± 0.080). The mean learning gain for students in large IT classes in genetics was not different ($P \leq 0.518$) from the gains of students in small IT classes.

*Table 7.* Summary of the comparisons made for the Photosynthesis and Genetics units, Mann-Whitney test values and probabilities (P). T = traditional teaching methodology, IT = using integrated technology as the teaching strategy. Small classes had 15 or fewer students.

| Comparison | Mann-Whitney test | P |
|---|---|---|
| Photosynthesis: Large Class T vs. Small Class T | 270.0 | 0.312 |
| Genetics: Large Class T vs. Small Class T | 108.0 | 0.003 |
| Photosynthesis: Large Class IT vs. Small Class IT | 319.0 | 0.586 |
| Genetics: Large Class IT vs. Small Class IT | 240.5 | 0.518 |
| Large Class T (Photosynthesis) vs. Large Class T (Genetics) | 306.5 | 0.748 |
| Large Class IT (Photosynthesis) vs. Large Class IT (Genetics) | 409.0 | 0.346 |

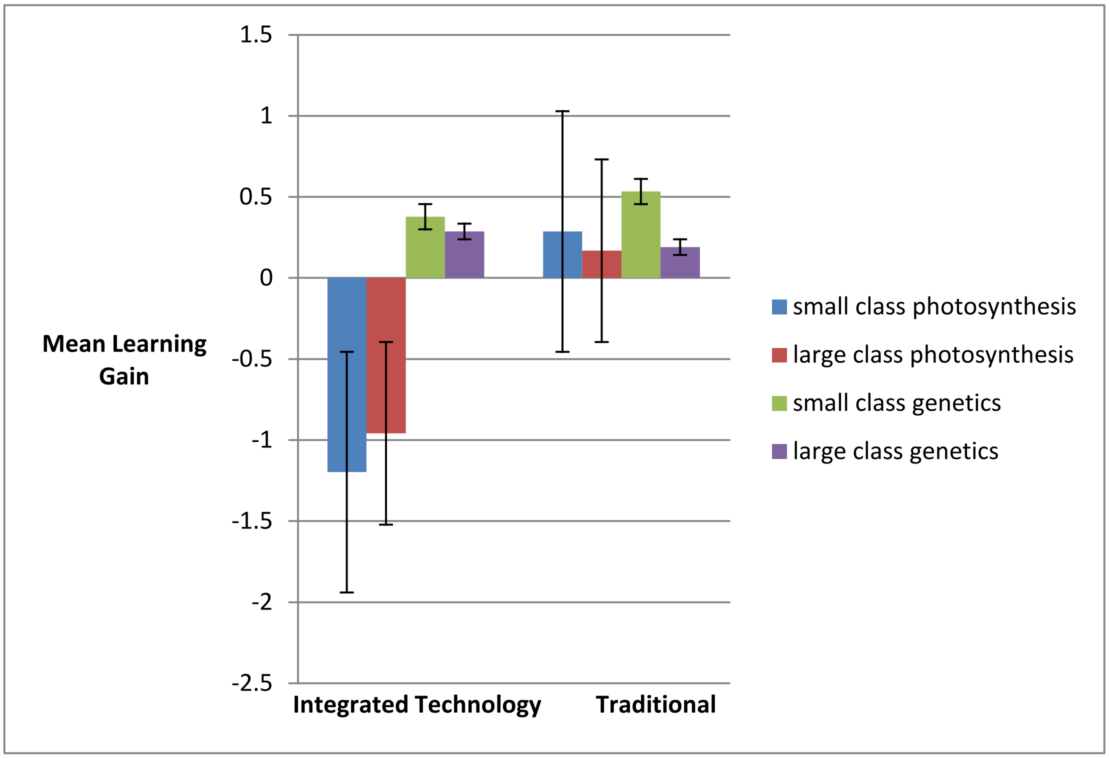


*Figure 1*. Mean learning gain in relation to class size for photosynthesis and genetics lessons using integrated technology (IT) and traditional (T) methods of teaching. For photosynthesis, there was no difference between mean learning gains in small vs large IT classes (P = 0.586) and small vs. large T classes (P = 0.312, n=104). For genetics, there was a difference between mean learning gains in small vs large T classes (P = 0.003, n=94), but there was no difference between mean learning gains in small vs large IT classes (P = 0.518, n = 104). Standard errors are shown.

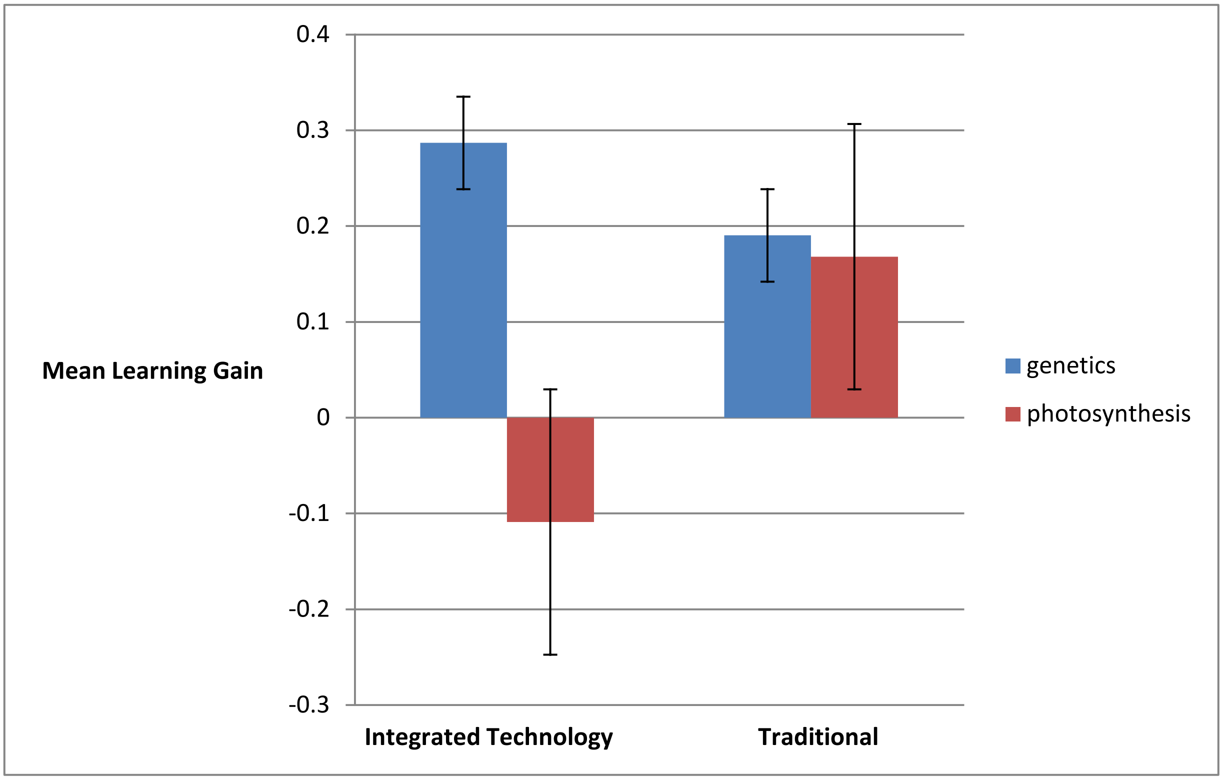


*Figure 2.* Mean learning gain in large classes taught using integrated technology or traditional methods. Standard errors are shown. There is no significant difference between gains using integrated technology in large class lessons on photosynthesis and genetics (P = 0.069, n = 62). There is no difference between traditionally taught large classes lessons on photosynthesis and genetics (P = 0.853, n = 51).

**Mean Learning Gain and Teaching Strategy**

There was no difference in the learning gains of students taught using integrated technology or traditional methods (Figure 3, Table 8). The mean learning gain for students in the genetics lessons classes using IT (0.315 ± 0.046) was not different from the scores of the students in classes using T methods (0.322 ± 0.060). For the photosynthesis lessons, the mean learning gain for students in classes using IT (-1.071 ± 0.824) was not different from the scores of students in classes using T (0 = 0.0230, ± 0.058) methods.

*Table 8.* Results of the Mann-Whitney Test when comparing Photosynthesis and Genetics integrated technology (IT) with traditional (T) methods of teaching. The probabilities (P) are shown.

| Comparison | Mann-Whitney Test | P Value |
|---|---|---|
| Photosynthesis: IT vs. T | 1213.5 | 0.370 |
| Genetics: IT vs. T | 961.0 | 0.293 |

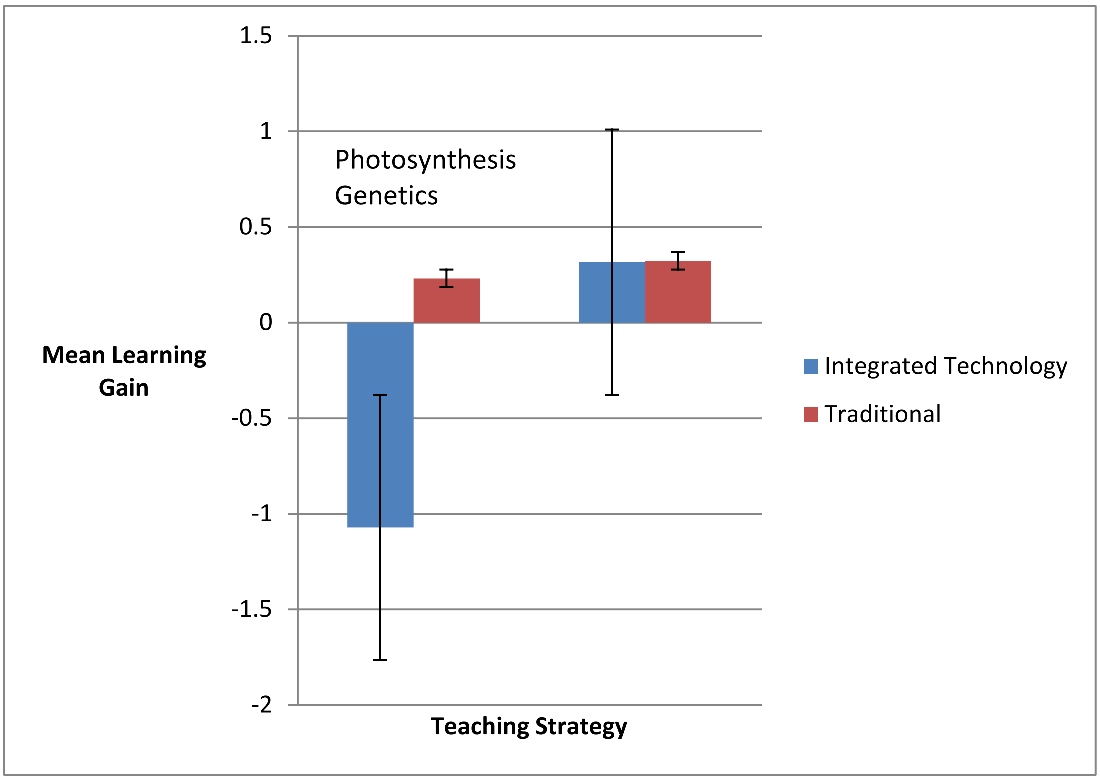


*Figure 3.* Mean learning gain compared by teaching strategy in both genetics and photosynthesis lessons. Integrated technology (IT) and traditional (T) methods of teaching were compared. Standard error is shown. For photosynthesis IT vs. T (P = 0.125, n=104) and genetics IT vs. T (P = 0.924, n=94).

**Mean Learning Gain and Gender**

The effects of gender on learning gain were tested (Table 9, Figure 4). For genetics classes using integrated technology, the mean learning gain did not differ between male (0.290 ± 0.058) and female (0.350 ± 0 .074) students. The mean learning gain in genetics classes using traditional methods did not differ between males (0.297 ± 0.083) or females (0.352 ± 0 .088, Table 9). For the photosynthesis, there were no differences between the sexes in learning gain using integrated technology (male: -0.700 ± 0.809; female: -1.554 ± 1.599) or traditional teaching methods (male: 0.207 ± 0.080; female: 0.263 ± 0.084, Table 9.)

*Table 9.* Comparison of the effects of gender on learning gains in the photosynthesis and genetics in classes taught using traditional methods (T) and integrative technology (IT). Mann-Whitney values and the associated probability levels are given.

| Comparison | Mann-Whitney Test | P Value |
|---|---|---|
| Photosynthesis: Male T vs. Female T | 292.0 | 0.666 |
| Genetics: Male T vs. Female T | 215.0 | 0.563 |
| Photosynthesis: Male IT vs. Female IT | 318.0 | 0.634 |
| Genetics: Male IT vs. Female IT | 301.5 | 0.960 |

Because there was a significant difference between large and small class learning gains using traditional instructional methods for genetics (Table 7, Figure 2) the potential interaction of class size and gender on these learning gains were tested using the non-parametric Kruskal-Wallis test. There were no significant differences identified (P = 0.1263). The difference in learning gain of the large and small classes was not due to gender effects.

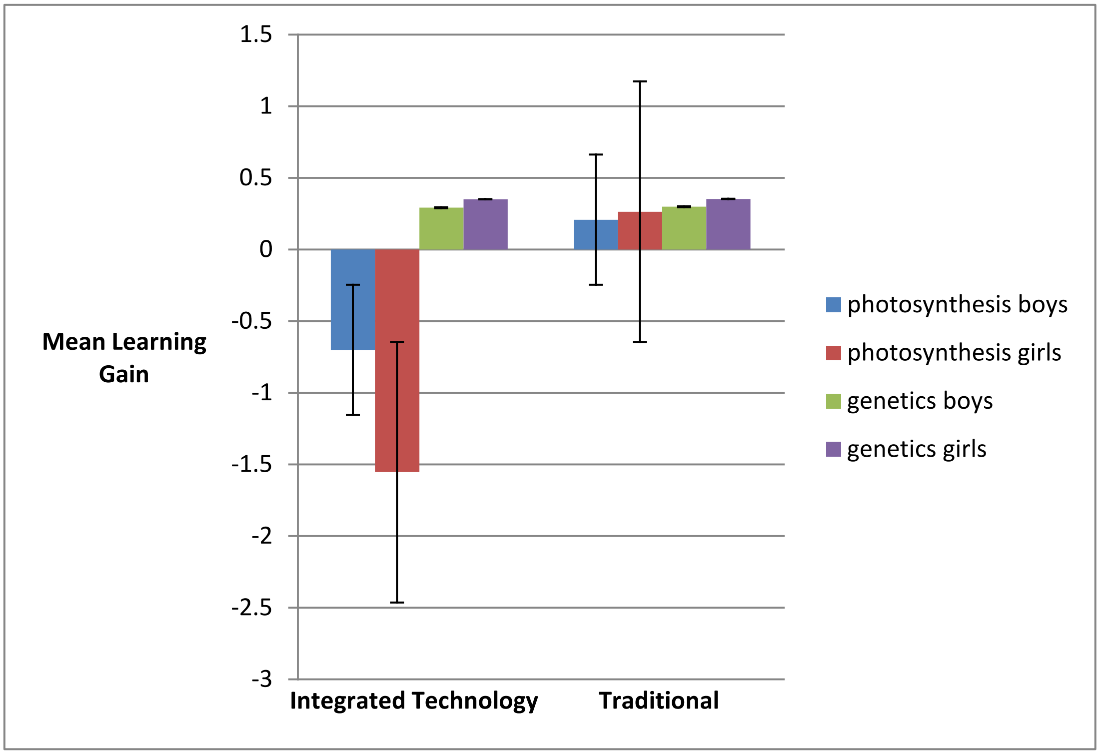


*Figure 4.* Mean learning gain in relation to gender using integrated technology and traditional methods of teaching during photosynthesis and genetics lessons, using standard error. For photosynthesis (P = 0.612 for IT, P = 0.643 for T, n=104) and genetics (P = 0.528 for IT, P = 0.657 for T, n=94).

## DISCUSSION

Computer-based technology is gaining popularity in the classroom. Few studies of the efficacy of this technology in increasing student learning have been undertaken. This study was performed to determine whether integrating technology into the class room affected learner outcomes in a 7th grade life science class. Two topics, which the students find challenging, genetics and photosynthesis, were chosen as the material. A comparison was made of the results obtained using traditional teaching methods and integrated technology. Student learning gains were calculated for each of these two topics using pre- and post-test scores.

For both biology topics, there was no significant difference between the students' learning gains under the two teaching protocols (Figure 3). Integrated technology and traditional teaching methods provided similar results. This was true for students taught in large and small classes (Figure 1) and there were no differences based on gender (Figure 4). Although not statistically significant, IT learning gains for photosynthesis were negative, whereas all of the other learning gains were positive. This could be explained because the photosynthesis concepts were more difficult for the students. The students appeared unsure of how the process of photosynthesis occurred, which resulted in mistakes on the post-test. In the traditionally taught classes, misconceptions were directly addressed in the textbook. Thus, it is imperative to ensure all technology based material is complete and covers all concepts that are to be tested.

The lack of an effect due to the use of technology in the classroom for these two life science topics contrasts with the results of another study which found that students made significant learning gains when participating in computer game-based activities (Tüzün et al., 2009). There are a number of differences between these two studies in terms of the technology used and the topics covered.

It was hypothesized that using integrated technology (IT) would improve learner outcomes in the classroom because it seems that students are more engaged in the learning process when they use computers. The topics of photosynthesis and genetics used for this study are complex and students often have misconceptions about them which may have made mastery of the material more challenging. For example, many people believe that plants get their mass from the soil, nutrients and even water they gather from the ground. While this is incorrect, an average seventh grader believes it to be correct. In genetics, one misconception is that blue-eyed parents cannot have brown-eyed children. This is also incorrect but again, the average seventh grader is misinformed. In order to correct those misconceptions, students must be presented the information in a new, effective and exciting way. It would seem that computer-based instruction could accomplish this. However, at least over the week-long time frame that these topics were covered, integrated technology did not improve students' mastery. These computer-based lessons were the first introduction of the students to the use of integrated technology in the life sciences class. It may be that the novelty and the short exposure four-day lessons on each of the two topics did not provide a fair test of the strategy of using technology in the classroom.

The effect of class size on learning gains was examined because the common perception is that the size of the classes might have a direct influence on learning gains. It is thought that teachers would have a harder time directing a large class in an online activity and that smaller class sizes would have a greater effect on the learning gain outcomes. Class size had little or no impact on the outcomes of the mean learning gain except in the comparison of the large class with small class sizes in genetics (Figure 1). Because this unit involved problem solving, the smaller classes received more attention and this may have yielded higher scores.

Other studies have examined the effects of class size on learning. Ainscough et al. (2001) used an analysis of covariance (ANCOVA) to test the impact of class size on student test scores in a multimedia based course setting. There was no difference in test scores between students enrolled in large classes and students in small classes. Kennedy and Siegfried (1997) concluded that larger class size does not reduce learning.

While the present study does not demonstrate a significant difference in learning gains, the utility of incorporating integrated technology into lessons is an open question. In an article by Bower (1998, as cited in Kotrlik et al., 2000, p 65), the author states: "Is computer based instruction popular with students and educators? Yes. Does it improve student performance? Maybe. Is it worth the cost? Probably. Must we continue to explore this innovative pathway to education? Definitely." Computer based instruction, while not always showing a measureable difference in learner outcomes compared to traditional methods of teaching, is the future of education because both students and teacher embrace this method.

It was noted that the students in this study were active in participating in the online activities. The student engagement was more than usual, and students were thoroughly enjoying themselves. One student stated that, "This was the most fun activity we have done all year." If students are having fun in the classroom and learning at the same time, both the student and the teacher benefit. Although the activities in this instance made no difference in the students' learning gain, it did seem to engage them more and allow them to have fun that they may not have had using traditional teaching methods. Such engagement by the students may affect other aspects of the educational experience not measured in this study, such as attendance, particularly when the integrated technology is employed routinely throughout the school year.

Thus, it may be that integrating technology in the classroom should be the preferred teaching style. Although not every activity will have the same "wow" effect, incorporating technology does show the students that the teacher is willing to be innovative.

While there was no increase in learning gains using integrated technology this could be due to the novel nature of this activity. The students were used to a routine of guided notes, an occasional video, a laboratory activity and then a test or a quiz. These novel activities were not a part of the normal routine in that classroom and it could have affected the students' overall attention to the material.

This study consisted of only eight days of activities and it may be possible to increase learning gains over a longer period of time. If this study were done over the whole year or even a whole semester, it would have allowed students to master the routine of the class and the technology. Also, because of student interest, these activities might encourage better attendance through the school year.

There is a great amount of variability among the students in terms of ability and motivation. Some do not take activities or any other novel types of class work seriously. Some students in this study simply rushed through tests to finish in a hurry. Such behavior would make it difficult to detect learning gains.

The learning gain calculation measures how a student, or group of students, does when given a pre-test and a post-test. These tests, as measures of learning, are valid only when students do better on the post-tests and when testing large numbers of students. This study had a limited number of participants, and thus student behavior and mood may affect the measure of learning gain.

The role of gender in education has become a topic of interest (Smith, 1996). One objective of the present study was to test whether there was a difference between boys' and girls' learning gains when using integrated technology or traditional methods of teaching. There was no difference in the learning gain due to gender (Figure 4, Table 9).

Other studies have reported similar results. When science grades and ability in middle school were reviewed, girls perform equally well, or even better, than boys (Catsambis, 1995). Kahle et al. (1993) found that boys, on average, were more interested in science associated with matter and energy, whereas girls were more interested in science associated with plants and animals. Such gender differences in interest were not apparent in the present study using genetics and photosynthesis as the topics.

Although in this study there were no differences in learning gains due to the use of integrated technology in the classroom, it should be noted that the technology does not detract from learning. Routine use of technology in the classroom throughout the school year may enhance student performance through a variety of means. It may enhance student understanding and engagement, stimulate curiosity and encourage class attendance. Clearly, the impact of technology in the classroom needs more extensive study. Such studies should focus on learning gains, but also on other parameters such as student engagement and attendance.

## SUMMARY AND CONCLUSION

This study tested teaching strategies using integrated technology and traditional methods to determine if they had an effect on learning gain in the topics of photosynthesis and genetics. The results suggested the integrated technology had little or no effect on learner outcomes. There were no significant differences between mean learning gain and the different variables; class size (Figure 1, Table 7) except in large vs. small classes in photosynthesis (Figure 1), gender (Figure 4, Table 9) and teaching styles (Figure 3, Table 8). Although there were no differences in learning gain due to the use of integrated technology in the classroom, technology was shown to not detract from learning. Students were engaged and had fun participating in this study while using technology, which may encourage student engagement, stimulate curiosity, increase attendance and create an overall positive classroom environment. The results of this study should encourage teachers to transition to a technology-centered classroom in order to create an improved, innovative, and exciting learning environment for all students.

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**APPENDIX A**
**PHOTOSYNTHESIS PRE-TEST**

1. The substance that makes plants green is known as:
   a. Chloroplasts
   b. Calcium
   c. Chlorophyll
   d. Carbon dioxide

2. What process makes food, or sugars, for plants?
   a. Reproduction
   b. Respiration
   c. Condensation
   d. Photosynthesis

3. When plants undergo photosynthesis, they produce:
   a. Carbon dioxide
   b. Oxygen
   c. Hydrogen
   d. Nitrogen

4. In plant cells, chloroplasts:
   a. Enable plant cells to produce their own food(sugar)
   b. Act as the cell's control center
   c. Allow materials to move into and out of the cell
   d. Support and protect the cell

5. If you planted a tree in a bucket that had 5 pounds of dirt in it and the tree grew or increased its size by 5 feet in height in one year, about how much dirt would be left in the bucket?
   a. 0.5 pounds
   b. 2.5 pounds
   c. 5.0 pounds
   d. 10.0 pounds

6. Complete the formula for photosynthesis:
   6 molecules of H2O + 6 molecules of CO2 → 1 molecule of glucose + 6 _______.
   a. Molecules of oxygen
   b. Molecules of carbon
   c. Molecules of hydroxide
   d. Molecules of water

7. Using the equation above, how are plants and photosynthesis beneficial to humans?

a. They supply us with water
b. They supply us with oxygen
c. They get rid of waste water
d. They make carbon dioxide

8. What would be the effects to the world if photosynthesis stopped?
   a. the atmosphere would be depleted of oxygen
   b. most animals would become extinct
   c. most plants would become extinct
   d. only a and b
   e. all of the above

## APPENDIX B
## GENETICS PRE-TEST

1. Factors that control traits you inherit, such as blood-type or eye color are called:
   a. Genes
   b. Dominant
   c. Recessives
   d. Chromosomes

2. What is a mutation?
   a. Any change that is harmful to an organism
   b. Any change in a gene or chromosome
   c. Any change that is helpful to an organism
   d. Any change in the phenotype of a cell

3. What does it mean when a scientist speaks of a dominant trait?
   a. It is a trait that is good
   b. It is a trait that is bad
   c. A trait that will be expressed in offspring
   d. A trait that will be expressed then hidden in offspring

4. What does it mean when a scientist speaks of a recessive trait?
   a. It is a trait that is good
   b. It is a trait that is bad
   c. A trait that will not be expressed in offspring
   d. A trait that will be expressed then hidden in offspring

5. If a great white shark that had a gene for a huge mouth with many rows of teeth mated with another great white shark that had a gene for a small mouth with few rows of teeth and all of their offspring had small mouths with few rows of teeth, what gene would be dominant?
   a. Huge mouth with many rows of teeth
   b. Small mouth with few rows of teeth
   c. Neither is dominant
   d. Both are dominant

6. Where do your genes come from?
   a. Parents
   b. Siblings
   c. Uncles
   d. Cousins

7. Which combination of sex chromosomes results in a male human being?
    a. YY
    b. XX
    c. XY
    d. None of the above

8. If the chromosome configuration for a female elephant is WW and the chromosome configuration for a male elephant is WZ, which is responsible for deciding the sex of a baby elephant?

a. male
b. female
c. baby elephant
d. both the male and female

9. Mendel studied almost 30,000 pea plants, thereby increasing _______________:

a. the chances of seeing a repeatable pattern
b. the height of the short pea plants
c. the number of genes controlling plant height
d. none of the above

## APPENDIX C
## PHOTOSYNTHESIS POST-TEST

1. The substance that makes plants green is known as:
   e. Chloroplasts
   f. Calcium
   g. Chlorophyll
   h. Carbon dioxide

2. What process makes food, or sugars, for plants?
   e. Reproduction
   f. Respiration
   g. Condensation
   h. Photosynthesis

3. When plants undergo photosynthesis, they produce:
   e. Carbon dioxide
   f. Oxygen
   g. Hydrogen
   h. Nitrogen

4. In plant cells, chloroplasts:
   e. Enable plant cells to produce their own food(sugar)
   f. Act as the cell's control center
   g. Allow materials to move into and out of the cell
   h. Support and protect the cell

5. If you planted a tree in a bucket that had 5 pounds of dirt in it and the tree grew or increased its size by 5 feet in height in one year, about how much dirt would be left in the bucket?
   e. 0.5 pounds
   f. 2.5 pounds
   g. 5.0 pounds
   h. 10.0 pounds

6. Complete the formula for photosynthesis:
   6 molecules of H2O + 6 molecules of CO2 → 1 molecule of glucose + 6 _______.
   e. Molecules of oxygen
   f. Molecules of carbon
   g. Molecules of hydroxide
   h. Molecules of water

7. Using the equation above, how are plants and photosynthesis beneficial to humans?
   e. They supply us with water
   f. They supply us with oxygen
   g. They get rid of waste water
   h. They make carbon dioxide

8. What would be the effects to the world if photosynthesis stopped?
   a. the atmosphere would be depleted of oxygen
   b. most animals would become extinct
   c. most plants would become extinct
   d. only a and b
   e. all of the above

## APPENDIX D
## GENETICS POST-TEST

1. Factors that control traits you inherit, such as blood-type or eye color are called:
   e. Genes
   f. Dominant
   g. Recessives
   h. Chromosomes

2. What is a mutation?
   e. Any change that is harmful to an organism
   f. Any change in a gene or chromosome
   g. Any change that is helpful to an organism
   h. Any change in the phenotype of a cell

3. What does it mean when a scientist speaks of a dominant trait?
   e. It is a trait that is good
   f. It is a trait that is bad
   g. A trait that will be expressed in offspring
   h. A trait that will be expressed then hidden in offspring

4. What does it mean when a scientist speaks of a recessive trait?
   e. It is a trait that is good
   f. It is a trait that is bad
   g. A trait that will not be expressed in offspring
   h. A trait that will be expressed then hidden in offspring

5. If a great white shark that had a gene for a huge mouth with many rows of teeth mated with another great white shark that had a gene for a small mouth with few rows of teeth and all of their offspring had small mouths with few rows of teeth, what gene would be dominant?
   e. Huge mouth with many rows of teeth
   f. Small mouth with few rows of teeth
   g. Neither is dominant
   h. Both are dominant

6. Where do your genes come from?
   e. Parents
   f. Siblings
   g. Uncles
   h. Cousins

7. Which combination of sex chromosomes results in a male human being?
    e. YY
    f. XX
    g. XY
    h. None of the above

8. If the chromosome configuration for a female elephant is WW and the chromosome configuration for a male elephant is WZ, which is responsible for deciding the sex of a baby elephant?

e. male
f. female
g. baby elephant
h. both the male and female

9. Mendel studied almost 30,000 pea plants, thereby increasing _______________:

e. the chances of seeing a repeatable pattern
f. the height of the short pea plants
g. the number of genes controlling plant height
h. none of the above

## APPENDIX E
## PARENTAL PERMISSION FORM

**Project Title**: Evaluation of integrated technology on learner outcomes
**Performance Site**: Woodlawn Middle School
**Investigators**: The following investigator is available for questions,
Mr. Adam Barrett (225)751-0436
Woodlawn Middle School
**Purpose of Study**: The purpose of this project is to determine if integrated technology affects learner outcomes.

**Description of the Study**: Students will participate in using online learning sites as well as regular classroom activities during a period of time during several units. I will be using pre-test and post-test scores from the students in order to determine learning gain among students who use online activities compared to those who perform "normal" classroom activities. The scores will be used to determine if integrated technology affects the learner's outcomes.

**Benefits**: All students will have the opportunity to earn bonus points for taking the pre-test and post-test for these lessons. The study is designed to evaluate the effectiveness of integrated technology.

**Risks**: The research is not expected to cause any harm or discomfort.

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

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

**Signatures**: I will allow my child to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.
**Parent's Signature**: ________________________________
Date: ____________________

Institutional Review Board Dr. Robert Mathews, Chair 203 B-1 David Boyd Hall Baton Rouge, LA 70803 P: 225.578.8692 F: 225.578.6792 irb@lsu.edu | lsu.edu/irb

**APPENDIX F**
**INSTRUCTIONS FOR LEARNING GAIN SCORES**

Sample Learning Gain Scores Calculation. Retrieved June 14, 2009, from www.emporia.edu/teach/tws/documents/GainScores.doc

When an individual student has scored higher on their post-test than they did on their pre-test (which is the common case), use the first formula given below to determine their individual gain score. When a student scores lower on their post-test than they did on their pre-test, use the second formula given below to calculate their individual gain score. Once every student's gain score has been figured, calculate the average gain scores for the class.

**Formula for positive gain (i.e., when an individual student scores higher on their post-test than on their pre-test):**

$$\frac{\text{(Post-assessment - Pre-assessment)}}{\text{(100\% - Pre-assessment)}}$$

Where: pre-assessment is the **percent correct** on pre-unit assessment
post-assessment is the **percent correct** on the post unit assessment

Ex. for student #1 below: $\frac{70 - 45}{100 - 45} = \frac{25}{55} = .45$ Student #1 demonstrated a gain of 25 percentage points out of a potential 55 percentage points that they could have gained. Thus, they gained .45 ( or 45%) of the possible percentage points they could have gained from pre- to post-assessment.

**Formula for negative gain (i.e., when an individual student scores higher on their pre-test than on the post test):**

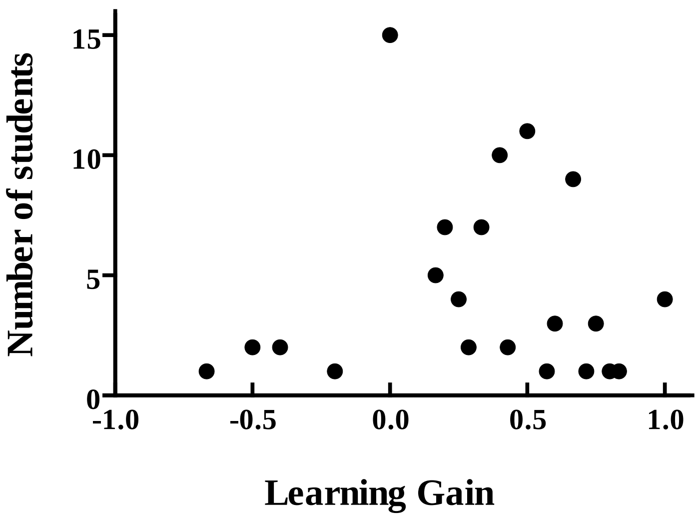
Ex for student #2 below: $\frac{50 - 75}{100 - 75} = \frac{-25}{25} = -1.00$ Student #2 could have gained up to 25 percentage points, but instead lost 25 percentage points (or 100% of what they could have gained.)

| Student # | Pre Assessment Score | Post Assessment Score | Student Gain Score |
|---|---|---|---|
| 1 | 45% | 70% | .45 |
| 2 | 75% | 50% | -1.00 |
| 3 | 60% | 80% | .50 |
| 4 | 40% | 40% | .00 |
| 5 | 65% | 70% | .14 |
| 6 | 90% | 95% | .50 |
| 7 | 53% | 59% | .13 |
| 8 | 60% | 90% | .75 |
| 9 | 40% | 95% | .92 |
| 10 | 42% | 45% | .05 |
| 11 | 58% | 88% | .71 |
| 12 | 24% | 30% | .08 |
| 13 | 45% | 89% | .80 |
| TOTAL AVERAGE GAIN SCORE | | | .31 (or 31% learning gain for entire class on average) |

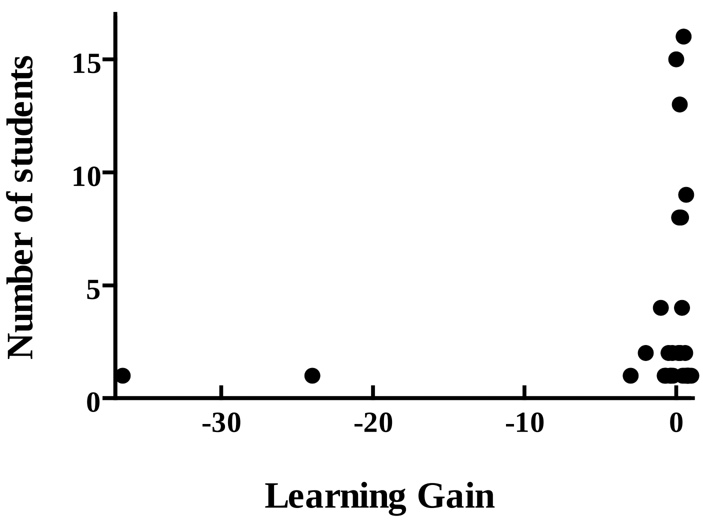
The test scores above are percentage correct.

* There is one exception to calculating *gain score*s that does not fit the above calculations. If a student scores 100% on the *pre-assessment*, record 99 for the *pre-assessment* score. **And** if the same student scores a 100 on the *post-assessment*, enter a 99 for the *post-assessment* score.

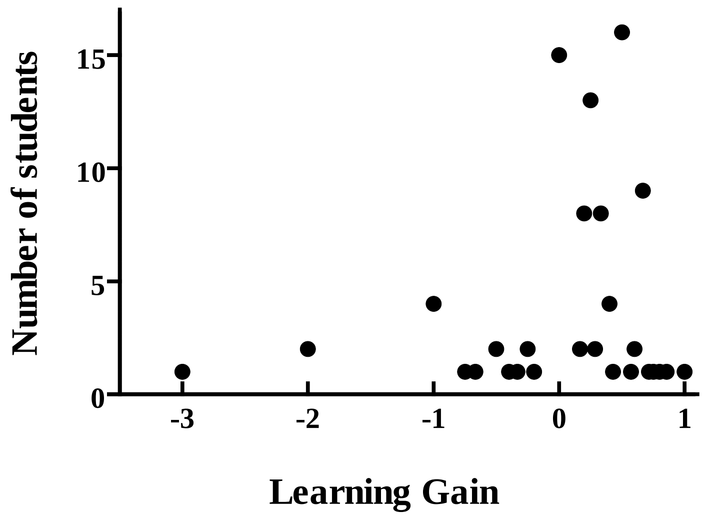
## APPENDIX G
## DISTRIBUTION OF LEARNING GAINS




Distribution of learning gains for all students completing the genetics topic.




Distribution of learning gains for all students completing the photosynthesis topic.




Distribution of learning gains for all students completing the photosynthesis topic, excluding the two large negative learning gains.

## VITA

Adam R. Barrett was born in Bay St. Louis, Mississippi in June 1983. He attended elementary school in Waveland, Mississippi and middle school in Slidell, Louisiana. He graduated with honors from Bay High School in Bay St. Louis, Mississippi in May 2002. The following August he entered Louisiana State University Agricultural and Mechanical College and in May 2007 earned the degree of Bachelor of Science. He entered Louisiana State University Agricultural and Mechanical College in June 2007 and is a candidate for the Master of Natural Science. He is currently teaching at Woodlawn Middle School in Baton Rouge, Louisiana.