THE EFFECT OF ADDING A COMBINATION OF INTERACTIVE ONLINE AND HANDS-ON ACTIVITIES ON HIGH SCHOOL BIOLOGY IN A BLENDED VIRTUAL ENVIRONMENT

by

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Kelly Marie Arnold

July 2013

DEDICATION

For Keith, without whom I would be lost and this project would never have been completed. Your unending support and your service to this country have made this possible.

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ABSTRACT

This paper discusses the effects of adding a combination of interactive online and hands-on activities on high school biology students in a blended, virtual-learning environment. The project was designed to determine if credit-deficient students in a self-paced, online biology course would learn more and become more engaged learners if active learning opportunities were added to the normal online program. Students in these courses normally receive only passive instruction and occasional tutoring when requested.

The students involved in the study were enrolled in the Virtual High School program in Clarksville-Montgomery County, Tennessee for the 2012-13 school year for the purpose of catching up to the required 22 credits necessary for on-time graduation. Each of these students was considered credit deficient to the point of not completing the graduation requirements before being dropped at the end of their fourth year of high school, as per district policy. Student learning using the traditional online program was compared to student learning using the online program combined with both interactive online activities and hands-on, small-group activities. Results indicated that student understanding was increased, but there was little effect on long-term memory. Data also indicated a negative impact on both teacher and student attitude and motivation due to the increased structure and time requirement for the additional activities.

INTRODUCTION AND BACKGROUND

The Virtual High School (VHS) in the Clarksville-Montgomery County School System (CMCSS) is one of the many tools used to support the district goal of 100% graduation. VHS is not a separate school, but a satellite program serving CMCSS's seven constituent high schools. Most students recommended for the program are credit deficient and will not graduate on time without intervention. Tennessee schools only allow a four year window of opportunity to complete the 22 credits necessary for graduation. A few students are nearing age 18 and have expressed an intention to drop out.

Credit deficiency or lack of interest in school has developed in these students for a variety of reasons including disciplinary issues, personal trauma, pregnancy or lack of childcare, illness (diabetes, cystic fibrosis, cancer), psychological issues (depression, anxiety, suicidal), homelessness, working full-time while going to school, and general truancy. VHS provides a solution by reducing the attendance requirement and providing an accelerated path to completion. The flexibility of the VHS environment provides the means for these students to complete the requirements for graduation rather than becoming permanently expelled or simply dropping out. In some cases, the attendance requirement is waived and students are allowed to work strictly from home. It also provides a safe, continually supervised environment, and employs instructors which express a sincere interest in the progress and well-being of the students.

This VHS program is considered a blended virtual environment because it includes a combination of web-based instruction with the opportunity for physical attendance. Most students are required to physically attend school at the VHS facility four times per week and must complete four hours or 10 mastery lessons per attendance session. Hours are extended beyond the normal 7:30 a.m. to 2:30 p.m. school day to 7:00 a.m. to 4:00 p.m., allowing flexibility to accommodate each student's schedule and circumstances. Students are free to attend at their leisure as long as they meet the requirements. Unfortunately, attendance cannot be enforced on students who are already 18 and have never entered the judicial system for truancy. The program has a high rate of success and most VHS students, approximately 99%, graduate on time.

A one semester course contains 15-25 lessons. For each lesson, students are required to spend a minimum of five minutes reading and taking notes in a textbook-like study, complete a 10-question practice test, and then a 10-question mastery test. Some students are either insincere or immature and do not comply with the requirements as directed. For example, in some cases, students repeat the practice tests multiple times, randomly guessing until they obtain the minimum score of 80%. A few students are hesitant to even attempt practice or mastery tests without the assistance of a teacher or tutor and record very few notes of any sort.

Changes in the program were needed to encourage students to become more engaged and independent learners to improve student learning. Although the VHS already operated under the definition of a blended virtual-learning environment by requiring physical attendance, the web-based assignments involved noninteractive reading and answering multiple choice or fill-in-the-blank questions with a very low cognitive skill level. The purpose of this project was to attempt to increase student engagement and learning in high school biology by blending this instructional model with additional interactive web-based learning and onsite, small group activities which required students to be more actively involved in the learning process.

To increase student engagement in the learning and understanding of high school biology, I considered the following focus question: What are the effects of adding a combination of interactive online activities and hands-on activities on students' understanding of high school biology in a blended, virtual-learning environment? The following subquestions were also considered: What are the effects of adding a combination of interactive online activities and hands-on activities on students' long-term memory of high school biology concepts, students' motivation and attitudes, and the teacher's attitude and motivation? The online activities required more active student participation than the normal VHS online curriculum which allowed students to be very passive learners. The small group, hands-on activities included simple, teacher devised activities which were completed onsite by participating students. Students were provided with verbal and printed instruction sheets to guide their participation in the activities.

The VHS program is constantly growing and evolving based on the availability of resources and the needs of students. Changes made to the curriculum have a direct impact on both the students taking the courses and the teachers responsible for supporting student success. Any changes that further student learning and/or improve the motivation of students to truly engage in learning will be well-received by both parents and administrators. If interactive online labs and hands-on, small group activities are beneficial to students, then these types of activities could also be incorporated into the other VHS science courses. However, if the activities do not have a positive impact on student learning or are found to detract from the motivation and attitudes of VHS students and/or teachers, then a different approach will be needed to increase student learning and engagement.

During this project, I depended on the support and assistance of a team of friends, colleagues, and advisors. My husband, Keith Arnold, who is a JROTC instructor at one of the district's high schools, helped me maintain my sanity and provided support through the many scheduling difficulties. My colleagues in the VHS program, Betty Poff (math) and Ted Hausauer (social sciences and special education), provided advice, support, and encouragement to work on the additional assignments being considered for implementation; Brenda Carnell (English) who is often referred to as "our English guru," enthusiastically provided her skill with editing and wording suggestions; Arthur Schultz (math tutor) provided a view from an additional perspective as the parent of a former VHS student; and Dr. Kim Sigears, the administrator over the VHS program whose dedication and effort to help students overcome the obstacles to graduation is admirable. Additional advisors for my project included members of the Montana State University faculty, Dr. Jewel Reuter (MSSE faculty) as my project advisor, Dr. Christian Bahn (Department of Chemistry) as my science content reader, and Diane Paterson as the MSSE program coordinator.

CONCEPTUAL FRAMEWORK

The articles in this literature review supported the addition of interactive online and onsite, hands-on activities to the current VHS program, because these changes would not only increase student understanding and long-term memory, but they would also improve student and teacher motivation and attitude as a result of more positive teacher-student and student-student interactions. A study by Roblyer (2006) presented the practices which tend to make online schools successful. One recommendation was that courses should be designed to contain interactive activities to encourage student involvement, not just time in front of the computer. A common theme in these studies is the increased teacher-student interaction and student engagement in interactive, rather than passive learning. This project considered the effects of making such changes to the VHS high school biology course which had previously involved mostly spending time in front of the computer which required very little action or thought on the part of the students.

Kiboss, Ndirangu, and Wekesa (2004) examined the use of computer-mediated simulations (CMS) on learning outcomes in biology. The animated CMS was designed to make cell division graphics more interesting and easier to comprehend. Three groups of secondary students were randomly selected and compared using the Solomon-Three group design analysis method, in which not all groups receive the same assessments or treatment. Only two out of the three groups were given preunit assessments, but only one of the preassessed groups received the treatment along with the nonpreassessed group. Postunit test scores were used to compare the effects of the CMS on all three groups. The treatment consisted of a CMS lesson addressing cell division along with a printed manual assigned to groups of five students each. Scores for both treatment groups were much higher than those of the nontreatment group indicating that the computer simulations had a positive effect on student understanding of cell division. The treatment groups were exposed to teacher-led instruction, web-based instruction, and small group interaction. A blending of instructional techniques should also help VHS students develop a deeper understanding of biology concepts more than the current VHS method which is primarily web-based instruction alone.

Hannafin and Foshay (2008) examined the role of computer-based instruction (CBI) in the improvement of test scores for students identified at-risk for failing the state Algebra I competency. Student participants were sophomores enrolled in a remediation program after receiving near or below passing scores on the state's eighth-grade math exam. The program included a CBI component four days per week and one day of teacher-led instruction on study and test-taking skills. Test scores on the states Algebra I competency were higher for those students who participated in the remediation as compared to those of students who did not participate, indicating a greater retention of algebra concepts. Because the CBI component was not tested independently, the authors of the study attribute the success in improving test scores to the district's overall remediation process, a combination of CBI and face-to-face tutoring in a blended environment. Although the current VHS program is blended with face-to-face instruction, the primary focus remains on the online instruction. According to this research, shifting the focus to a more blended approach including more organized face-to-face sessions, rather than simply providing tutoring for specific questions, would benefit students' long-term memory.

In a study conducted by Riffell and Sibley (2005), a blended undergraduate biology course was offered along with the same course in the traditional, face-to-face manner. Both courses covered the same material, were taught by the same instructor, and contained the same active, face-to-face, teacher-led learning experiences. Students in the traditional course were required to attend lectures twice weekly. The students in the hybrid course instead participated in online assignments in place of the lectures using textbooks to assist them in answering the questions. The studied showed increased retention of concepts for those students participating in the hybrid version of the course, with average scores being a full letter score higher than their traditional class counterparts. Although this study is the reverse of this project, which added online assignments to an already established set of active learning experiences, combining the two activities by adding interactive online and hands-on learning experiences to the noninteractive online instruction should still produce similar results and thus increase long-term memory of biology concepts.

Paechter and Maier (2010) found that students benefitted most from blended learning when the information portion was distributed online, but face-to-face opportunities were available when application of this learning is needed. Face-to-face encounters included both teacher-student interactions as well as student-student interactions. The blending of learning environments increased student satisfaction with their online learning experiences when the appropriate learning situations were addressed by the preferred means. Students in 29 Austrian universities volunteered to complete questionnaires to determine these preferences and attitudes toward the use of online learning or face-to-face learning on various learning activities. Students in VHS show a similar preference for assistance when application of knowledge is required rather than memorization of concepts. Face-to-face teaching opportunities could be presented through small group activities at the VHS facility to accommodate this learning preference and thus would improve the satisfaction and attitudes of VHS students.

Pyatt and Sims (2012) explored the instructional value of labs completed in physical and virtual labs based on student attitudes in an Advanced Placement (AP) Chemistry course. Although virtual labs were slightly favored in the study according to student surveys, the benefits of hands-on learning, whether in the virtual or physical setting, were more associated with the interactive manipulation of the equipment. Student attitudes were positive toward both methods of lab activity. Although not explicitly stated, it is assumed that students worked in small groups to complete the labs. Students in the VHS program complete all online activities independently. The addition of small group, hands-on activities would provide opportunities for students to experience this type of interactive learning and provide student-to-student interactions, both of which should improve overall student attitude.

Richardson and Newby (2006) studied the "cognitive engagement" of college students with their online courses through the comparison of demographic data and testing of the learning approaches and motivation of student volunteers. Data were collected using an online survey from two groups of students, one group enrolled in an engineering program, the other in education. Younger students were found to be more likely to engage in "Surface Strategy" and "Surface Motive" techniques than older students enrolled in same online courses. Surface strategy is described as putting forth the minimum effort to pass. Surface motive is described as memorizing only the necessary facts long enough to pass a test. These characteristics have been observed in the CMCSS VHS students. Suggestions for increasing the engagement of these younger students include training students to use the resources and apply new learning methods while using the online program and improving general learning skills. This can be accomplished in the VHS program by helping them to identify the benefits of more engaged learning through participation in hands-on learning and completion of interactive online assignments.

Hawkins, Barbour, and Graham (2011) interviewed teachers in a completely online VHS program. Interactions between students and teachers were found to be reactive, rather than proactive and mainly for the purpose of answering specific student questions or providing feedback on assignments. The lack of teacher-student interaction beyond those of instructional nature detracted from teacher attitude and motivation. Although the current VHS program requires student attendance, student-teacher interaction occurs in a similar manner, with students requesting help when needed. The study suggests implementation of more proactive interactions could improve the attitudes and motivations of both teachers and students. This can be partly accomplished in the CMCSS VHS program through teacher-mediated small group activities.

The articles suggest that student participation in either interactive online activities or small group, hands-on activities improves understanding and long-term memory of biology concepts. The increased interaction improves student engagement resulting in improved student motivation and attitude. Positive, proactive interactions also positively affect teacher attitude. Combining small group, hands-on activities and interactive online activities could provide increased opportunities for students to discuss biology concepts with other students, allow the teacher to provide immediate, specific feedback to clarify concepts or encourage further student inquiry, and provide a more engaging online experience.

METHODOLOGY

Students participating in this project were taking a first semester high school biology course for a new credit or repeating the credit due to failure or noncredit status as a result of excessive absences. Those students who are receiving a new credit in biology were also required to take the state biology end-of-course exam in the spring following course completion. The current VHS format employs a readable online study followed by mostly multiple choice practice and mastery tests. The only interactivity involves occasional questions embedded in the studies which provide corrective explanations when answered incorrectly.

Project Treatment

This project was conducted over seven weeks and included two treatment units and one nontreatment unit. The nontreatment unit covered cell organelles and the cell theory using the standard VHS format with online lessons delivered through the APlus, *A+nyWhere Learning System*® (American Education Corp., 2008). Treatment unit 1 covered mitosis and meiosis, and treatment unit 2 covered Mendelian genetics. Both treatment and nontreatment units included a preassessment, the standard VHS online lesson format with five online lessons, student surveys, postassessment, and individual interviews of selected students. The treatment units also included small-group, hands-on activities and a variety of interactive online activities made available to students through links posted on an Edmodo (2008) site, a free social networking site specifically designed for educational purposes. The research methodology for this project received an exemption by Montana State University's Institutional Review Board, and compliance for working with human subjects was maintained. The following provides a description of the activities for each unit.

<u>Nontreatment Unit: Cell Organelles and the Cell Theory</u>

Instructional content for the nontreatment unit addressed cell organelles and the cell theory. Unit materials were available through the current VHS APlus (2008) program and included online lesson titles (a) *Cells and Cell Theory, (b) Types of Cells, (c) Cell Structure and Function, (d) Cells at Work, and (e) Energy and Cells*. Each lesson was divided into 20 to 25 short, slide-like pages. In most cases, interactivity was limited to clicking the arrows to advance to the next page. In a few instances, there are questions which must be responded to before the student can advance. Figure 1 presents an example of an APlus (2008) lesson page.

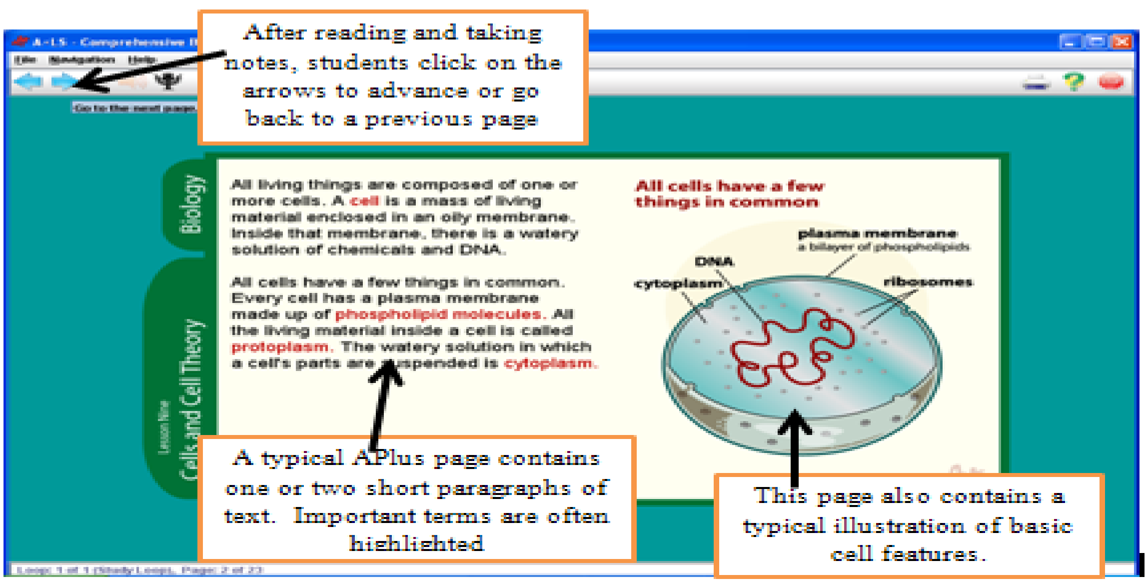

Figure 1. Example of APlus page with the directions that they receive to do the assignment.

Students were asked to work on the nontreatment APlus (2008) lessons during a one week time frame. Although off-site work was allowed, most student work was completed onsite. To receive credit for the APlus (2008) lesson, students were instructed to follow the normal guidelines for VHS courses: take notes while reading the online, textbook-like study for a minimum of five minutes, repeat a practice test as many times as necessary to score at least 80%, and then complete a mastery test with a score of at least 80% with a maximum of three attempts. If an 80% score was not obtained by the third try, the student would inform the teacher to have the lesson manually mastered with the lower score or unlocked for further attempts. Although students are required to have notes for each section, no specific guidelines were provided. During the nontreatment unit, the teacher acted in a tutorial role by answering questions, providing feedback, and providing additional information as requested by students. Teacher-student interactions were mostly student initiated, occurring when a student asked a direct question or teacher observation revealed a need for assistance.

Treatment Unit 1: Cell division (Mitosis and Meiosis)

Instructional content for treatment unit 1 covered mitosis and meiosis and contained materials available through the current VHS APlus (2008) materials with online lessons titled (a) *Cell processes, (b) Cells: Mitosis, (c) Cells: Meiosis, (d) Cell division and (e) Reproduction and development*. Students were asked to complete all of the APlus (2008) sections within the first week and to spend the second week working on the additional online activities and participating in small group activities. Four online activities were made available through the Edmodo (2008) website: (a) assembling the stages of mitosis (Prentice Hall), (b) the control of the cell cycle (Nobelprize.org), (c) label the diagram game: mitosis, and (d) label the diagram game: meiosis (NeoK12). Students were again allowed to complete the online activities anywhere they had Internet access, although most were completed onsite. Students were given an access code to create their own accounts in Edmodo to access links to the websites as well as the online assignments to be completed for each activity. For example, once the student logged into the Edmodo website, he/she would click on the “folders” tab to reveal a list of available activities. The student would click on the activity title, i.e. “the control of the cell cycle” to open and complete the activity. The work on the activity website was recorded as the total time spent. The online interactive activities were made available two days after the beginning of the APlus lessons for treatment unit 1.

Two hands-on activities were conducted in small groups: (a) manual mitosis (Appendix A) and (b) fork and spoon mitosis (Fisher,1997), were completed during the second week of treatment unit 1. The students were provided with both printed and verbal instructions. For example, in the manual mitosis activity, students received handouts with a description of the basic premise of the activity and pictures and explanations for each hand motion. Students practiced and discussed the process in their small groups, and then demonstrated mastery by modeling and explaining mitosis to other students who had not participated in the activity. For each activity, the teacher modeled and explained the process of mitosis while referring to a set of printed instructions. Each of the hands-on activities provided a similar experience but used different materials giving students a variety of kinesthetic methods to memorize and understand the process. During this segment of treatment unit 1, the teacher provided direct instruction and guidance, monitoring students as they participated rather than passively observing and only answering questions. Students were required to actively participate in the onsite, hands-on activities and complete interactive online activities that were not previously included in the biology coursework. Pre, post, and delayed unit data were collected at various times during and after the treatment unit.

Treatment Unit 2: Mendelian Genetics

Instructional content for treatment unit 2 addressing Mendelian genetics contained the APlus (2008) lessons titled *(a) DNA: Genes and chromosomes, (b) Mendelian genetics, (c) Heredity and Genetics 1, (d) Heredity and Genetics 2 and (e) Patterns of inheritance*. Five online activities were added: (a) Mendel's peas, (b) dragon genetics (BioLogica, 2000), (c) build a DNA molecule, (d) DNA extraction virtual lab and (e) gel electrophoresis virtual lab (Genetic Science Learning Center, 2012).

Links to the interactive online activities were made available through the Edmodo (2008) site. Two hands-on activities were added: (a) Do It Yourself (DIY) DNA modeling activity (ENSI, 2006) and (b) genetics with a smile (Trimpe 2003). An example of the hands-on activities for this unit was the DIY DNA modeling activity in which students used patterns to cut out the component parts of nucleotide units. Each mock portion of the DNA molecule contained 10 sections. The sections were taped end-to-end, twisted, and displayed hanging on the wall to represent the DNA model. Students experienced the building of the DNA subunits and also visualized the twisted, double helix structure. Pre, post, and delayed unit data were collected at various times during the treatment unit.

Data Collection Instruments

Students who participated in this project were typical VHS students who have been identified as credit deficient beyond the point of recovery for on-time graduation by their home schools. Of the 12 students taking biology, only nine had previously demonstrated regular attendance and were present an average of three days per week in the previous four weeks. Of these, only six agreed to participate. The overall racial demographics of the participating students were 57% black and 43% white, compared to 28% black, 3% Asian, 10% Hispanic, 1% Native American, and 58% white for the district. The participatory group was 83% male, 17% female, compared to the district's 49% male, 51% female ratio. Only one of the six students (17%) was taking biology for the first time and will require the state biology end-of-course exam, while 83% are repeating biology due to a previous failure.

CMCSS is located between Fort Campbell, Kentucky and Nashville, Tennessee and is Tennessee's seventh largest school district. Seven high schools serve approximately 8,500 students. The city of Clarksville and the surrounding county which make up the district is home to a large military population which leads to a highly transient student population, with a typical military family moving approximately every three years. Tennessee's graduation requirements are very specific and many students transfer in with an insufficient number of credits or lacking credits in the required disciplines to graduate on time. A great effort has been instituted within the district and the community to promote the goal of 100% graduation. Virtual programs are one method to support this goal.

The district currently offers two separate virtual programs, VHS which has served a total of 205 students this year and a separate virtual program, Connections Virtual School, with approximately 30 students. CMCSS's 2012 graduation rate was 95.2% compared to the overall state average of 87.2 %. Although VHS is serving less than 2% of the total student population at any given time, the overall impact is increased due to the continuous rotation of new students into the program as current students complete their programs of study. Each of the seven high schools currently has a waiting list for students to move into the VHS program as slots become available.

Data were collected from several sources to compare the effects of the intervention to the nontreatment unit on students' understanding and long-term memory of biology concepts and students' and teacher's attitude and motivation of the learning experiences. A triangulation method was used for the focus and subquestions to provide a cross-reference for each treatment. Various data were collected at each phase of the project. Table 1 displays the data triangulation matrix used for this project.

Table 1
Data Triangulation Matrix

Focus Questions	Data Source 1	Data Source 2	Data Source 3
Primary Question:			
1. *What are the effects of adding a combination of interactive online and hands-on activities on* students' understanding of high school biology in a blended virtual-learning environment?	Pre and postunit student assessments	Pre and posttreatment student surveys	Pre and postunit student concept interviews
Secondary Questions:			
2. students' long-term memory of biology concepts?	Post and delayed unit student assessments	Post and delayed unit student surveys	Postunit and delayed unit concept interviews
3. students' motivation and attitudes?	Teacher field observations	Pre and posttreatment student surveys	Pre and posttreatment student nonconcept interviews
4. the teacher's attitudes and motivation?	Colleague observations with prompts	Pre and posttreatment teacher surveys	Teacher reflection journal with prompts

Student understanding of biology concepts was determined by comparing preunit and postunit student assessments (Appendix B), pre and posttreatment student surveys (Appendix C), and student concept interviews (Appendix D). Long-term memory of biology concepts was determined by comparing postunit and delayed unit students' assessments (Appendix B), postunit and delayed unit student surveys (Appendix C), and postunit and delayed unit student concept interviews (Appendix D). The delayed unit assessments were completed at least 14 days after the postunit assessments for each unit. Student motivation and attitude were determined through teacher field observations with quotes (Appendix E), pretreatment and posttreatment student surveys (Appendix C), and pretreatment and posttreatment student nonconcept interviews (Appendix D). Teacher attitude and motivation was monitored using colleague observations with prompts (Appendix F), pretreatment and posttreatment teacher surveys with prompts (Appendix G), and an ongoing teacher reflection journal with prompts (Appendix H).

Using a variety of instruments which included student assessments, student and teacher surveys, and teacher observation and reflective journaling provided both the qualitative and quantitative date necessary for determining the benefit of adding both online and hands-on activities to the VHS program. Data sources covered a variety of perspectives, including student, teacher, and outside observers.

Preunit assessments and preunit and postunit student surveys were conducted using Edmodo (2008). Students were instructed to use the Edmodo (2008) website to sign up for the appropriate class using a class code supplied by the teacher. Once the student established an account, access was granted for all assignments connected to the class code, including links to online activities, student surveys, opportunities for student comments, assessments, and preunit, postunit, and delayed unit/treatment surveys. The student surveys (Appendix C) were modified between preunit, postunit and delayed unit student surveys to monitor changes in student attitude. All students participating in the intervention were asked to complete the surveys. Due to the small number of participants, all six were included in the face-to-face interviews. Informal interviews were conducted and students were encouraged to provide detailed, honest answers. In addition to the specified interview questions (Appendix D), students were also asked to clarify and explain any comments posted on the student surveys. Although student interviews were somewhat structured, oral interviews allowed for the addition of alternate questions at the discretion of the interviewer. The inclusion of nonconcept questions in the student surveys and pretreatment and posttreatment interviews provided feedback concerning students' attitudes and motivation. Feedback obtained during interviews also provided information to be further analyzed through teacher journaling.

Student surveys were conducted to provide qualitative data for assessing student attitude and motivation toward the addition of online and onsite labs. Using Edmodo (2008) to conduct the student surveys allowed quick assessment and response because responses could be sent to the entire group or an individual student. The use of both pretreatment and posttreatment surveys allowed a comparison of students' confidence before and after the implementation of the interactive online and hands-on activities. Pretreatment and posttreatment surveys provided information to compare how students felt about the changes to the course as opposed to the standard course requirements requiring only the APlus (2008) online lessons before and after participation in the activities.

This project was conducted over a seven-week period, beginning approximately one week after the start of the second semester. All students were given one week to complete the nontreatment unit with the only change being the addition of preunit and postunit student surveys and interviews. For the two treatment units, students were allowed two to three weeks for each unit, to complete the APlus (2008) content, the student surveys, the additional online activities, the onsite, hands-on activities, and the interviews. Delayed assessments and delayed student concept interviews were conducted at least 14 days after the postunit assessment for each unit. A timeline for the project is included in Appendix I. Ranges of dates are provided to accommodate student schedules, but were extended for some students due to attendance issues.

DATA AND ANALYSIS

Pretreatment and posttreatment data were collected for one nontreatment and two treatment units. Data were collected as described in the triangulation matrix so that each focus and subquestion could be analyzed to determine the effect of adding a combination of online and hands-on activities on high school biology in a blended virtual-learning environment.

The data collected during preunit and postunit assessments were used to calculate the percent change and normalized gain scores for scores on the nontreatment and treatment units. Percent change between preassessments and postassessments was calculated using the following formula:

$$\frac{\text{postunit}\,\% - \text{preunit}\,\%}{\text{preunit}\,\%}$$

Normalized gain scores were calculated using:

$$\frac{\text{postunit }\% - \text{preunit }\%}{100\% - \text{preunit }\%}$$

The average scores, percent change, and normalized gain scores are presented in Table 2.

Table 2

Average Scores of Unit Pre-assessments and Post-assessments

Unit Data	Nontreatment Unit	Treatment Unit 1	Treatment Unit 2
Preassessment	43.0	50.0	38.9
Postassessment	61.1	75.0	71.2
Percent Change (%)	42.1	50.0	83.3
Normalized Gain Scores	0. 32	0.53	0.53

Note. All assessments out of 100 points. *N* = 6.

There was an increase in student scores between all preassessments and postassessments. The difference in the normalized gain scores between the nontreatment and treatment units showed a greater gain between preassessments and postassessments after the treatment units, which suggests that the hands-on activities help the students advance their understanding.

In a second analysis, results were compared for students divided into groups based on teacher perception of the frequency of requests for teacher help. This comparison shows a larger improvement in scores on the treatment units for those students who asked occasional questions as opposed to those who asked questions either frequently or rarely. Those students who occasionally asked questions asked more of the types of questions which led to greater understanding, such as "what does this mean." Those who frequently asked questions asked questions, such as "what is the answer", which did not lead to deeper understanding. The percent changes in scores for students in these groups are presented in Figure 2.

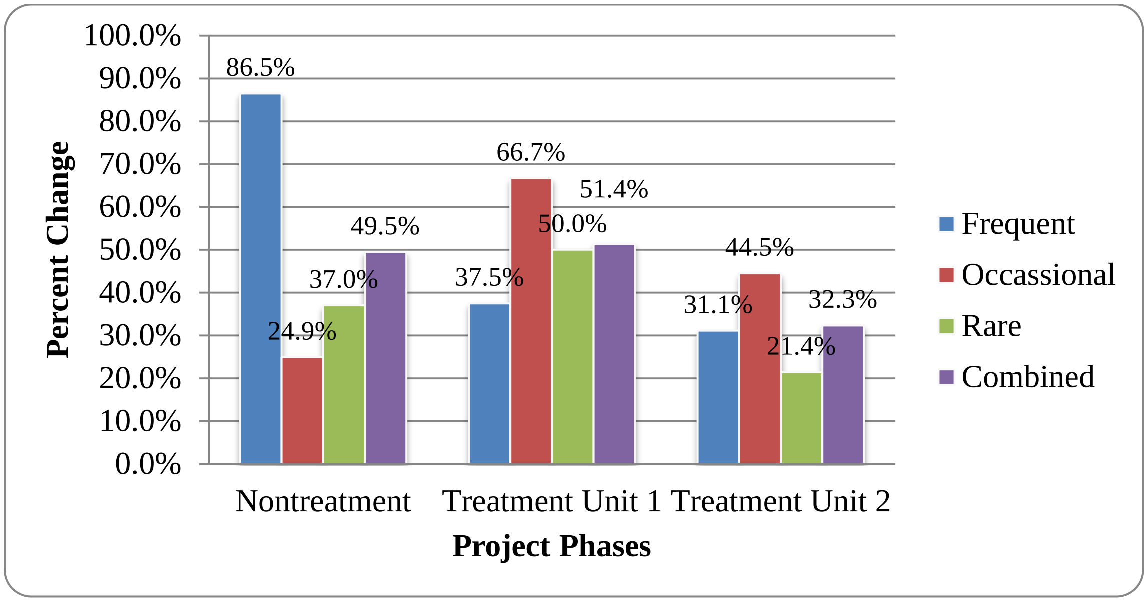

Figure 2. Average percentage change of scores between preunit and postunit assessments based on frequency of student questioning the teacher for help, (*N*=6). *Note.* Students were grouped as frequent (three or more questions per APlus lesson), occasional (one to three questions per APlus lesson), and rare (zero or one questions per APlus unit).

Although preunit and postunit assessment scores indicated that adding a combination of hands-on activities and interactive computer activities to the VHS high school biology curriculum would improve student's ability to answer online true and false or multiple choice questions, there is no clear indication that a true depth of knowledge was achieved. For Treatment Unit 1, only two out of the six students were able to place the stages in order when given a list of the stage names on the preassessment. When given simple diagrams, five out of six students correctly placed the stages in the correct order before any instruction took place, but in the case of both correct and incorrect answers, provided very vague explanations for the events in each stage, i.e. "chromosomes move apart" during anaphase. In the postassessment, the descriptions were only slightly more detailed, i.e. “chromosomes are pulled to opposite sides of the cell” without mentioning spindle fibers or the action of centrioles. Student answers were similarly vague for Treatment Unit 2 pre and postassessments, i.e. when explaining why “false” was selected for “phenotypes are always either dominant or recessive,” one student inaccurately replied “they are a type of gene and have to be one or the other” in the preassessment, then in the postassessment stated “sometimes they are a blend.” The postassessment answer is more accurate, but still vague.

A second data source was collected from pretreatment and posttreatment student surveys concerning student opinions on whether the combination of hands-on activities and interactive computer activities improved their abilities to learn biology concepts more than using APlus online lessons alone. Results of selected Likert questions are presented in Table 3.

Table 3
Student Responses on Pre and Posttreatment Selected Survey Questions Addressing Student Learning Preferences

Survey questions	Likert Choices 5	4	3	2	1	Average
Pretreatment: APlus helped me learn more than I would in a regular biology class	0	2	4	0	0	3.3
Posttreatment: Activity helped me remember more about biology than APlus alone	0	0	2	4	0	2.3
Pretreatment: APlus makes me more motivated than a regular biology class	1	1	2	2	0	3.2
Posttreatment: Activity made me feel more successful than APlus alone	0	1	2	3	0	2.7

*Note.*5 = Strongly Agree, 4 = Agree, 3 = Undecided, 2 = Disagree, 1 = Strongly Disagree. *N* = 6.

Student surveys indicated that although student answers show a slightly positive effect on learning, there was a less than positive effect on students' feeling of success. This was mirrored in the lack of enthusiasm when attempting to promote participation in group activities amongst students who are normally engaged in the independent nature of the VHS program. Students were more concerned with the disruption of their progress through the course than the benefits of group learning. The social aspect alone was not enough to encourage participation.

Student concept interviews were conducted as a third data source with all six participants, due to the small number of participants. There was very little difference between student responses to questions in the preassessments and postassessments for the nontreatment unit, however, student detail did improve between the preassessments and postassessments for both treatment units.

In the posttreatment interview for Treatment Unit 1, five out of six students used the hand motions taught in one of the activities to demonstrate and explain the steps of the cell cycle, but used only very simple descriptions, i.e. "an-away they go" for anaphase, that were intended to help with the memorization of steps. Details concerning specific events and terminology to identify the organelles involved in the process were not present, but most students had a general understanding. Student answers on the pretreatment interviews showed a lack of understanding for most concepts covered in both treatment sections. No student could correctly recite the names or any details of the stages of the cell cycle much less place them in the correct order in the preassessment, but in the postassessment five out of six students were able to correctly describe the order of steps with few errors in reciting the stage names accurately.

For Treatment Unit 2, the terms genotype and phenotype and homozygous and heterozygous were explained in the pretreatment interview with a plethora of inaccuracies, i.e. genotype was described as “the one you can see,” but phenotype was described as “the more discreet trait.” Heterozygous was described by one student as “the stronger trait” versus homozygous as “the weaker trait,” indicating confusion between genotype/phenotype and heterozygous/homozygous. Another student described the terms as “the more masculine” as opposed to “the more feminine” traits. In the posttreatment interview, most students improved their answers to the simple explanation of “the genes that make up the trait” versus “the trait you can see in the animal” or similar answers for genotype and phenotype. Heterozygous and homozygous were described by five out of six students in the postunit interviews as genes that are the same versus genes that are different, with only two students describing the letters as representing alleles.

Posttreatment and delayed treatment data were collected to determine the effect of adding a combination of interactive, online activities and small group, hands-on activities on students’ long-term memory of biology concepts. The average scores and percent change from postassessment to delayed assessment are presented in Table 4.

Table 4
Average Scores of Unit Postassessments and Delayed Assessments

Unit Data	Nontreatment Unit	Treatment Unit 1	Treatment Unit 2
Postassessment (%)	61.1	75.0	71.2
Delayed assessment (%)	47.2	65.3	61.4
Percent Change (%)	-22.6	-13.0	-13.8
Normalized Gain	-0.36	-0.39	-0.34

Note. All scores out of 100%. *N* = 6.

The percent change between postassessment and delayed assessment scores between the nontreatment and treatment units showed a positive impact on long-term memory of biology concepts as a result of adding the combination of online and hands-on activities. The difference in the percent change for the nontreatment unit versus the treatment units indicates that APlus alone is less effective than the combination of APlus with the additional activities but the normalized gain is about the same. This indicates that the long-term memory was not affected much.

Consistent with the preassessment and postassessment comparison, student answers were not very specific or detailed on the delayed assessments. For Treatment Unit 1, as in the postassessment, five out of six students correctly placed the mitosis diagrams in the correct order, but there were fewer correct descriptions of the stage names and events. Many answers counted as incorrect on these questions were simply left blank on the delayed assessments. Those which were answered tended to be correct, but not very detailed, i.e. "the nuclear membrane disappears" for prophase. Delayed assessments for Treatment Unit 2 showed a similar trend, also with more explanatory answers left blank than in the postassessment. Those which were completed in the delayed assessment were nearly mirror images of the postassessment answers.

Postunit and delayed unit student surveys provided a second data source. These survey questions indicated that students were not convinced that the activities truly impacted their long-term memory of the biology concepts. Responses changed very little between postunit and delayed unit when asked whether the activities helped the students remember more; however, for the second question concerning whether the activities would increase preparation for the end-of-course test, confidence decreased on the delayed unit survey, indicating students did not feel the activities would increase their test scores. Results of selected Likert questions are presented in Table 5.

Table 5
Student Responses on Post and Delayed Unit Selected Survey Questions Addressing Student Long-term Memory

Survey questions	Likert Choices					Average
Activity helped me remember more about biology than APlus alone	5	4	3	2	1	
Postunit:	0	4	2	0	0	3.7
Delayed Unit:	0	2	3	1	0	3.2
I feel more confident that I am prepared for the end-of course test after participating in the activities than using APlus alone						
Postunit:	0	3	2	1	0	3.3
Delayed Unit:	0	1	2	3	0	2.7

Note. 5 = Strongly Agree, 4 = Agree, 3 = Undecided, 2 = Disagree, 1 = Strongly Disagree. *N* = 6.

The third source, student concept interviews continued to show very little difference between student responses to questions in the postunit concept interviews and delayed concept interviews for the nontreatment unit, however, student detail did improve between the preunit and postunit concept interviews for both treatment units. Results were very similar to those from the postassessments and delayed assessments, with only a small decrease in the number of correct answers along with a small decrease in detail on the answers.

In the nontreatment unit, only one student identified prokaryotes as “bacteria” and eukaryotes as “everything else” in either the postunit or delayed unit concept interviews. One identified prokaryotes as protists and eukaryotes as “everything else” in the postunit interview, but in the delayed unit interview described them as “the ones that carry things” versus “the ones that get rid of things,” respectively. Students displayed a surprising array of partially correct answers in both the postunit and delayed unit interviews. Another student who also identified prokaryotes as protists in the postunit interview went on to describe them correctly as having “no nucleus” and that the word means “before the nucleus,” and correctly identified them as bacteria in the delayed interview. All six students identified the nucleus as one of the five most important organelles in the postunit interview, but descriptions included “the main part,” “the part that stores energy,” and “controls the function of the cell brain.” Only five of the six selected the nucleus as one of the most important organelles in the delayed unit interviews.

For the delayed interviews in Treatment Unit 1, the number of correct responses did increase as compared to those from the nontreatment unit. Student responses in the nontreatment postunit and delayed unit interviews relied on memorization only with no additional techniques being used for assistance such as the hand motions from the manual mitosis activity. The same five students used the hand motions to demonstrate and explain the steps of the cell cycle as in the postunit interviews, but were observed to spend more time thinking between the steps and explanations. One student did use a description from the fork and spoon mitosis activity, describing centrioles as “those things that look like wrapped candy” that was not used in the postunit interview, but never mentioned the word “centrioles” and used only very simple descriptions, i.e. “an-away they go” for anaphase, that were intended to help with the memorization of steps. In the delayed unit interview, this student made no mention of centrioles using either description, but did use the hand motions and simple phrases from the activity to demonstrate the correct order of the steps. Details concerning specific events and terminology to identify the organelles involved in the process were again missing as in the postunit interviews. When describing how mitosis differs from meiosis in the postunit interviews, three out of six students correctly described the daughter cells as identical after mitosis and haploid after meiosis, but only one actually used the term "haploid." The other three students described them as producing exact copies versus producing cells that were similar, respectively, and this was the answer given by four out of the six in the delayed unit interviews. One student described mitosis as the process for cells themselves to grow and meiosis as the process for cells to duplicate, as opposed to the connection between the growth and reproduction of the organisms. Overall, the answers between postunit and delayed unit interviews in Treatment Unit 1 changed very little, but there was a slight decrease in the detail and accuracy of descriptions.

For Treatment Unit 2, responses on postunit and delayed unit interviews echoed the descriptions from the hands-on activities. Students seemed to have a surface understanding of common genetic terms, i.e. genotype and phenotype and homozygous and heterozygous, but could not give detailed explanations. The only student who could not identify genotype and phenotype correctly in both the postunit and delayed unit interviews did not participate in the hands-on activities for Treatment Unit 2. In the delayed unit concept interviews, one student described genotype as "which genes are present" and phenotype as "what you see as a result of the genes," not very detailed but generally acceptable explanations, and only a slight change from the most common answers on the postunit concept interviews, "the genes that make up the trait" and "the trait you can see in the animal." Descriptions of "sex-linked" traits improved only slightly between the preunit and postunit interviews, with four out of six identifying them as traits that are carried on the sex chromosomes. The same four also identified them correctly in the delayed unit interviews. Incorrect answers in the postunit interview concerning sex-linked traits included "traits that are passed down from only one side of the family, like the father's side."

The interview data indicated that student understanding of concepts improved more as a result of the activities with students being able to correctly describe more concepts in both the postunit and delayed concept interviews than in the preunit concept interviews. Some detail was lost in the descriptions between postunit and delayed concept interviews as students could not recall specific terminology such as "alleles" or as in one cases, could not recall the terms "dominant" or "recessive" when describing Punnett squares.

Teacher observation is the first of three data sources that were collected and triangulated to determine the effect of adding a combination of online and hands-on activities on students' motivation and attitude. Students appeared to enjoy the activities, but wanted to complete them as quickly as possible in order to return to their normal VHS activities. Even students who said they liked the additional online activities needed frequent reminders to complete the online activities. Although students were asked to participate in Edmodo discussions after completing the online activities, only three comments were made during the entire project. Students resisted using the Edmodo site for anything more than access to the online activities and in most cases only used it when prompted.

Observations were made also conducted during the hands-on, small-group activities. In most cases, only two students participated per session because the decreased rate of attendance made it difficult to find opportunities to work with larger groups. Observations of students as they worked on APlus lessons showed no changes in the methods employed by various students in completing the online lessons. Students who took notes continued to do so, and those which did not also continued as before. The student observations also provided the opportunity to estimate the frequency of student/teacher or student/tutor interaction, allowing the division into the subgroups of frequently asked questions, infrequently asked questions, or never asked questions. Those who never asked questions were the most difficult to get through both the online and hands-on activities. In an attempt to better communicate with these students, messages were frequently attached directly to their APlus lists, as illustrated in Figure 3.

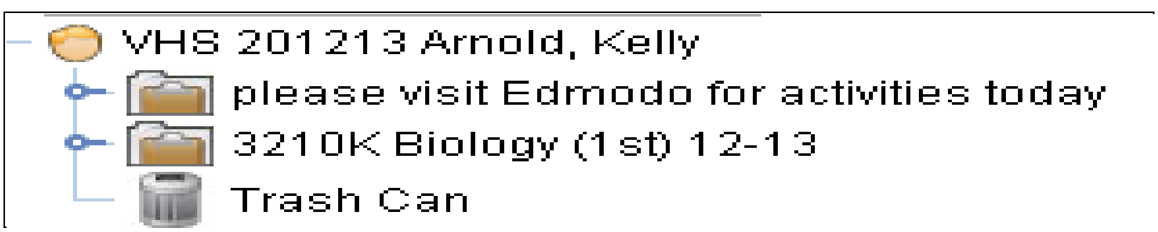

Figure 3. Example of communication to student using APlus assignment list.

For a second data source, the comparison of pretreatment and posttreatment survey questions indicated a decrease in student motivation and attitude toward both the hands-on and online activities. When asked in the pretreatment survey what should be added to improve the VHS biology course, four out of six students suggested some sort of online video lessons with demonstrations or examples. Only one specifically suggested hands-on activities and one other suggested online labs. When asked how additional online or hands-on activities would affect their attitudes about learning biology, two of the six responses were “nothing really” and “it doesn’t.” The remaining four responses were varying degrees of positive, but nothing suggesting they really wanted to do the activities. The posttreatment surveys were somewhat discouraging as well. “The hands-on activities were fun, but APlus is faster” was the summarizing comment.

A third data sources was pretreatment and posttreatment student nonconcept interviews. Pretreatment interviews indicated students looked forward to the activities, but posttreatment surveys indicated that the extra activities were too time consuming. The most common complaint was that the modified course was taking longer than the traditional APlus only version. One student clearly reminded me of the various “reasons” students become VHS students when she explained that during the weeks during which the activities were taking place, the death of her dog had caused her to become very depressed and she had lost interest in most things, not just VHS. Although the students asked to participate had previously demonstrated consistent attendance, another indication of decreased attitude and motivation was inconsistent attendance for five of the six participants.

The effect of adding a combination of online and hands-on activities on the teacher’s attitude and motivation was measured using three data sources and the triangulation method beginning with colleague observations. Colleague observations revealed that the additional activities increased teacher stress, teacher workload, and the workload of others. Organizing multiple sessions of hands-on activities detracted my focus from the normal tutoring activities which increased the demand on the other teachers to compensate for the time I spent working with small groups. On a normal day, I may be helping up to ten students simultaneously, whereas during these small group activities, only two or three students were involved.

The second data source, pretreatment and posttreatment teacher surveys, also indicated a negative change in teacher attitude and motivation. Just as the participating students initially indicated that they would enjoy the additional activities, the teacher's expectation was for a positive experience for both teacher and student. The most challenging factor was trying to achieve synchronized activity within a normally asynchronous program. Teacher and student alike were stressed by the inability to accomplish all of the required activities within the scheduled window of opportunity and the disruption of the normal routine. As one student stated, "Do I have to do this? It's slowing me down."

A teacher reflection journal with prompts (Appendix H), used as a third data source, also indicated a negative impact on teacher motivation and attitude. This negative impact was seen not only in my personal reflection, but also in comments from frustrated colleagues that "we just need to focus on getting them done." Although this comment was not aimed at this project, I shared the frustration of having too many things going on at the same time to complete any of them efficiently. This, too, was often reflected in the journal. There were moments of elation, i.e. finally getting all the participants through Treatment Unit 1, but there were more moments of desperation, i.e. "between the days missed due to inclement weather and poor student attendance, I may never get this finished." In the very first journal entry, I commented that "student attendance was lower than normal due to weather." Later the comments became, "Student attendance continues to be unusually low. This makes it very difficult to stay on schedule with the additional assignments." The learning experience was worth the journey, but the journey was more difficult than I had previously anticipated.

INTERPRETATION AND CONCLUSION

Student understanding of the biology concepts increased more as a result of the activities according to differences between preunit and postunit assessment data than with the APlus (2008) units alone. These improvements were also evident in the differences between preunit and postunit interviews. Greater gains were made between the preunit and postunit assessments, surveys, and concept interviews for both treatment units as compared to the nontreatment unit with nontreatment normalized gains at 0.32 and normalized gains for both Treatment Unit 1 and Treatment Unit 2 at 0.53.

Although the percent change between postunit and delayed unit assessments seemed to show an improvement in student long-term memory of biology concepts as a result of the activities, the normalized gains between postunit and delayed unit assessments showed very little impact on student long-term memory of biology concepts as compared to the nontreatment unit. The normalized gains showed consistent decreases between postunit and delayed unit testing with normalized scores of -0.36 for the nontreatment compared to -0.39 for Treatment Unit 1 and -0.34 for Treatment Unit 2. The concepts that students remembered in the postunit and delayed unit assessments and concept interviews, although only basic knowledge, are concepts that are likely to have a positive impact for those students who must take the biology end-of-course (EOC) test, indicating that with a different approach, these activities could be used to benefit students. Offering review sessions before the EOC tests are given that are not connected with the required course curriculum may encourage more enthusiastic participation, especially if students only participate on a strictly optional, voluntary basis. These sessions could be prescheduled as a one-time event for those who are interested with the anticipation that EOC test scores will be improved, thus preventing failure of the course. The EOC test counts as 25% of the second semester grade for a new credit of biology. Depending on the student's final average, a low EOC test score could result in course failure.

Although pretreatment data indicated students had a positive outlook toward participation in the activities, postunit and delayed unit data suggest that students' attitude and motivation were surprisingly negatively affected by adding the combination of online and hands-on activities. This is probably due more to the scheduling difficulties and the resistance to being "required" to stay on a set order of completion for the project activities. VHS students are normally not required to work through the APlus lessons in a particular order, but are allowed to skip around and complete the lessons in any order. The APlus biology lessons were locked in order requiring the students' to complete study, practice, and mastery in order for each individual lesson, rather than being allowed to complete all studies first, then practices and masteries by their own choice. Because so many students do not follow the suggested study, practice, mastery pattern, this became a source of stress and frustration for some students as well. The long pause required to complete the additional online and hands-on activities also prevented these students from their normal expedient completion of the APlus lessons, again resulting in student frustration.

Teacher attitude and motivation was also adversely affected, again, mostly due to the difficulty in synchronizing student work. This was partly due to the inability to follow any specific schedule. The self-paced nature of the program resulted in students being finished with the units at different times and because attendance was asynchronous, it was nearly impossible to preschedule the hands-on activities. This led to increased frustration for those students who could not move forward with the APlus lessons until the activities were completed. Some student frustration was self-induced as students failed to check their Edmodo accounts regularly. In some cases, students had to be continually prodded to complete the additional online activities. One student was allowed to complete the Treatment Unit 1 hands-on activities individually and another never completed the last activities due to lack of attendance. Although participation was explained as voluntary with the option to decline at any time without penalty, I did not expect any students to actually back out. One student backed out almost immediately. A second student never officially opted out, but suddenly stopped attending. By the end of the project, I seemed to be pleading with some students to complete various activities that I thought they would finish with little or no prodding. This was most frustrating.

After reviewing the data from this project, one change that I would make to improve the data collection is to collect the notes students took as they completed the APlus lessons. Although students are required to submit notes to receive credit for their classes, these notes were not considered in any part of this study. It would be interesting to examine how the quality of the notes taken by these students influenced understanding of the subject matter as well as how or if this had any effect on their requests for help.

VALUE

At the conclusion of this project, I have attained knowledge about my students and my teaching that is somewhat different than what I expected. I truly expected enthusiastic participation from the students in adjusting their schedules in order to participate in the activities and a willingness to be patient in following the plan I had so carefully devised. I also expected my own attitude to be positive and focused on the accomplishment of the goal. What I discovered was that by the end of the project, all participants were simply glad that it was finished. However, even with the frustration far out-weighing the benefit in my opinion, the learning experience was beneficial and a few changes to the implementation would make the additional activities easier to blend into the current VHS program.

First, I expected the scheduling to be challenging, but I found it to be impossible in this specific VHS setting. In spite of this challenge, I still feel that providing opportunities for these types of activities will be beneficial to the students. The focus needs to be placed on making opportunity available at any given time. One method would be to create kits which various activities, not just for biology, but for all the science courses offered through VHS. Rather than requiring specific activities in a specific order, students could be allowed to complete the activities at their leisure just as they would any APlus activity. Students could be allowed to choose from a variety of activities and the only requirement could be that they must complete three hands-on activities and the related interactive online activities by the time they complete the course and complete teacher made assessments specific to those activities through the APlus program. This would eliminate scheduling issues, as the student has the responsibility to complete the activity at the time of his or her own choosing either individually or with one or more other students at their discretion. Kits could be available for checkout similarly to the manner in which calculators are checked out to students with very little difficulty. Assessments for the activities added into the APlus assignments would also reduce teacher frustration because there would be no need for multiple website access.

Second, I expected the students to dislike the reduced flexibility caused by locking the order of APlus lessons, but I learned that any reduction to the flexibility of the program for them will be met with, in some cases, extreme resistance. No matter what is added to the VHS program, it must remain extremely flexible. This continues to be one of the main contributing factors to the success of this program. For many of these students, this is an area of their life that they can feel they have control over. The VHS program allows them to at least some degree to self-determine the method they will use for completing the courses within limits. When planning this project, I did not realize that reducing this flexibility would have a negative impact and result in such a disruption of the students' routines. Although it was necessary to lock the lesson order for the purpose of this project, under normal circumstances, the same activities can be offered without imposing these restrictions on the APlus lists. Without the restrictions, students will again be able to self-determine the speed and order of activities for completing the courses.

A third determination was that students will benefit from the combination of additional online and hands-on activities if they are presented in the same manner as the current APlus lessons. Student comments indicated that they liked the activities, but did not like the interruption to the flow of their APlus completion. Making the activities available in any order by simply clicking on the APlus list will allow students to use the activities as an introduction, a break from the normal APlus monotony, or a review at the end.

Some of the methods and activities used is this project, i.e. manual mitosis, will continue to be used in the VHS as a quick instructional method, but not as a universal requirement for all students. I have used these methods numerous times successfully and it was only when the implementation took on the more formal structure that any issues developed. Overall, the necessity of keeping the lessons in a specific order seems to be the factor that detracted most from the success of the project. I look forward to testing a new plan in which the activities are more flexible and students have to freedom to choose not only the specific activities they will complete, but also the time frame in which they are completed.

All the other areas of VHS instruction that will benefit from this study through the consideration of providing more flexibility for students to complete any added activities. Activities are often used in VHS to review in preparation for EOCs, but these review sessions only benefit a limited number of students within the VHS facility. Making the activities more student schedule friendly and providing the instructions as a part of the APlus list would also allow other schools within the district to use them. Adding new activities also provides a means of improving the curriculum available through the APlus program by providing learning modules to cover some common core standards which are not well addressed by the traditional options on APlus.

Using structured, scheduled activities would be more successful if students were attending on a regular basis. The district also offers “independent study” classes in which students attend class on a daily basis to work on credit recovery for failed classes. The consistent attendance for these classes would make implementation of scheduled activities possible, unlike in the VHS program where students attend irregularly.

The next step in this research is to conduct a second implementation of using both the online and hands-on activities without locking the order of the activities. Activities could be completed on an individual or group basis in a designated area in the VHS facility at the students' convenience. Tying the grading of these activities to a specific APlus module would make assessment easy for the teacher and more important to the students. A study such as this would possibly require a whole semester or longer to complete. Pretesting and posttesting could be conducted using the current EOC practice booklets as well as the EOC test scores for some students

In spite of the many issues that made this study seem at times unmanageable, I became very aware of the impact of both the online and hands-on activities. As in a traditional classroom, I have discovered that the best method of instruction is not necessarily the easiest or least labor intensive. As a professional teacher, I will not choose what is easy to implement over what is most beneficial to students and I will continue to offer more of these types of activities in all science courses offered through the VHS program. I will also make what I have learned available to others in the district who are involved in using the APlus program so that these types of activities are available to students using the APlus program in the districts traditional schools.

In conclusion, the activities both online and hands-on were more interesting to the students and the teacher than the normal VHS APlus curriculum. The scheduling difficulties are only a small set back as the VHS program moves forward. A new set of students will be available in the fall with which to try a new implementation of these strategies with fewer schedule restrictions. Students will still get the benefits of hands-on activities available on their schedules.

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APPENDICES

APPENDIX A

MANUAL MITOSIS ACTIVITY

Manual Mitosis

Lesson Implementation:

1) Trick for memorizing cell cycle steps

2) Hand motion simulation of mitosis

Manual Mitosis activity steps

- Memorizing the steps of the cell cycle
- I petted my aunt's turtle "Clyde"

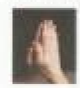
I p m a t C

Manual Mitosis activity steps

- Interphase – before mitosis
- A closed fist represents a single cell which must grow and develop before replication takes place.
- Chromosomes are locked within the nuclear membrane.

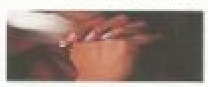
Manual Mitosis activity steps

- Prophase
- Open hand represents cell with visible chromosomes
- Nuclear membrane disappears to release chromosomes
- Hands together show copied chromosomes



Manual Mitosis activity steps

- Metaphase
- Chromosomes "met" in the middle
- Can be demonstrated using clasped hands



Manual Mitosis activity steps

- Anaphase
- "ana – way" they go......
- Can be demonstrated by dragging clasped fingers apart

Manual Mitosis activity steps

- Telophase
- 2 fists together show separating cells with reappearing nuclear membranes

Manual Mitosis activity steps

- Describe the steps with the appropriate level of detail depending on the grade level of the students.
- The activity can be performed in a fluid motion from beginning to end emphasizing specific events in the process to make the steps more memorable.

APPENDIX B

STUDENT ASSESSMENTS

Nontreatment Unit: Pre, post, and delayed unit Assessment

Cell Organelles and Cell Theory

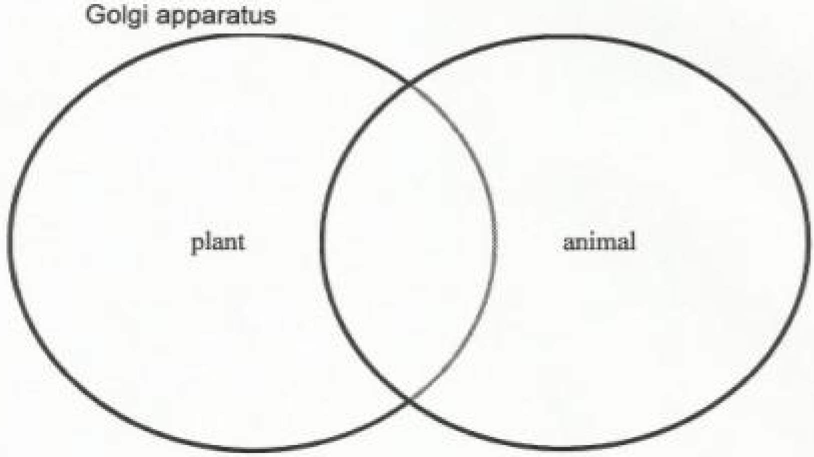
Note: Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1) Draw an animal cell and label as many parts as you can remember.

2) Use a Venn diagram to compare plant and animal cells.

Word bank:

autotrophic	heterotrophic
cell membrane	mitochondria
cell wall	nucleus
central vacuole	ribosomes
centrioles	small vacuoles
chloroplasts	uses photosynthesis to make food
cytoplasm	uses respiration to break down food
endoplasmic reticulum	vesicles
Golgi apparatus	



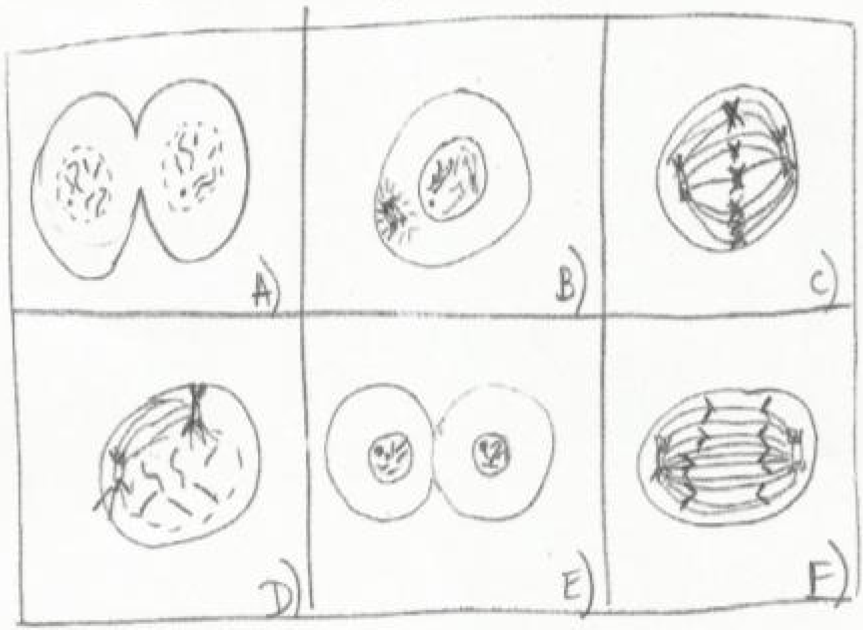
3. Why is it important that cells have organelles?

Treatment Unit 1: Preunit Assessment
Cell Division

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

1) Why is mitosis important to organisms?

2) The following cells are in various stages of their life cycle.



Label each stage with the proper description from the word bank, then indicate using numbers 1-6, the order in which the stages occur.

anaphase, cytokinesis, interphase, metaphase, prophase, telophase

step number		phase	Word Bank:
A) #________	-	____________________	anaphase
B) #________	-	____________________	cytokinesis
C) #________	-	____________________	interphase
D) #________	-	____________________	metaphase
E) #________	-	____________________	prophase
F) #________	-	____________________	telophase

Treatment Unit 1: Post and delayed unit Assessment
Cell Division

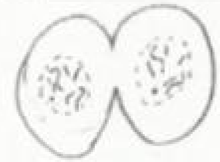
Note: Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

1) The following cells are in various stages of their life cycle. Use the following list to label the diagrams with the appropriate stage name:

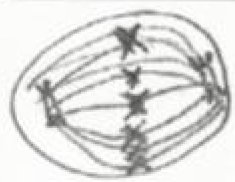
anaphase, cytokinesis, interphase, metaphase, prophase, telophase

A) ____________________

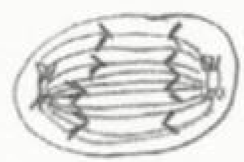
D) ____________________



B) ____________________



E ____________________



C) ____________________

F ____________________

Describe the basic process taking place in each mitosis stage.

1.

2.

3.

4.

5.

6.

Treatment Unit 2: Pre, Post, and Delayed unit Assessment
Mendelian Genetics

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

Answer each question as either true or false, then explain why you know this is the correct answer.

_____1) Traits are called "dominant" when they make the organism better.
WHY?____

_____2) Recessive traits are sometimes hidden in the phenotype.
WHY?____

_____3) Phenotypes are ALWAYS either dominant or recessive.
WHY?____

_____4) In a heterozygous genotype, the dominant phenotype is ALWAYS expressed.
WHY?____

_____5) In a homozygous phenotype, the recessive phenotype is ALWAYS expressed.
WHY?____

6. Place the following in order of least to greatest complexity:

alleles, chromosomes, DNA, genes

APPENDIX C

STUDENT SURVEY QUESTIONS

Pretreatment Student Survey Questions

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

1. I will be taking the biology end-of-course exam in May 2013. yes no not sure

On a scale of 1-5, with 5 being best, rank your confidence in completing each activity using the current APlus (American Education Corp., 2008) instructional units in biology.

1	2	3	4	5
Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagre

_____2. I will learn more about biology using APlus than I would have in a regular class.

_____3. I feel more motivated to learn about biology using APlus than I would have in a regular class.

_____4. I feel more successful using APlus to study biology than I would have in a regular class.

_____5. I feel confident that the APlus biology course will prepare me for the end-of-course exam more than a regular biology class.

6. What could the teacher do that would help you to learn more about cells when using APlus (American Education Corp., 2008)? Explain.

7. What could be added to the biology course, other than APlus (2008) lessons to help you understand biology? Explain.

8. How would adding additional activities, other than APlus (2008) lessons, affect your attitude about learning biology? Explain.

9. Would you prefer to participate and be graded on interactive online biology labs or labs that you complete at the VHS building with lab equipment? Why?

10. What could the teacher do that would help you to learn more about cells when using APlus? Explain.

11. What could be added to the biology course, other than APlus lessons to help you better understand biology? Explain.

Posttreatment Student Survey Questions

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

1. I will be taking the biology end-of-course exam in May 2013. yes no not sure

On a scale of 1-5, with 5 being best, rank your confidence in completing each activity using the current APlus (American Education Corp., 2008) instructional units in biology.

1	2	3	4	5
Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree

_____ 2. I remember more about biology from the activities than I would have using APlus alone.

_____ 3. My motivation to learn about biology increased with the activities more than it would have using APlus alone.

_____ 4. I felt more successful with remembering biology with the activities than I would have using APlus alone.

_____ 5. I feel more confident that I am prepared for the end-of-course exam after participating in the activities than if I had used APlus alone.

6. Would the additional online materials have helped as much or more if they were provided with the APlus (2008) lessons, or would they be more helpful if used as a review for the EOC? Why?
7. Which was more fun, the hands-on activities or the computer activities? Why?
8. Which was more beneficial to your learning? Why?
9. What could the teacher do that would help you to learn more about cells when using APlus? Explain.
10. What could be added to the biology course, other than APlus (2008) lessons to help you understand biology? Explain.

APPENDIX D

STUDENT INTERVIEW QUESTIONS

Pretreatment Nonconcept/Nontreatment Preunit Student Concept Interview Questions

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

1. What is your primary goal in taking this biology class in VHS?

2. What types of activities do you remember participating in that improved your understanding in science classes before you began taking classes at VHS? Explain.

3. Do you prefer using APlus to cover biology concepts more than participating in a traditional classroom? Why or why not?

4. What types of activities would you like to have offered at VHS to increase your understanding of biology as you take it on APlus this semester? Why would this help?

5. What specific methods do you plan to use to while completing the APlus (2008) biology lessons? How will this help you to remember what is needed to pass the practice and mastery tests?

6. What are some differences between the different types of cells?

7. Why are cells important to organisms?

8. Is there anything else you would like to share?

Nontreatment Post/Delayed-unit Concept Student Interview Questions

Cell Organelles and the Cell Theory

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

1. How are prokaryotic cells different from eukaryotic cells?

2. Describe the purpose of the 5 organelles that are most important to cell functions? Why are these the most important compared to the other organelles?

3. Is there anything else you would like to share?

Treatment Unit 1 Pre, Post and Delayed-unit Concept Student Interview Questions

Cell Division

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

1. Describe the process of mitosis. (Teacher note – method used?)

2. How does mitosis differ from meiosis? Why is this difference important to reproduction?

3. Is there anything else you would like to share?

Treatment Unit 2 Preunit Concept Student Interview Questions

Mendelian Genetics

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

1. Complete the following Punnett square. Describe what it represents?

	G	G
g		
g		

2. What is the difference between genotype and phenotype?

3. What does it mean when a trait is described as "sex-linked"? How does being "sex-linked" affect the passing of traits to male and female offspring?

4. Is there anything else you would like to share?

Treatment Unit 2 Post and Delayed-unit Concept Student Interview Questions

Mendelian Genetics

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

1. Using a Punnett square, demonstrate and explain how to show the expected offspring of a cross between two flowers that are heterozygous for color.

2. What is the difference between genotype and phenotype? How does being "sex-linked" affect the passing of traits to male and female offspring?

3. What does it mean when a trait is described as "sex-linked"?

4. Is there anything else you'd like to share?

Posttreatment Nonconcept Student Interview Questions

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

1. What is your primary goal in taking this biology class in VHS?

2. What types of activities do you remember participating in that improved your understanding in science classes before you began taking classes at VHS? Explain.

3. Do you prefer using APlus (2008) alone to cover biology concepts more than participating in group activities? Why or why not?

4. Which type of activity would you most like to have offered at VHS on a regular basis to increase your understanding of subjects other than biology as you take them on APlus (2008)? Why would this help?

5. What could the VHS instructors do to make taking notes easier and more productive for all the VHS courses?

APPENDIX E

TEACHER FIELD OBSERVATION PROMPTS

Teacher Field Observation Prompts

Unit ____ Activity ________________________________ Session_____ Date______________

Phase of Class Begin Middle End

SD for strongly disagree, D for disagree, N for neutral, A for agree, and SA for strongly agree. Achievement Levels – H for high, M for middle, L for low

1. Students' were generally on task during the hands-on activity.

Level						
A)______________________	SD	D	N	A	SA	_____
B)______________________	SD	D	N	A	SA	_____
C)______________________	SD	D	N	A	SA	_____
D)______________________	SD	D	N	A	SA	_____
E)______________________	SD	D	N	A	SA	_____
F)______________________	SD	D	N	A	SA	_____
G)______________________	SD	D	N	A	SA	_____
H)______________________	SD	D	N	A	SA	_____

Average

High	SD	D	N	A	SA
Middle	SD	D	N	A	SA
Low	SD	D	N	A	SA
Total	SD	D	N	A	SA

Notes:____

____

2. Students asked questions related to this activity.

						Level
A)______________________	SD	D	N	A	SA	_____
B)______________________	SD	D	N	A	SA	_____
C)______________________	SD	D	N	A	SA	_____
D)______________________	SD	D	N	A	SA	_____
E)______________________	SD	D	N	A	SA	_____
F)______________________	SD	D	N	A	SA	_____
G)______________________	SD	D	N	A	SA	_____
H)______________________	SD	D	N	A	SA	_____

Average

High	SD	D	N	A	SA
Middle	SD	D	N	A	SA
Low	SD	D	N	A	SA
Total	SD	D	N	A	SA

Notes:____

____

3. Students put forth real effort to understand the concepts presented in this activity.

Level						
A)________________________	SD	D	N	A	SA	_____
B)________________________	SD	D	N	A	SA	_____
C)________________________	SD	D	N	A	SA	_____
D)________________________	SD	D	N	A	SA	_____
E)________________________	SD	D	N	A	SA	_____
F)________________________	SD	D	N	A	SA	_____
G)________________________	SD	D	N	A	SA	_____
H)________________________	SD	D	N	A	SA	_____

Average

High	SD	D	N	A	SA
Middle	SD	D	N	A	SA
Low	SD	D	N	A	SA
Total	SD	D	N	A	SA

Notes:____

____

4. Students were generally successful at reaching the learning goals for this activity.

Level						
A)________________________	SD	D	N	A	SA	_____
B)________________________	SD	D	N	A	SA	_____
C)________________________	SD	D	N	A	SA	_____
D)________________________	SD	D	N	A	SA	_____
E)________________________	SD	D	N	A	SA	_____
F)________________________	SD	D	N	A	SA	_____
G)________________________	SD	D	N	A	SA	_____
H)________________________	SD	D	N	A	SA	_____

Average

High	SD	D	N	A	SA
Middle	SD	D	N	A	SA
Low	SD	D	N	A	SA
Total	SD	D	N	A	SA

Notes:____

____

APPENDIX F

COLLEAGUE OBSERVATION PROMPTS

Colleague Observation Prompts

Please select from the following options using this scale: SA = strongly agree, A = agree, N = neutral, D = disagree, SD = strongly disagree.

1. Adding hands-on activities seems to be a positive change overall for:

   a) the teacher's attitude: SA A N D SD

Notes: ____

____

____

   b) the teacher's stress level: SA A N D SD

Notes: ____

____

____

2. Adding hands-on activities seems to have no effect on:

   a) the teacher's workload SA A N D SD

Notes: ____

____

____

   b) the workload of others SA A N D SD

Notes: ____

____

____

3. Anything else? ____

____

____

APPENDIX G

TEACHER SURVEYS

Pre/Posttreatment Teacher Survey Questions

Please select from the following options using this scale: SA = strongly agree, A = agree, N = neutral, D = disagree, SD = strongly disagree.

1. The hands-on activities will have/had a positive impact on:

a) student attitude SA A N D SD

Notes: ____

____

____

b) teacher attitude SA A N D SD

Notes: ____

____

____

c) student learning SA A N D SD

Notes: ____

____

____

2. I feel motivated to begin/to continue using

a) the hands-on activities in the VHS program SA A N D SD

Notes: ____

____

____

b) the computer activities in the VHS program SA A N D SD

Notes: ____

____

____

APPENDIX H

TEACHER REFLECTION JOURNAL PROMPTS

Teacher Reflective Journal

Date _______________ Unit _____________________

Today's focus was: ______________________________

1. How were today's activities different from the norm?
2. How successful do you think today's activities were?
3. Were there any epiphanies from today's activities?
4. What was most encouraging from today's activities?
5. What was most discouraging from today's activities?
6. What did the students seem to enjoy about today's activities?
7. What are you looking forward to in the future?
8. What changes would you make to improve this activity in the future?

APPENDIX I

TIMELINE

Project Timeline

Start Project Implementation: January 14, 2013

January 14-18: Nontreatment unit (Cell organelles and cell theory).

Jan 14-15: Nontreatment preunit online assessment, pretreatment online student surveys, and pretreatment teacher survey.

Jan 15-16: Nontreatment preunit concept and nonconcept student interviews.

Jan 14-16: APlus units.

Jan 16-17: APlus postunit assessment, postunit online student surveys.

Jan 17-18: Postunit concept and nonconcept student interviews.

Jan 30-31: Nontreatment delayed assessment and student concept/nonconcept interviews.

January 22- February 1: Treatment Unit 1 (Cell division: mitosis and meiosis).

Jan 22-23: Preunit online assessment, concept and nonconcept student interviews.

Jan 22-25: APlus units.

Jan 24-29: Other nonAPlus online activities.

Jan 29-31: Onsite, small-group, hands-on activities.

Jan 31-Feb 1: APlus postunit assessment, postunit online student surveys.

Feb 14-15: Treatment Unit 1 delayed assessment and delayed concept/nonconcept interviews.

February 5-15: Treatment Unit 2 (Mendelian Genetics).

Feb 5-6: Preunit online assessment, concept and nonconcept student interviews.

Feb 5-8: APlus units.

Feb 8-13: Other nonAPlus online activities.

Feb 12-14: Onsite, small-group, hands-on activities.

Feb 14-19: APlus postunit assessment, postunit online student surveys.

Feb 20-22: Student posttreatment concept/nonconcept interviews.

Feb 22: Postreatment teacher survey.

Feb 28-March 5: Treatment unit 2 delayed assessment and delayed concept/nonconcept interviews.