THE EFFECTS OF PARTICIPATING IN PLANT-PEOPLE ACTIVITIES ON GENERAL BIOLOGY COLLEGE STUDENTS

by

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ABSTRACT

Student interest in plants and botany generally declines around the fifth grade and continues to decrease throughout the middle and high school years. New lectures and lab exercises for a mixed-majors general biology course that focused on plant-people relationships were developed. These activities were hypothesized to improve student attitude and awareness of plants and to increase their motivation to learn more about them.

Students were surveyed regarding their interest in plants and regarding their knowledge of local woody plant species both pretreatment and post-treatment. During the non-treatment unit, students were instructed using the traditional lecture method and participated in lab exercises on plant structure. At the end of the unit, a standard exam was used to assess their knowledge. Topics examined during the treatment unit were medicinal plants and teas and relationships amongst plants, soil, water and people. For an introduction to ecology, plant examples were used to illustrate ecological principles wherever possible. The lecture method combined with two short assessments and two out-of-class assignments focusing on these topics. In lab, students completed a drawing exercise, created a woody plant portfolio, and participated in exercises on medicinal properties of plants, and tea brewing and tasting.

There was no change in student interest in plant-related topics over the course of this project. Student ability to identify common woody plants and vines significantly improved after developing a plant portfolio. Grades for post-treatment assessment were higher than non-treatment assessment. Instructor motivation to teach botanical topics was low-to-medium at the beginning but was high at the end of this project. A new botany course intended for non-science majors has been proposed using many of the materials and tools from this project.

INTRODUCTION AND BACKGROUND

Many of my students are afflicted with "plant blindness" meaning that they are unaware of plants in their environment as evidenced by their inability to identify trees and common herbaceous plants in their local environment from images or in the field, have little knowledge of the importance of plants other than as food items or oxygen-producers, and openly express a disinterest in and dislike of studying about plants. Part of this is thought to be due to poor exposure to plants in science curricula for both teachers and students (Uno, 2009), as most general biology textbooks and instructors primarily use animal-based examples to illustrate biological concepts (Zimmer, 2014; Reece, Urry, Cain, Wasserman, Minorsky & Jackson, 2013). Another reason proposed for lack of awareness of plants is their lack of movement and, that when not in bloom, plants tend to form a mass of green that provides little visual stimulation to the vertebrate eye (Allen, 2003; Wandersee & Schussler, 1999).

In the last couple of semesters, I have noticed that many of my students when studying plant related topics in general biology and botany courses want to run through the labs and leave. In lecture, they ask many questions about content to be on the exam but don't really seem to want to understand plants. My impression is that the plant-based portion of the curriculum for the General Biology and the General Botany courses I teach is not interesting to my students and may even reinforce their attitude that plants and botany are boring. My evidence that students lack interest in general botany is – the failure to ask questions during lab, and sometimes outright refusal to view specimens and microscope slides whether live, fresh or preserved. They rarely ask follow-up questions regarding plant-based course materials and may ask at the beginning of lab what is the amount of time required to be in lab to get their attendance points. In previous semesters, there has been erratic attendance to lecture classes and, in general, students do poorly on lab quizzes. Despite advertising, some semesters the general botany course has been cancelled due to low enrollment. Most recently, a new people and plants course scheduled for this past spring failed to meet the minimum number of students needed to run the class. Therefore, I share the concern of Link-Pérez and Schussler (2013) that "This lack of botanical interest and knowledge should be of concern on a planet where the survival of animals, including humans, is dependent on the health and ecosystem services of the green plants that are the foundation of terrestrial life" (p. 1).

Currently, the general botany course and the plant topics in general biology tend to involve a passive and low-level form of learning (i.e., memorization and simple recall). Although I try to illustrate concepts by providing a variety of real-world examples, students often do not appear interested nor do they seem able to relate to plants. Apart from producing life-needed oxygen, students fail to make additional connections with the roles of plants in their daily lives. Part of this appears to be that they are unable to provide plant examples to support their ideas. Making connections with previous knowledge and carrying out science experiments is critical to students understanding of plants and botany (Uno, 2009). Therefore, I was interested in determining what are student attitudes towards plants and botanical topics, what knowledge they have regarding plants, and what topics might be interesting to them. The last was most critical, as knowing this could help me tap into previous student knowledge and find topics that might capture their attention and encourage their interest in plants.

I was becoming increasingly frustrated teaching the plant portion of our general biology course as well as an annual general botany course. Poor class attendance and lack of student interest in plants, as well as a lack of respect for botany as a profession, was beginning to negatively impact my attitude and motivation towards teaching botany and plant-related topics. Perceptions of teacher attitudes and enthusiasm play a role in student engagement and motivation to learn, specifically those behaviors regarding student autonomy and involvement with course material. Likewise, student attitudes, behaviors and enthusiasm can act as a feedback mechanism on teacher motivation (Skinner & Belmont, 2003). For these reasons, and my intrinsic desire to teach at my best, it was very important that I improve both my attitude and motivation regarding teaching botany. One method for achieving my personal and professional goals and improving student understanding of plants would be to develop and teach botany using new materials that focused on interactions between people and plants.

Developing such materials would allow me to establish new relationships with non-biology faculty within my science division and with faculty in the liberal arts division. I was involved with a Science, Technology, Engineering, Art and Math program (STEAM) recently for a semester. The focus of this program was to get faculty across disciplines to collaborate on art projects with science students. Faculty involved in the STEAM program found that the interdisciplinary activities increased student and faculty creativity, improved students' critical thinking skills and deepened student understanding of science (NOVA, 2014). I enjoyed working with the other STEAM faculty and hoped doing so again would improve my own attitude and motivation towards teaching botany.

I thought that botany exercises focusing on interactions between people and plants would be of greater interest to students, especially non-science majors, than the plant exercises typically taught during a general biology course. We could focus on a variety of topics (e.g. agricultural economics, botanical art, history and plants) that might have a broader appeal to non-majors. I hypothesized that using a greater variety of assignments than I do in a traditional general biology course (i.e., quizzes and exams) would also engage students who have different learning styles. The question was – would my students agree?

Research Questions and Sub-questions

The main research question was, "What are the effects of participating in plant exercises that focused on interactions between humans and plants on student interest in plants?" Sub-questions for this portion of my research were, "What are the effects of participating in plant exercises that were focused on interactions between humans and plants related to student attitudes toward plants or having an appreciation of plants?", and "What are the effects of participating in plant exercises that were focused on interactions between humans and plants on student awareness of plants as evidenced by their ability to identify common campus plants?" An additional sub-question was, "What are the effects of teaching these new materials on my level of interest and motivation toward teaching of botanical topics in a general biology class?"

Project Committee

The committee members for this capstone project were Dr. Walt Woolbaugh, my project advisor and Robyn Klein, my project reader. Walt and Robyn are Montana State University faculty members and teach courses in the MSSE program. Cindy Miller, the current director for the Center of Teaching and Learning (CETL) at Northern Virginia Community College (NOVA), served as a support team member. Cindy uses her own teaching experiences and innovative ideas to provide guidance and exposure to new pedagogical practices to faculty at NOVA; she is a master teacher and mentor. The assistant dean for our Department of Biology, Dr. Mary Vander Maten, gave permission for me to carry out this action research project and observed me and my students during a lab class.

CONCEPTUAL FRAMEWORK

According to Notebaert (2009), college and university science classes are usually taught in a traditional lecture fashion that does not provide much individual feedback. It also does not encourage actively considering the information presented, as a form of deep learning. For example, his dissertation surveys revealed that anatomy and physiology students perceive that anatomy is just about memorizing structures, a type of superficial rather than "deep" learning. He posited that our current way of teaching this particular science subject negatively reinforces students' perception of the subject and contributes to their lack of active, or deep, learning. When reading his article, I felt that he was describing my botany students. Memorization is the lowest level of learning but it does provide a foundation for deeper learning (Bloom, Englehart, Furst, Hill & Krathwohl, 1956). For some students, this form of learning is quickly forgotten, often within the same semester. If students can build on this foundation within their first semester, perhaps they will retain this knowledge for a longer period of time in their deep memory. Retaining this information is especially important for biology majors.

Various types of activities, drawing attention to unusual characteristics of live plants (Strgr, 2007), mixed methods teaching utilizing mini-lectures in combination with class activities that included the use of concept maps, problem solving and forming analogies (Goldberg & Ingram, 2011), encouraging student inquiries that incorporated dialogues with online mentors (Hemingway, Dahl, Haufler & Stuessy, 2011), and teaching students drawing techniques (Ainsworth, Prain, & Tytler, 2011) have been used with botany students to increase their motivation, and to improve their observation and higher order thinking skills.

Carroll & Bandura (1982; 1987; 1990) developed the social cognitive theory of observational learning. They posited that people engage in social behaviors that provide feedback on their learning and that this feedback allows them to correct their errors. Practically, they have suggested that students work in dyads in which the instructor assigns low-performing students with high-aptitude students. This idea is supported by the research of others (Grandos & Wulf, 2007; Hughes, 2011). Several researchers have also found that drawing also challenges students to take an active role in class, to organize their thinking, and ultimately to communicate more clearly (Babaian, 2009; Ainsworth, Prain & Tytler, 2011).

Constructivism assumes that all learning is individual and is developed based on the individual's experiences of the world (Jonassen, 1991); therefore, this is a very active form of learning. This type of learning differs from objectivist learning in which the teacher is the main source of information to be disseminated and the student is a passive vessel receiving that knowledge. Short-term learning only becomes long-term learning when knowledge can be related to what people already know. This allows the information to be stored both verbally and visually in memory. Focusing on people and plant relationships relates to both types of learning as each exercise (short-term learning) helps students make more links with information previously learned and allow them to keep this information from year to year (long-term learning).

Student attitudes towards plants, one of many components of motivation, was evaluated before a traditional (i.e., non-treatment unit) instructional unit covering plant topics and after a non-traditional instructional unit (i.e., post-treatment) in a general biology course. A number of studies have considered the possible sources of student motivation. Many note that motivation may be intrinsic (i.e., interest, goal or achievement orientation, or enjoyment of learning). However, motivation may also be extrinsic (i.e., conforming to please others or the need to prove oneself to others). A study of university undergraduates (Alarcon & Edwards, 2013) found that lack of motivation was the primary factor for students dropping out between their freshman and sophomore years. Ability (skill and knowledge) was the secondary factor in dropping out. Student affect (emotional response to experiences) and conscientiousness (carrying out tasks to completion) also play roles in student motivation. Students who have a positive affect have better academic success and deal with problems better than students with negative affect (Alarcon & Edwards, 2013). A study by Williams, Kurtek and Sampson (2011) assessing student attitudes towards science noted that their interest and attitudes impacted their motivation to succeed in science. Positive attitudes regarding ability, self-image, cultural beliefs about science, and valuing science were found among students who had a desire to learn science. However, negative attitudes, or negative affect, toward these characteristics or perceptions are possible reasons for students not putting forth effort to learn science.

Goldberg and Ingram (2011) studied attitudes and confidence levels of undergraduate students enrolled in two different sections of the same botany course. In their treatment section (*N*=36), active learning activities (e.g., concept maps, drawing, and categorizing grids) with mini-lectures were the main modes of teaching whereas a traditional lecture approach with no activities was utilized with the second class (*N*=34). High rates of student attendance and increased exam grades throughout the semester in the treatment class were interpreted by the researchers that these students were highly motivated. Although students were highly engaged in this class, they did not self-report an increase in confidence regarding course material at the end of the semester. Baldwin and Crawford (2010) incorporated student drawings along with accessing external information sources (e.g., online resources and reference books) into an observation journal in their botany course as a means for increasing detailed student observations of plant structures. Although they noted that their students were actively engaged in the journal drawing activities during lab periods, they could not relate this level of engagement to increased student achievement in their botany courses. They did, however, find that bringing an art instructor into their lab class increased student interest in drawing and increased their own collaboration with faculty in other disciplines.

Most educational research on student attitudes towards science, and more specifically to plants, has been carried out with elementary and middle school students. Students often lose interest in science between the middle and high school years. Research into student attitudes toward biology by Prokop, Prokop and Tunnicliffe (2007) found that by grade 5 (ages 10-11) students were already showing a lack of interest in science and biology. Girls found botany more interesting than boys and this related to their more positive attitudes towards biology. However, both genders found it difficult to grasp plant-related material. In their discussion (Prokop et al., 2007) proposed that more research was needed to determine why the difference in attitude towards biology in male students and suggested that involving them in fieldwork and more hands-on activities could engage their interest. Interestingly, several studies appear to support this suggestion. Fančovičová and Prokop (2011) found that middle school students who participated in outdoor activities showed an increased interest in science. Goulder and Scott (2006) found that undergraduate student attitudes towards plants not only improved, but their positive attitudes were maintained beyond three months, after participating in a one-week outdoor program. More recently, Resasco (2013) determined that undergraduate interest in observing the natural world increased after participating in field-based labs and experiments using living organisms. Others have used novel approaches to capture student interest. For example, Poli (2011) used tea brewing to help her students make connections between culture and botany and to pique their interest in the medicinal properties of teas. Keeping students actively engaged in such exercises may help change their attitudes towards science.

Teachers' motivation may suffer when they feel constrained in their teaching by pressure from administrators or colleagues. This pressure occurs in the form of requiring them to conform to strict curriculum guidelines, performance standards, other teachers' style of teaching, or classroom discipline (Pelletier, Se´guin-Le´vesque, & Legault, 2002). Teachers who experience this type of controlling behavior feel less self-determined and, in turn, exhibit more controlling behaviors towards their students; this results in lower engagement and task achievement by their students. Teachers' perceptions of their students' motivation and self-determination may also be dependent upon their perception of their average student self-determination or autonomy (Pelletier et al., 2002). Taylor and Ntoumanis (2007) noted that physical education teachers who had a high degree of self-determination regarding their teaching provided a higher level of self-determination motivational strategies to their students than teachers with a lower degree of self-determination and those teachers who perceived their students to have a lower level of self-determination. The first group of teachers also spent more time trying to understand their students and seek various means to support them. Therefore, I also documented my own motivation regarding the teaching of plant topics in a general biology course and my interactions with my students.

I had positive experiences piloting two new laboratory exercises with students in another instructor's botany class. Therefore, I was interested to see if my attitude and motivation, as well as those of my students, remained the same when the students would be enrolled in a semester-long general biology course that included plant topics and with me as the instructor.

METHODOLOGY

Treatment

The goal of this action research project was to determine the effects of participating in plant-people interaction activities on student attitudes and awareness of plants. To answer my research question, I developed one new learning unit and several data collection instruments. This project consisted of one non-treatment unit on basic plant structure and anatomy (i.e., cells, tissues, organs) and plant growth, and one treatment unit on the relationships amongst plants, soil, water and people. Approximately three weeks were spent on each unit. Lecture and lab classes were taught separately, as is common for undergraduate education. For both units, lecture classes met for 1.25 hours twice each week and lab class met for 2.5 hours once each week. There was a delay of 1.75 hours between the lecture and lab classes. My hypothesis was that the lecture activities and lab exercises carried out during the treatment period would increase student awareness of and interest in plants, improve student observations of plants and their motivation to learn about plants, and that their knowledge of how plants are important to humans would increase. In addition, that teaching the class using these materials would improve my motivation to continue teaching botany and plant science.

Treatment Unit: Plants, Soil, Water and People

A mixture of traditional lecturing, viewing video clips, two out-of class assignments, small-stake assessments, development of a plant portfolio and participation in two new lab exercises were used for the treatment unit. The purpose of including several different types of activities during the treatment unit was to capture the interest of students with a variety of learning styles. Capturing their interest would hopefully increase their awareness and appreciation of the various roles that plants play in their lives (e.g., historic, economic, and ecological). Although lecturing was the primary teaching method used in lecture classes, the plant topics covered were nontraditional. Rather than strictly focusing on physiology and reproduction in plants, as is typically done during this unit, plants were considered from historical, chemical, medicinal and economic points of view.

During the 3.5 days of the treatment unit, I provided information on plant nutrition, including a discussion of how water and soils meet those nutritional needs. Much of the background information was similar to that presented during previous semesters. However, this time I incorporated many more colorful and larger plant images and images of people interacting with plants in their environment. I also included a historical discussion of the U.S. Dust Bowl of 1930-1940, noting how human interactions (i.e., farming practices) with this particular environment along with extensive droughts produced this severe landscape change. Two videos on erosion, one on wind erosion and one on water erosion, and a music clip of Woody Guthrie singing “So Long, It’s Been Good to Know You”, a song about the Dust Bowl, were incorporated into this discussion. Comparisons were then made with modern day droughts and dust storm damage to make a connection between the past and the present.

For the first lecture treatment assignment, students were directed to several web sites to find farm subsidy information and to consider economic decisions that U.S. farmers make when growing two of our largest crops – corn and soybeans. Students also did some brief research into high-fructose corn syrup (Appendix A). For the second lecture treatment assignment, students were required to view two short online videos about soil and soil restoration and read two brief articles on plant nutrition. They then answered several question on the content of these materials (Appendix B).

The treatment for the lab portion of this class consisted of several activities designed to increase student observation skills of their surroundings and of local plants. During the first treatment lab session Virginia Pates, a professor of art, taught the students basic observation and sketching techniques. With her guidance, they practiced sketching live plant materials brought into the lab; see examples of student artwork in Appendix C. We left the classroom to view campus trees outside our building; however, our visit was brief due to a high wind and extremely low temperatures. At the end of this lab session, students were tasked to develop a portfolio of 10 plants from a list of 23 local trees and vines (Appendices D and E). A Campus Nature Trail map that could be used when observing, photographing, and sketching campus trees and vines on their own time was provided via a web-link in the course Blackboard. Copies of several booklets including “A Winter Tree Finder” by Watts and Watts (1970) and “Common Native Trees of Virginia” (VDOF, 2012) were made available for students to borrow to use to identify their chosen plant species.

The next 2.5 classes focused on medicinal plants and then ecological principles using plant, rather than animal, examples were introduced. My students come from many different cultures. Hoping to attract the attention of the greatest number of students, I began the lecture on medicinal plants with a history of plant medicinal uses incorporating historical art images and information from a number of different cultural sources (i.e., Chinese, Egyptian, Arabic, Indian, Native American and European). The lectures included information on the chemical nature of medicinal compounds found in plants, and their roles in nature regarding human health. The unit concluded with a discussion of a spice (turmeric) and a plant root (ginseng) that have been used in the past and in the present to improve human health. Current scientific data was used to support the efficacy of using these plant materials to treat certain human health issues.

For the second lab session of the treatment unit, several students collected live materials from eastern arborvitae trees (*Thuja occidentalis* L.) on campus and brought these into the lab for everyone to evaluate the antimicrobial properties of different structures (i.e., bark, leaves and cones). During the final treatment lab, students participated in a tea-brewing activity that included tasting various teas purported to have medicinal or positive health effects. As part of this lab exercise, students also researched which chemicals were present in the teas, in which plant structure(s) the chemicals are located, and noted any physical reaction that they may have had to the teas (Appendix F). A number of books on medicinal and herbal plants were put out for students to refer to and they were allowed to access Internet sources to determine the chemicals present in the various teas.

Non-treatment Unit: Plant Structure and Growth

The non-treatment unit covered plant structure (i.e., cells, tissues, organs) and plant growth in both the lecture and lab portions of the class. I relied solely on the lecture method of teaching for the lecture classes. Classroom equipment failures resulted in the inability to access the computer and projector to share notes with the students during the first three lecture classes. Despite posting Adobe-PDF files of notes in the course Blackboard, few students accessed them or printed them off prior to each lecture class. Therefore, I had to resort to "chalk talk" to present material as students were not comfortable with just an oral presentation.

The lab portion of the non-treatment unit lasted for 2.5 hour periods over two weeks. During that time, students participated in traditional exercises by preparing microscope slides with fresh plant materials to be viewed through binocular microscopes. These slides were supplemented with pre-mounted commercial microscope slides. Using dissecting microscopes, students viewed emergent roots and root hairs on radish seeds that had been germinated for three days as part of examining plant development and growth. They also grossly viewed the leaves and stems of bean seedlings that had been growing for 2-3 weeks. A limited number of images, herbarium specimens, and fresh materials of stem and root modifications were placed out for students to view.

Research Design and Instrumentation

Prior to implementing data collection for this project, approval to carry out this capstone project was obtained from Dr. Mary Vander Maten, the Assistant Dean for Biology and Natural Sciences (Appendix G) at NOVA's Annandale campus. She also exempted the project from requiring informed consent for the participants (Appendix H). The research methodology for this project also received an exemption by the Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix I). Student participation in project activities was voluntary.

This capstone project was conducted over seven weeks from January 12 through March 3, 2015; see Appendix J for the project timeline. In order to answer my research questions, several instruments were designed to collect quantitative and qualitative data from student participants regarding their attitudes and knowledge of plants. Data were collected from several different sources (Table 1). This triangulation of data was used to help ensure that the instruments I used to collect data were valid. Reviews of surveys and assessment instruments by my project advisor, Dr. Walt Woolbaugh, guided the development of these evaluation tools. Additionally, several activities were piloted with classes of other instructors. Feedback from those instructors and their students helped to improve the content and quality of surveys, worksheets and activities. Peer observation of me and my class provided objective views of our interactions. Student interviews provided additional project data.

All of my students were presented with three surveys and two assessments during the course of this project. Baseline data regarding general knowledge of, past experiences with, and interest in plants and plant-related topics were gathered from all enrolled students using an anonymous survey on the first day of lecture class (Appendix K). During the first lab session, students viewed 27 plant-based lab stations to determine their interest in various topics regarding plants. Questions were present at some stations for students to evaluate their prior knowledge of plant importance to humans. As students rotated past each station, they filled out a lab worksheet (Appendix L). Several students were also interviewed during this pretreatment unit (Appendix M).

During the non-treatment unit, students were assessed regarding their ability to identify local woody trees and vines using a worksheet to record their answers (Appendix N). Twenty images of 17 trees (e.g. dogwood, white oak, hickory) and three vines (i.e. poison ivy, Virginia creeper, and wild grape) common on our campus and in local forests were downloaded from the Internet and imported into an MS-PowerPoint presentation. For the non-treatment survey, each PowerPoint slide contained two to three images of the whole plant in leaf and a close-up of its flower and/or fruit (Appendix O) as these forms

Table 1
Triangulation of Data

Focus Questions	Data Source 1	Data Source 2	Data Source 3
Primary Question:			
What are the effects of participating in people-plant exercises on student attitudes towards plants and student motivation to learn about plants?	Pretreatment and post-treatment class-wide student surveys	Pretreatment interview with individual student regarding their attitudes towards plants and their motivation to learn about plants	Post-treatment selected individual student interviews regarding attitudes towards plants and their motivation to learn about plants
Sub-questions:			

What are the effects of participating in people-plant exercises on student understanding of the importance of plants?		Pretreatment survey of plant knowledge Pretreatment and post-treatment field observations of class by instructor		Pretreatment interviews with individual student about the importance of plants		Post-treatment assessment about the importance of plants
What are the effects of participating in plant-people exercises on student ability to identify campus woody plants?		Pretreatment survey of student ability to identify campus woody plants		Delayed spontaneous post-treatment assessment of student ability to identify campus woody plants		Pretreatment and post-treatment individual student interviews regarding their ability to identify campus woody plants
What are the effects of teaching plant-people focused exercises on teacher attitude, motivation, and pedagogy?		Field observation of class by colleagues during non-treatment unit; student survey post non-treatment and post-treatment		Instructor weekly reflection journal		

of the whole plant in leaf and a close up of its flower and/or fruit (Appendix O) as these forms were mostly likely to be the ones that student would recognize. At the end of the non-treatment unit, all students were surveyed regarding their level of interest in the course material and their impression of the instructor interest in the course material to date (Appendix P).

At the end of the treatment unit, all students enrolled in the class were individually reassessed on plant identifications (Appendix Q). For this post-treatment assessment, images of winter twigs, overall winter shape of each tree, and images of the bark were used because students had worked with these to create their plant portfolios. For both assessments, I used images of many of the species that Schussler and Olzak (2008) used for their project involving recall of plant and animal images. All students were surveyed post-treatment regarding their attitudes towards plants (Appendix R). Three students were selected to be interviewed individually to gather more detailed information about their attitudes and motivation post-treatment (Appendix S).

By including all students in the plant identification survey and assessments, I could evaluate any improvement in class-wide observational skills and in the class' understanding of the various roles plants play in human lives. Comparison of pretreatment and post-treatment survey results, allowed me to evaluate changes in student attitudes. Surveys were not graded; however, students were awarded three points for participating in each exercise.

Students completed one graded assessment each after the non-treatment and post-treatment units. All of the multiple-choice questions for the non-treatment period came from previous assessments that I have used for this course. A number of new multiple-choice questions were developed for the post-treatment assessment. If less than 50% of the class missed a question, I assumed that it was a valid question that could be considered a reliable indicator of student learning. Comparison of these two assessments allowed me to quantitatively evaluate student learning, assuming that grades are indeed indicators of learning.

Field observations of me and my class in both lecture and lab by two of my teaching colleagues provided objective evaluations of my teaching and its effects on my students provided qualitative data for this project. For these evaluations, colleagues observed me and my students early in the non-treatment period. The colleague chosen for the lab observation period was the assistant dean for my department, Mary Vander Maten. Mary has been teaching at NOVA for over 20 years; she has been the assistant dean for 10 of those years. Part of her job is to observe and evaluate all teaching faculty during the year. Mary observed me and my students during the initial plant identification survey. Afterwards, she shared her comments with me.

The colleague chosen for the lecture observation period was Cindy Miller. She has over 25 years of teaching experience and is an excellent professor. She does evaluations regularly as part of her current job as the director for NOVA's Center for Excellence in Teaching and Learning (CETL). At the end of the observation period, I was asked to leave the room while she interviewed the class. Cindy's classroom evaluation included comments on both my teaching techniques and the reactions of students to my teaching. Her observations helped me determine if I presented a positive attitude towards the subject matter and my students. Her observation of my students provided an independent view of student interest in the course material and their reaction to my teaching style and course content. After her classroom observation, she provided me with insights into improving my teaching and relating better to my students. Due to weather-related school closings and subsequent schedule changes, observations during the treatment period were not possible.

I also observed my students during the lab portion of class, once each during the treatment and non-treatment units. I focused mainly on their engagement with the lab activities and attempted to gauge their level of interest in those activities. Several students were randomly selected pre-instruction and were interviewed to gather more detailed information about their attitudes and previous experiences plants (Appendix M). Three to four students each were interviewed after the non-treatment and post-treatment units (Appendix P). To ensure that students were aware of the importance of all surveys and interviews, I spent 10-15 minutes during our first lab class explaining why this project was being carried out and how their learning would be assessed.

To assess my own attitudes and motivation to teach plant biology, I relied on journaling throughout the entire project. This type of data is qualitative and was useful for me to keep track of my observations and reflections regarding the class over time (Mills, 2011, p. 86). I took notes during informal observations of the class regarding any positive or negative behaviors that occurred, as well as my reactions or impressions of the class activities. Notes were entered into my journal in the evenings after the classes by typing them into a word document. I used these notes later that same day or during the week to help me reflect on the class and its activities, as well as reflecting on my attitude and motivation during the semester. These reflections were also noted in my journal.

Methods of Data Collection and Data Analysis

In order to answer my primary research question – “What are the effects of participating in people-plant exercises on student attitudes towards plants and student motivation to learn about plants?” − I relied on pretreatment and post-treatment surveys of student interest in and awareness of plants. These surveys were carried out using Likert scale and open-ended responses. The Likert scale responses were numerically coded – strongly disagree (1), somewhat disagree (2), neutral (3), somewhat agree (4), and strongly agree (5). Averages for Likert-based responses, plant identifications, and grades for non-treatment and post-treatment assessments were calculated. Using numerical values allowed means and standard deviations for responses to be calculated. All of these data were entered into an Excel spreadsheet. Using the Excel Data Analysis Pak add-on, the pretreatment and post-treatment numerical data were analyzed using a Student t-test.

A Student t-test, or t-statistic, is an analysis of two populations or of the same population at two different points in time (Zar, 2010). This is a relatively simple test that can be used for a small population, such as a single class section ($N \leq 28$). The data for the two points in time to be compared would the pretreatment and post-treatment scores for plant identifications and assessments. The t-test was performed using two-tails, assuming unequal variance between groups as the data sets were uneven, and the significance value was set at $\alpha = 0.05$. This test allowed me to determine if there was any significant difference ($p \leq 0.05$) between pretreatment and post-treatment student interest in plants, in student ability to correctly identify 20 plants commonly found in their immediate environment, and in non-treatment and post-treatment assessments (Zar, 2010). Use of this simple statistic would allow me to accept or reject my null hypotheses.

The responses to open-ended survey questions, information gleaned during student interviews, and my journal notes and reflections are qualitative data. Therefore, I incorporated that information into the narrative in the results section.

Class Demographics

I teach the second semester of a two-semester general biology course that includes plant biology, general botany, and special topics in botany at Northern Virginia Community College in Annandale, Virginia. The college is located 14 miles west of the District of Columbia. Our community college serves approximately 78,000 students annually with 22,000 of those students attending the Annandale campus (OIESSI, 2014). My students are freshmen and sophomore undergraduates on this campus, the largest of our six campuses. The second-semester general biology course has two prerequisites – placement into college-level English and a passing grade (D or better) in the first semester of general biology.

This capstone project was conducted with 28 freshmen enrolled in my general biology class. Students in this class predominantly identified themselves as non-science majors who were taking this course to satisfy their general education science requirement (Table 2). The class population had more female students than male students. The class was culturally diverse with a population that was 39% Caucasian, 32% Hispanic, 21% Asian, and 7% African and African-American. Twenty percent of students at NOVA are international students and many others are first generation English speakers. The second greatest number of full-time teaching equivalents at NOVA is for English as a Second Language (ESL) courses, indicating that many of our students are ESL students (OIESSI, 2014). Although eight of my students had strong non-English accents, only four identified themselves as being non-native English speakers. One student had a learning disability and required an accommodation of additional time for taking assessments.

Students were the traditional age for college freshmen and sophomores (18-23 years) at NOVA (OIESSI, 2014).

Table 2
Student Demographics (N=28)

	Male	Female	Native English speaker	Non-native English speaker	Science major	Non-science major
N	12	16	24	4	4	24
%	43	57	86	14	14	86

DATA AND ANALYSIS

The initial survey of class awareness and interest in plants (Appendix K) included questions about student attitudes towards science and general learning (Figure 1), preferred learning methods (Figure 2), as well as prior experiences with plants (Figure 3) and opinions of plants (Figure 4). The latter was surveyed both pre- and post-treatment.

Although students strongly agreed that hands-on learning was an important method of learning and somewhat agreed that they were confident in their knowledge of science, they were neutral regarding enjoying learning about plants (Figure 1). Students ranked video viewing as their preferred learning method (Figure 2). Ranking this learning method so highly became a problem during the non-treatment portion of the project when computer failures would not allow in-class showing of videos. While links were provided in the course Blackboard, students stated that they preferred viewing them in class as part of the lecture. Students agreed strongly with the statement that plants are important in their daily lives and were somewhat interested in naming things (e.g. trees). Despite this, they were again neutral regarding wanting to learn more about them. Although students were confident in their drawing ability, this did not correlate with a preferred method of learning.

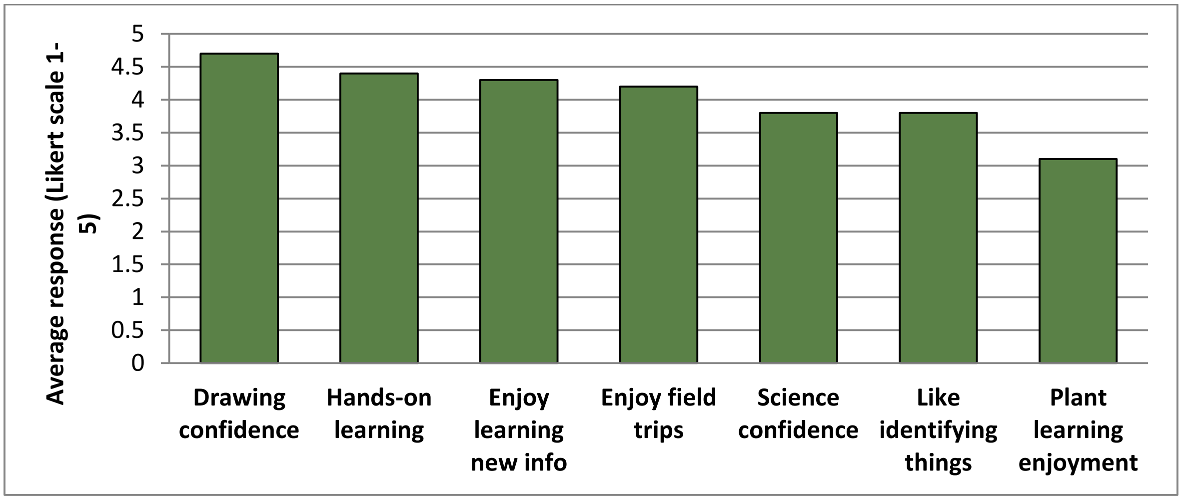

Figure 1. Initial survey of student learning enjoyment, (*N*=28).

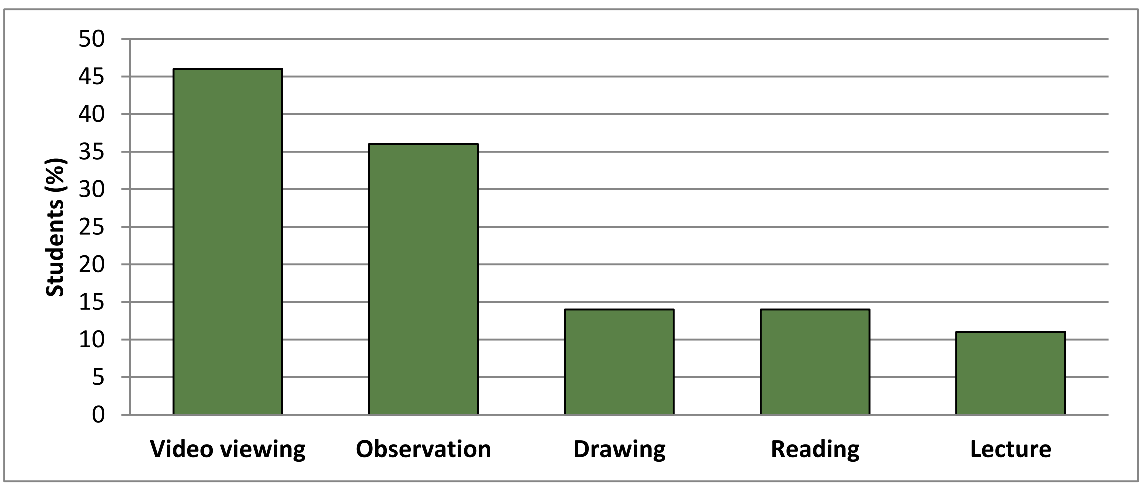

Figure 2. Student-preferred learning method, (*N*=28).

Most students had some experience caring for or working with plants prior to this semester (Figure 3). However, one-third of the students (*N*=9) had no reported prior experience with plants. Fifty-seven percent of the students (*N*=16) had at least grown plants from seeds in elementary school. I found this surprising, as I thought that this was an experience shared by all elementary school children.

Figure 3. Prior student plant experiences, (*N*=28).

In a pilot study, several students noted on their answer sheet that they knew the name of a plant in their native language but not in English; two students wrote some of their answers in Korean and Arabic. Thus, I was curious to see if the responses of ESL students would differ from native speakers and responses by language groups were examined. Before conducting the initial surveys, I had considered allowing students to use Google Translator to write English equivalents. However, I decided against allowing their use as I was concerned that if computers were made available to all students, some would use them to look up the answers ruining the baseline, or pretreatment, data.

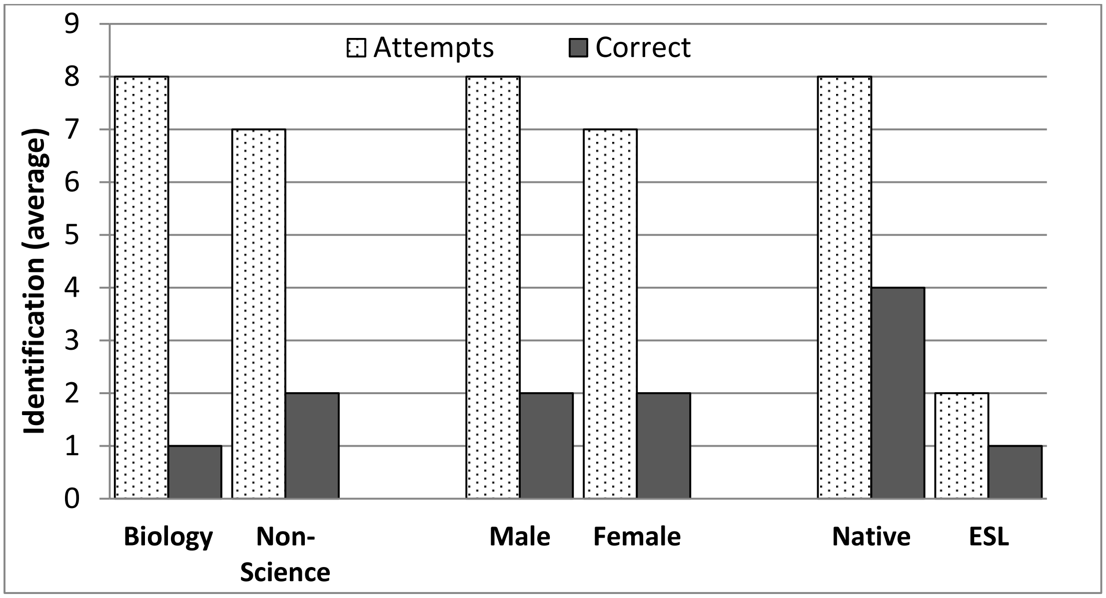

Figure 4. Pretreatment identification of plants by student major, gender, and language, *(N*=27*).*

Data for the initial number of attempted identification of plants and the number of correct responses by all students are presented in Figure 4. Biology students attempted to identify slightly more plants than did non-science majors; interestingly, non-science majors correctly identified more plants (p=0.00). Male students attempted to identify more plants than female students, but identification success was the same for both genders. The average number of attempted plant identifications by native English-speaking students was significantly higher than attempts by non-native English-speaking students (*p*=0.00). However, the percent of correct identification of plants attempted was the same (50%) for both language groups.

The plants that students were initially best able to identify were pine (*N*=9), sweetgum (*N*=8), holly (*N*=8), and poison ivy (*N*=7). Students were best able to identify these same species post-treatment. The pine and holly are evergreen species in leaf year-round. Poison ivy and sweetgum each have distinctive characteristics that students easily recognize – a hairy vine form for poison ivy and the spikey fruits of the sweetgum.

Pretreatment and post-treatment identifications for all students were compared and these results are presented in Figure 5. Despite the use of different image sets, correct identification of woody plant species increased between the pretreatment and post-treatment units. Gains for the class as a whole (50%) were significant (*p* =0.04). Although correct recognition of plants by females was higher than males, this difference was not significant.

There was a single outlier in the data for the post-treatment identifications. One student identified 11 trees correctly. This student stated that he had prior experience identifying trees when involved in scouting activities and in another biology course. Removing this outlier value did not alter the significance (*p*=0.11) of the results for comparing male and female identifications post-treatment.

The ability of students to identify common local plant species was consistent with that found in a study by Schussler and Olzak (2008) involving plant and animal recall. Their study also found that female identification of plants was significantly better than that of male students (*N*=327; $p < 0.0001$). They posited that females are more able to correctly identify common cultivars and local plants because they may receive flowers as a cultural expression of affection. However, all the species identified in this project were woody and not in flower. Students participating in this project disagreed with their hypothesis by noting that the person with the most successful identifications was male, not female, and many female students felt that gender was of no consequence. Although some female students agreed that they do like receiving flowers, they also stated that this doesn't mean that they can identify the flowers given.

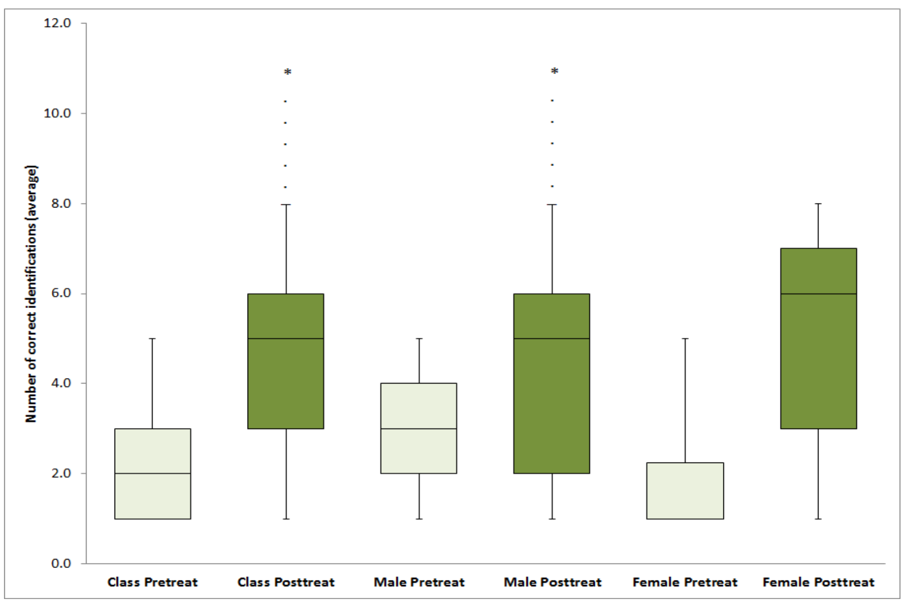

Figure 5. Correct identifications of woody plant species, (*N*=27).

Overall, students were neutral (3.0 out of 5 on a Likert scale of 1-5) regarding learning about plants. This attitude score was unchanged between the pretreatment (3.1), and non-treatment (2.9) and post-treatment (3.0) unit surveys. Students did find that the class "somewhat" impacted their thinking that plants are important. Students rated plant importance to be slightly lower post-treatment (4.4) compared with pretreatment (4.6) (Figure 6).

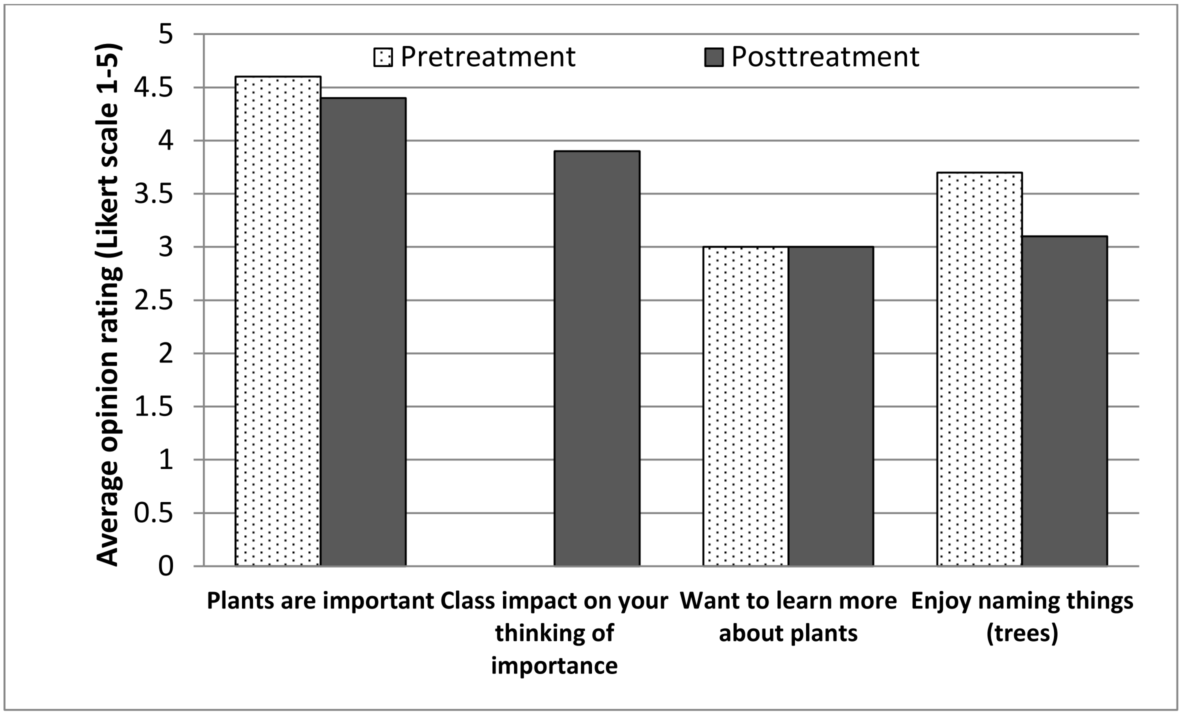

Figure 6. Student opinions regarding plants, (*N*=28).

Although I focused on plants in the environment and medicinal uses of plants, I did not specifically talk about plants in their daily lives, nor did I assign them work or have them participate in a discussion of possible roles or uses of plants in their daily lives. Additionally, students gave the lowest interest ratings to the pretreatment stations with plant-based materials commonly found in our lives, such as rubber, cotton, and art materials. The highest ratings were for coffee and tea, grains (i.e. barley, corn, millet, oats, rice, sorghum, and wheat) and medicinal uses of plants. The interest in grains was surprising as students showed little interest in seeds. Perhaps their curiosity was piqued as to the identity of the grains other than rice and corn.

Student attitudes regarding enjoying plants or wanting to learn more about plants remained unchanged over the course of the pretreatment (3.1), non-treatment (2.9), and treatment (3.0) periods. Several students persisted with their initial assertions that they just weren't interested in plants. One student ended his comment by reassuring me, "but it's ok if you like them." In the open-question responses on the survey and during student interviews post-treatment, 61% of students attributed this to having to do the plant portfolios during the winter months – "This should not be part of the class when it's –15° outside", "I didn't enjoy identifying trees in the wintertime," and "I didn't like having to take pictures myself outside for the portfolio project."

I found the results for the portfolio assignment to be mixed. Although class-wide identifications of plants improved (50%), there was no apparent correlation between individual portfolio grades and individual post-treatment identification grades. Several students with poor academic performances received grades of 90% or better on the portfolio assignment but failed to do well on the post-treatment assessment. Some of my previous students who scored poorly on exams, did better on out-of-class assignments. This may be due to having more time to do their work and to use multiple learning skills, such as observing and drawing, other than taking a standard assessment.

The highest grades earned were by students who followed the directions for carrying out the assignment most completely. The student who enjoyed doing the portfolio the most (5 out of 5 on the Likert scale) had a physical disability that required her to use a multi-tipped cane. Yet this student spent the most time outside observing, photographing and sketching trees. She even went to a county garden, walked the trails there after a snowstorm, and recommended the garden to other students. On the other hand, the student with the highest course grade steadfastly maintained her position that plants were of no interest to her throughout this project.

Despite being worth 40 points (3% of the overall course grade), two students did not do the assignment and 12 (43%) turned in an incomplete assignment. The uncompleted portion for most of these assignments was the dichotomous key of 10 chosen plants. Students began these keys during one of the lab periods but interviewed students commented that this portion of the assignment was "too hard" and "would have taken too much time, so I didn't do it." Although the average attitude scores were neutral, student grades for plant identifications post-treatment were significantly higher than those non-treatment (p = 0.04).

At the end of the non-treatment unit, only half of the students rated themselves as being somewhat interested (*N*=13) or very interested (*N*=1) in the information on plant structure. An equal number were neutral (*N*=8) or not interested at all (*N*=6), in the material. Repeated equipment failures, snow closings and one instructor absence due to illness may have contributed to the overall low ratings for the course at that time. Many students (*N*=12) commented on the projector failures; additional comments from the student survey given after the non-treatment period are found in Table 3. Despite the extremely cold weather, three students asked about the possibility of going on field trips. For this same period, the majority of students (*N*=21) rated my apparent interest in the course material as being very high.

The highest pretreatment interest was in the coffee and tea station. Therefore, I was excited that I had incorporated a tea excise into the lab schedule at the beginning of the semester. This tea lab followed a lecture assessment and a number of students were very interested in trying teas that purported to have calming effects. A few students claimed that they did not like tea but they did participate in the exercise. One student emphatically stated, “I don’t like any kind of tea!” However, when she saw everyone else brewing and sipping tea samples, she decided, “but I think I’ll try the green tea” and even rated this as her favorite lab activity. Several students carefully studied different tea boxes before making their four selections. Post-treatment, the majority of students (52%) rated this as their favorite activity by giving it their highest interest rating (4.3 out of 5). This was the activity that I enjoyed the most, too as the students were very relaxed and chatting with one another and weren’t in a big rush to leave the lab. One of the male

Table 3
Student Comments on Making Non-treatment Information More Interesting

Videos demonstrating plants or something to actually see; more pictures	11
Hands on, feeling plant, looking at it; field trips (botanical gardens); it would be helpful to see the parts on a plant in person because most of them are very strange to us	6
Be more entertaining or exciting; games; lazers [*sic*]	4
Seeing how plants can be used for other things, for example medicine, how they work in the body	3
Administrative comments (request for study guidelines, exam questions, class timeliness)	3
Clear data; some information all very similar	1
Nothing much; plants do not interest me at all	1

students interviewed stated, “I’ve never done anything like this before. Men don’t usually drink tea but I really enjoyed it.” Other students commented on the flavors, “I liked it [ginger tea] because it was different from other teas” and “it was spicy,” “great with honey,” and “I liked the bitter taste [of the green tea].” On their worksheets, students also commented on the sweet and strong fruity flavors of the honey-lavender and pomegranate-raspberry teas.

From the outset of the course, I had planned on presenting a lecture on medicinal plants and was relieved to find out from the pretreatment survey that the students gave their second highest interest ratings to medicinal plants. Interestingly, they rated their interest in the roles of plants in cultures to be equal to that in medicinal plants. Students gave the antimicrobial lab their second highest post-treatment interest rating. Several stated that they liked testing fresh materials from plants found in their immediate environment for their antimicrobial properties. At the end of the treatment unit, students somewhat agreed (3.9 out of 5) with the statement, “The antimicrobial lab increased my awareness of, or interest in, medicinal plants.”

Knowledge assessments were made after the non-treatment and treatment units (Figure 7). Males performed better on the non-treatment unit assessment (i.e., plant structures and growth) whereas females performed better on the post-treatment unit assessment). The class overall performed better on the post-treatment than the non-treatment assessment; however, the difference between the two assessments was not significant.

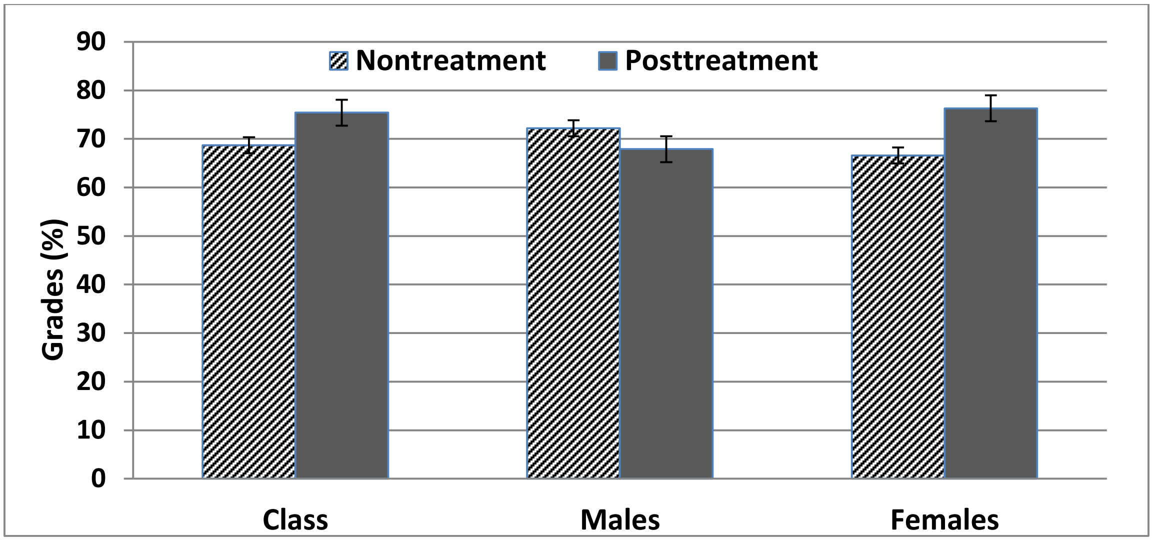

Figure 7. Knowledge assessments after non-treatment and treatment units.

High grades on assessments did not correlate with an interest in plants. One student, a Business Administration major, provided negative (1 out of 5) or neutral responses to every statement about plants. She even gave field trips a neutral rating and stated that what she didn't like about them "was the inconvenience of going somewhere new." The student also did not like to name things, had never grown anything from seed, never cared for plants or picked fruit, and whose only early memory of plants was "we had pots in my balcony when I was a child." On the final survey, the student did not comment on any open-ended questions except one and that was to state that she "did not like the plant portfolio and it didn't help me much." The only activity that the student enjoyed during this project was the tea exercise (5 out of 5). Surprisingly, this student earned a near-perfect grade in lab and the second-highest grade in the course. My experience has been that students in this major are often very focused and can do well in science even when they don't especially like the subject. However, I was disappointed that the student was steadfast in her assertion that she recognized the importance of plants in our daily lives (5 out of 5) but still had no interest in learning about them. Two of the four biology majors surveyed were also neutral regarding their interest in plants.

My disappointment stems from hoping that this approach to learning about plants would be more palatable to just such a student. However, I need to accept that some people persist in their ideas even when presented with a smorgasbord of new ones or new approaches to ideas. I think that the student's comment regarding field trips may have been telling. Perhaps the biology requirement and learning about plants, like going on field trips, was merely an "inconvenient" course needed to satisfy a general education requirement rather than a true learning experience.

Classroom observations by two colleagues provided objective qualitative data of student engagement with course materials. Dr. Vander Maten noted that the students were intently watching the plant images during the identification survey in lab. After the survey, I told the students to put away their pens and pencils and then showed them the images again with the answers. Dr. Vander Maten commented that the students laughed or groaned at their mistakes and were teasing one another about their scores. Perhaps because this wasn't graded but they were given participation points there wasn't a pressure to perform well but students did appear to take the survey seriously.

I met with Cindy Miller about a week after her observation of me and my students during a lecture class. She noted that the content, my level of interest, and my presentation of the material was fine. She thought that student attendance was exceptionally good as everyone enrolled was present and most were seated at the beginning of class. Cindy then made two very important comments for me regarding my behavior towards the students. One was that I was tardy coming to class and because I didn’t have things set up this resulted in getting the class started unacceptably late. Several students were upset and commented on this. They stated that this showed a high degree of disrespect for them. She really took me to task on this and told me that I needed to get off on a better footing with the class by apologizing to them for this behavior. I took her admonishment seriously and did apologize during the next class.

The second comment was that I failed to make eye contact immediately with the students. She didn’t think that this was related to being tardy as she had observed me once before. Even though it has lessened as I've aged, my nature is to be shy. After 10 years of teaching, I think of myself as being comfortable in the classroom and with my students. However, after meeting with Cindy, I was more aware of both behaviors during successive classes and worked on changing them.

Writing in a journal on classroom management and pedagogy has always provided me with a good source of self-feedback. Although I have good intentions to do this on a regular basis, I don’t often make the time do so. Being required to journal for this capstone was a good requirement for me and one that I hope I can continue with in future semesters.

Reading through my journal, one of the important themes related to time management, as noted by Cindy with regard to being tardy. About two weeks into this project, I already noted my concern for its outcome:

I’m worried that I haven’t provided clear enough guidance on the direction of the class. I’ve been coming up with materials last minute. Some are modifications of what I originally proposed to do and others are new materials [e.g. lecture notes and assignments] I’m developing last minute. One of my faults is that I don’t always finalize the development of materials until the last minute because I overthink them and spent too much time researching background information. I also let family needs distract me from my work.

Another theme that journaling revealed is that I can get discouraged by student lack of interest in botany, in science, in learning, and by student cheating and overreliance on technology for answers. One of biggest advantages to journaling is that as I write out my frustrations, they begin to dissipate. Rereading the entries can also reveal trends in classroom management quickly so small problems don’t escalate into more difficult ones. I also noted positive feedback from students regarding plants, “a student told me about enjoying plants because his mother grows herbals and he helps her with them. He even volunteered that he’d collected some amber from trees and would share a piece with me.” The student did share some and this prompted me to do some research about amber.

Lastly, I also noted positive interactions with colleagues in my journal. Previously, I’ve felt that many my colleagues have a disinterest in plants or lacked enthusiasm for them. In doing this project and reaching out, I did get some much-needed positive feedback and support from adjunct faculty members. I will try to interact more with faculty identified as having an interest in plants.

To improve my teaching, I need to truly commit myself to journaling at the end of each teaching day. The way to make myself accomplish this task on a regular basis is to take 15 minutes before leaving school, shut my office door, and ignore the emails and phone messages. This is the only way to accurately record my daily observations so I can reflect on them later. I am able to find reflection time at home before bedtime but need to have the observations noted in a journal to do so.

INTERPRETATION AND CONCLUSION

The null hypothesis for my primary research statement – that lecture and lab activities focusing on plant-people relationships would have no effect on student attitudes and awareness of, and interest in, plants – was accepted. The null hypothesis for the first research sub-question, that student participation in lecture and lab activities focusing on plant-people relationships would not improve their knowledge of plant importance to humans would increase was rejected based on increased grades for an assessment post-treatment compared with an assessment taken after the non-treatment unit. The null hypothesis for the second research sub-question that student participation in lecture and lab activities focusing on plant-people relationships would have no effect on student ability to identify campus woody plants was also rejected. This rejection was based on greatly improved grades between the pretreatment and post-treatment tree identifications. Finally, the null hypothesis for the last research sub-question, that plant-people focused exercises would have no effect on my attitude and motivation to teach botany was rejected. Although disappointed that student interest in plants did not change, I was encouraged by the level of involvement observed in lab activities. Developing new course materials reinvigorated my own interest in botany and I feel challenged to expand on topics in which students were interested. I enjoyed watching my students' enthusiasm for the tea lab. Their interest was so great that I've been inspired to find more types of teas for them to try in the future.

In the future, expanding on those topics and activities that students did enjoy might help change their attitudes and level of interest. For instance, I'm doing more reading on tea and am considering adding the cultural aspects of tea drinking into a future class. I might challenge (or give an assignment to) some of my business students to do some research into the economics of teas and coffees to the class. Students expressed a strong interest in field trips in the pretreatment survey. Therefore, it might be useful to include field trips to a local park or botanical garden during warmer summer and fall semesters. During winter months, a field trip to the (warm and indoor) Conservatory of the U.S. Botanic Garden in nearby Washington, D.C., may produce more positive responses from students rather than developing a plant portfolio. I think that drawing requires patience and improves observation skills, so would like to encourage this type of activity. Perhaps students could create information sheets on two or three local trees rather than developing an entire plant portfolio.

Due to equipment failures and missing two classes, the schedule had to be modified from the original one. Planned in-class activities (i.e., student discussions) were omitted to try to complete the project within the project time constraints and the need to move on to other required course topics. I could have better prepared some of my instruments before the project. For instance, the homework assignments could have better aligned with the lecture material covered. Working with the data in a more timely fashion, especially the survey result, might have provided the opportunity to modify some materials to better support this project. I could have altered some of the interview questions to get a better sense of individual student reactions. For instance, while students noted that "observation" was their preferred method of learning, they meant viewing videos whereas I thought that this meant direct observation. It wasn't until I was collating the data near the end of the project that I recognized this difference.

VALUE

Carrying out this research project allowed me to learn which plant topics are of interest to students. I'm encouraged to build on this interest by developing more materials regarding topics that the students did enjoy. Expanding the medicinal plant lecture to include specific health-related topics, expanding the antimicrobial lab exercise by incorporating more plants (e.g. garlic, ginger, and peppermint), and focusing on the most liked teas for the brewing and tasting exercise might increase student interest. I'm also considering a homework assignment in which students research plants that contain chemicals for maintaining health or used for certain medical conditions. For example, ginger and peppermint are used in several cultures to aide in digestion. Taxol, a chemical currently used to treat several forms of cancer, was originally isolated from the bark of yew trees.

In my journal, I noted that sharing new plant material with students and having it received well was refreshing. In one of my reflections, I was also reminded how flexible students can be at times. Despite the equipment failures and resulting negative responses regarding old-fashioned" methods of teaching (i.e., writing and drawing on a chalkboard), students regularly attended class and behaved appropriately in class.

Having colleagues come into my lab and classroom provided needed objective evaluations of my pedagogy. After 10 years, I'm quite confident in my teaching but have been concerned that I might be becoming complacent. Based on evaluations by my students, that is not the case. However, I do have two behaviors that have negatively impacted my interactions with my students – failing to make initial eye contact with students upon entering the classroom and being tardy. I began monitoring myself and found I did fail to make that initial eye contact, so I started to be more conscientious about doing so. It was quite an uncomfortable experience for me. However, I recognize the importance of making that initial eye contact and will continue to practice doing so until it becomes a more natural act for me.

The more important lesson I learned was that the failure to be timely in my work and in arriving to class tardy risked negatively impacting this project and the relationship with my students. I spend a lot of time researching and updating teaching materials for my classes each semester and try to keep abreast of current news items to bring into classroom discussions. However, in the last year or two, I am often rushing just before classes to prepare a quiz, print off a handout, or make copies of the day's assignment. I'm beginning to realize that while I may be good at long-term course preparation, I've recently allowed myself to lose focus on preparing for my daily classes. I need to regain this focus to ensure positive relationships with my future classes and feel a stronger sense of confidence in the classroom.

Doing this action research project has played a very important and positive role in helping me renew my interest in teaching botany classes. I enjoyed working with my students this semester and am looking forward to teaching botany classes in the near future. I enjoyed teaching the plant exercises, especially those focusing on health and medicine in the general biology course. Gathering ideas and developing materials for these new exercises, and working with faculty in another discipline was stimulating. I appreciated that I was given the responsibility for developing these activities. It was interesting to pour through books written by authors who considered plants from non-traditional aspects. Interacting with people outside of my institution has also been refreshing. My advisor, Walt Woolbaugh, has provided me with a number of ideas for my classes and Dorthybelle Poli (Roanoke College) gave pointers for carrying out the tea lab.

Sharing some of my new teaching materials from this project at a peer-group science meeting with faculty from other community colleges in Virginia was helpful in stimulating ideas for more new lab activities. Several faculty members are now interested in working with me to develop new plant-based lab activities for our general biology and ecology courses. One faculty member has approached me about collaborating with her on a lab activity isolating bacteria from plant nodules that could be used in both courses as well as our microbiology classes.

Incorporating some of these new activities into our general biology course is unlikely to happen in the near future as the course has to meet specific standards of learning (SOLs). While these new lab activities might support the SOLs, a committee would have to justify and approve their use. Although I was able to carry out these activities with a single class, some of the activities might not be suitable for 30 class sections. However, these could be offered as supplementary activities to be used at the option of the instructors.

Developing a new course specifically focusing on plant-people relationships and using these project activities may be a more practical alternative as I could have more control over the course content. Including faculty identified as “plant friendly” would increase support and improve content for such a course. A strong course might require 5-7 years to build and this project is the start of that new course development.

All of the students who had experiences with plants had one experience in common – growing plants from seeds in elementary school. Most of their plant memories were from childhood. Numerous studies have noted that science education at all levels focuses on animals to the exclusion of plants. Thus, this project supports the idea that grabbing and directing student attention towards plants may need to be accomplished well before undergraduate years.

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APPENDICES

APPENDIX A

TREATMENT UNIT CLASS ASSIGNMENT 1

TREATMENT UNIT ASSIGNMENT 1 – CORN, SOYBEANS and YOU

According to Andy Hecht, in a commentary piece written for CGQ (an online trading tool), the price of a commodity (something of value that is bought and sold) may be cheap or expensive depending on economic decisions made by the producers or consumers of that commodity. If the price of a commodity becomes too expensive, consumers may select another, cheaper commodity as a substitute. Conversely, producers that have a choice between producing one commodity or another will choose the one that yields the best economic return. For example, each year farmers may choose which of two crops to plant on their land – soybeans or corn. A farmers' decision is usually driven by which crop is expected to yield them the greatest profit that year.

After reading the above, answer the following questions. You may refer to any internet source except Wikipedia. List your source of information with each response. When writing your answers, use your own words to summarize any information used – to just rewrite, type or cut-and-paste from other sources as this would be plagiarism. Type your responses directly into this Word document.

1. **List** three items in human diets that are made from, corn, besides high fructose corn syrup (HFCS).
2. **List** two human uses of soybeans. Who, or what, are the largest consumers of soybeans in the U.S. (i.e., soybeans NOT traded away)?
3. **State** the important agricultural relationship (not the business or economic relationship) between corn and soybeans – i.e., **explain** why farmers may grow these two crops singly in different growing seasons or grow them in different proportions from year to year.
4. If corn was the only crop planted on all the farms in the state of Iowa for five years in a row:
   a. What do you think might happen to corn prices nation-wide? **Explain** your reasoning.
   b. What you think would likely happen to the soils of those farms? **Explain** your reasoning.
5. What is a farm **subsidy**? Visit: http://farm.ewg.org/progdetail.php?fips=00000&progcode=corn&page=states&regionname=theUnitedStates
   a. Which state received the greatest amount of monetary corn subsidies 1995-2012?
   b. What is Virginia's state ranking with regard to receiving corn subsidies?
6. Visit these three websites regarding high fructose corn syrup (HFCS):
   a. http://hfcshfcs.weebly.com/bibliography.html
   b. http://www.livestrong.com/article/276694-the-hidden-dangers-of-high-fructose-corn-syrup/
   c. http://www.ncga.com/news-and-resources/news-stories/article/2012/1/nothing-sweet-about-flawed-hfcs-research
      i. What is **high fructose corn syrup** (HFCS)?
      ii. Evaluate the types of sources of information for each website. [Summarize the types of sources – i.e., opinion pieces, government data, consumer advocacy group, trade association]
      iii. Come to class prepared to defend or support the use of HFCS.

APPENDIX B

TREATMENT UNIT CLASS ASSIGNMENT 2

PLANT, SOIL, WATER and PEOPLE – ASSIGNMENT 2

1. Read Chapter 36 in your textbook and/or read the PowerPoint (PPT) slides for "Plants, Soil, Water and People.

2. Watch the video about The Importance of Soil [6.39']: https://www.youtube.com/watch?v=qMFo5fxE8Bs

   ANSWER: Based on this video and/or your textbook and/or class PPT notes, describe the role of water in soil formation:

3. Watch the very short video about "Restoring the Earth" [2:12']: https://www.youtube.com/watch?v=hZx2nsrJG3Y

   ANSWER: Based on this video Based on this video, ***describe*** two things that humans can do to restore the soils of the earth:

4. Read the 1-page article "Dirt Poor: Have Fruits and Vegetables Become Less Nutritious: http://www.scientificamerican.com/article/soil-depletion-and-nutrition-loss/

   ANSWER: 1. Why are the following minerals found in plants important in your diet? [HINT: You may need to refer to your textbook or a good internet source to answer this question]

   i. Calcium:

   ii. Iron:

   iii. Phosphorous:

   iv. Magnesium:

   ANSWER: 2. What is one explanation give by the author for why our food has become less nutritious?

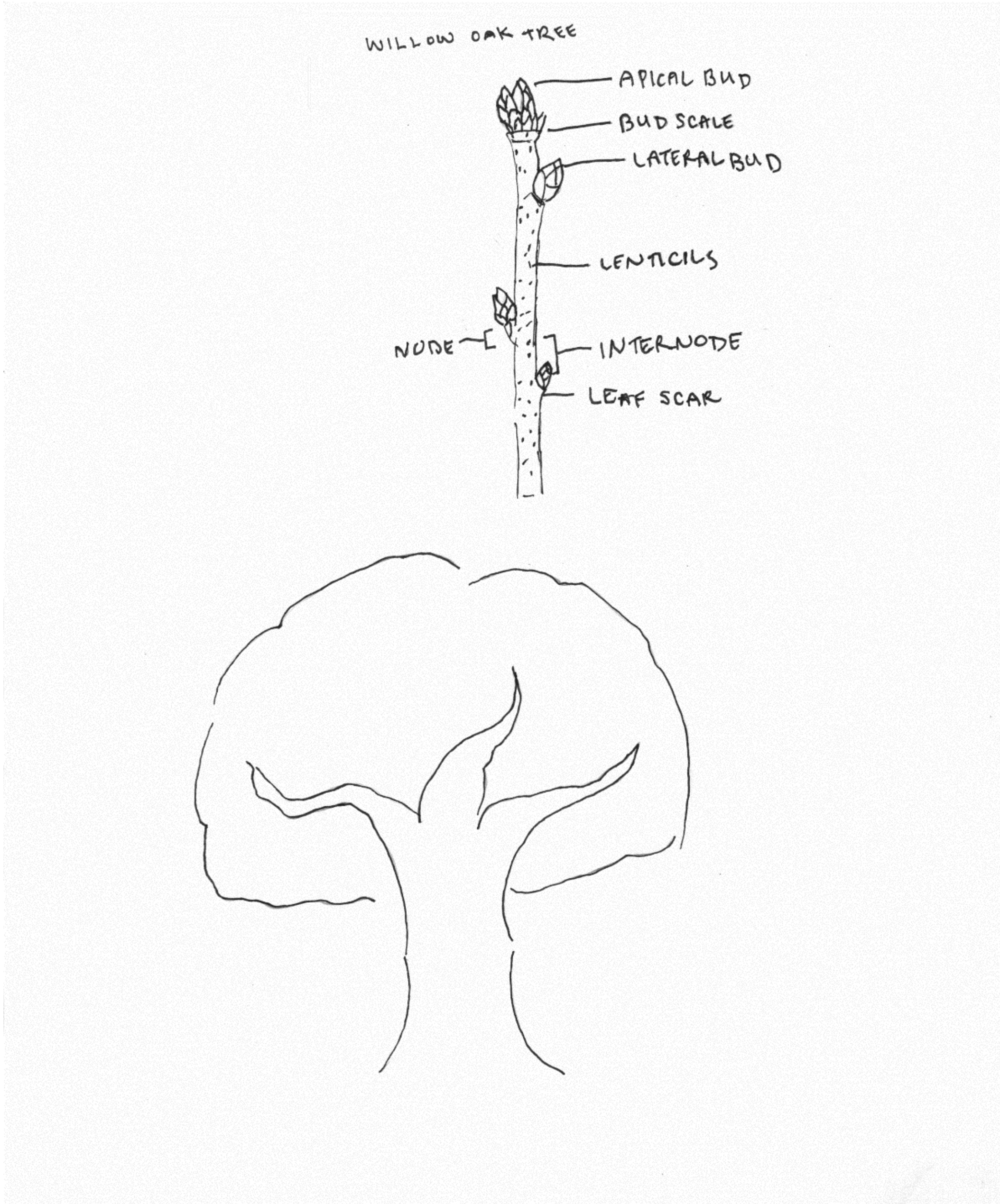
5. Read the Scientific American article "Future Farming: A Return to Roots" – PDF is linked in Bb; based on this article:

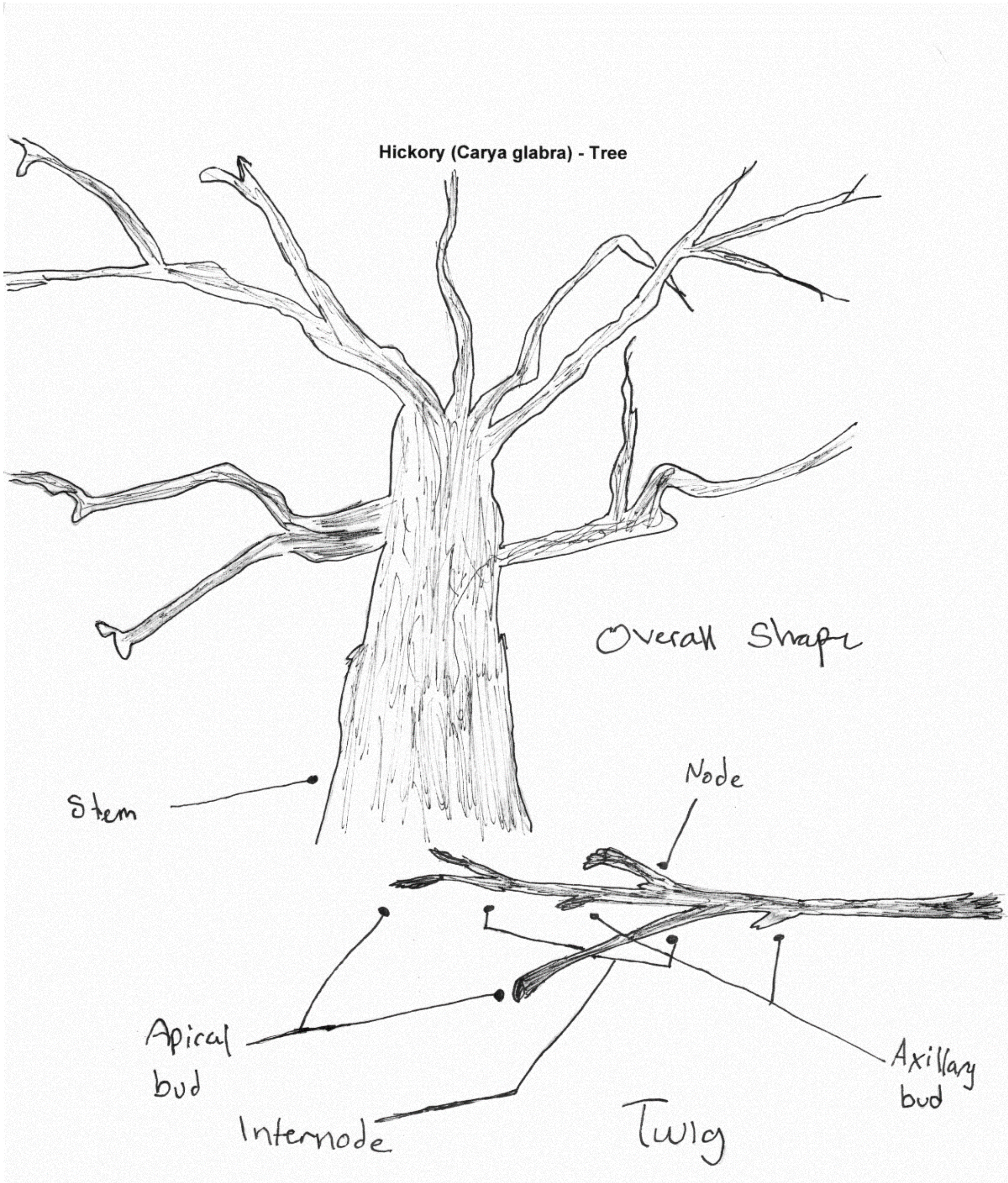
a. Write out a definition for “sustainable agriculture”:

b. Describe one way that farmers can increase their future yields of crops:

APPENDIX C

EXAMPLES OF STUDENT BOTANICAL ARTWORK


WILLOW OAK TREE
APICAL BUD
BUD SCALE
LATERAL BUD
LENTICILS
NODE
INTERNODE
LEAF SCAR


Hickory (Carya glabra) - Tree
Overall Shape
Stem
Node
Apical bud
Axillary bud
Internode
Twig

APPENDIX D

PLANT PORTFOLIO GUIDELINES

Guidelines for Woody Plant Portfolios

DIRECTIONS: In addition to the directions below, you are encouraged to work with a partner but you must each choose 10 different plants. This will help you become familiar with all 20 species assigned. All written and drawn work MUST be your own!

A. **Goal** – Choose 10 species of the 20 plants on the "BIO 102 – Plant Portfolio" checklist to work with for the next month. At least one of these species must be a vine. The **purpose of this assignment** is for students learn to identify 10-20 common woody plants in our area. In doing so, you will hopefully develop an awareness of, and appreciation for, local tree and vine species. Becoming aware of other living things is the first step in promoting the ethic of conservation.

B. **Portfolio information requirements**, for <u>each</u> tree or vine chosen:
   1. A drawing of the winter woody twig or vine on a blank sheet of white paper – we will begin this part of the assignment in lab together on 2/2/15:
      a. Drawing must have a title at the top of the page that includes the common name of the plant and its growth form (i.e., tree or vine)
      b. Identify structures – refer to general twig graphic previously used for homework, but additional or unique features should be included in sketch or as a note with your graphic
   2. A photo of the bark taken by you or one of your lab partners – document the source.
   3. View and sketch or collect an image (may be your personal photograph or copy of a line drawing from a book or online image) of the overall tree shape. At the bottom of the page you must document your source as being yours with your initials or book/website citation.
   4. A one-line description of the type of habitat the species is found in.
   5. A short description of how humans specifically utilize that plant species (i.e., medicinal, economic, religious, etc.) written in your own words, *not just copied from an internet or book source;* source of your information must be included.
   6. A short description of how other organisms utilize that plant species written in your own words, *not just copied from an internet or book source*; source of your information must be included.

C. **Dichotomous Key** – You must create a dichotomous key of your 10 species that you created with a lab partner. This is the one item that may be identical in both of your portfolios. We will begin the work on these in lab.

D. **Portfolio Format**
   1. Portfolio must be submitted in a paper-based notebook or folder with your checklist.
   2. Portfolio must have a cover page with a Title, Your name, Date of Submission, BIO 102
   3. Each page must have a title that includes the name of the plant sketched, photographed or written about.

4. Sketches and photographs must go on one page. Short, typed (10-12 point font) or VERY neatly written descriptions [see #4, #5 and #6 above] for each species must be on a single page.

APPENDIX E

PLANT PORTFOLIO CHECKLIST AND RUBRIC

Student name: ____

BIO 102 - Plant Portfolio Checklist **LOCAL VIRGINIA TREES and VINES**

	Common name	Sketch of twig	Bark Photo	Tree silhouette (drawn/image)	Plant use by humans	Plant use by others	In plant i.d. key	Points
1.	Sweet gum							
2.	Poison ivy							
3.	Red cedar (juniper)							
4.	Beech							
5.	Sassafras							
6.	Pine (white)							
7.	Holly (American)							
8.	Magnolia							
9.	Oak (willow)							
10.	White cedar (Atlantic)							
11.	Sycamore							
12.	Oak (white)							
13.	Maple (red)							
14.	Arborvitae (eastern)							
15.	Dogwood							
16.	Cherry							
17.	Virginia creeper							
18.	Hickory							
19.	Redbud							
20.	Tulip tree (tulip poplar)							
21.	Wild grape							
22.	Sumac							
23.	Boxelder							

COMMENTS: ____ **TOTAL:** ____

APPENDIX F

TEA LABORATORY EXERCISE

TEAS and Medicinal Uses for Plant Chemicals

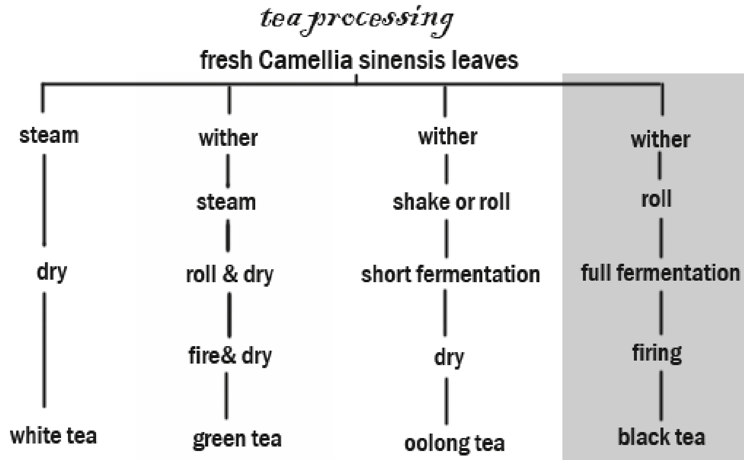
Lab Objectives – After this lab, you should be able to:

1. Define the following terms – **tea, medicine**, **disease** and **placebo**. Review the term **pathogen**.
2. State the name of the plant that produces leaves used in black teas.
3. Identify several chemicals found in plants used in teas.
4. Give two specific examples of chemicals in teas that have medicinal effects on the human body.

Background Information

Plants are known to produce chemicals called phytochemicals in their flowers, leaves, roots, bark, seeds and/or cones. After water, tea is the most consumed drink on earth! Tea was first consumed by the Chinese as a medicinal drink. **Medicines** are chemicals that cure, treat or prevent a **disease** – a disorder of a structure or function of an organism. Most of our synthetically produced pharmaceuticals were originally derived or isolated from plant materials. Some medicines, both those from plants and pharmaceuticals, are actually used as **placebos** – substances that have no true physiological effect on the body but may have a positive psychological effect on someone.

Shen nong (神 农), a Chinese emperor and herbalist, is credited with introducing tea drinking to people over 4,000 years ago. True teas such as black, green or oolong teas comes from the leaves of the plant *Camellia sinensis*, an evergreen shrub that grows on acidic soils (pH = 5.4 to 5.8) in Asia. As mechanical harvesting is difficult on slopes and bruises leaves, the tea leaves are plucked by hand from the shrub and then steamed or roasted. The leaves are “fermented” or oxidized to release different polyphenol chemicals that produce the unique flavor of each tea type.



On the other hand, **herbal teas** are actually infusions of herbs or flowers and berries from plants other than *Camellia sinensis*. For example, chamomile tea comes from the dried flowers of several different aster species such as *Matricaria chamomilla* ("pineapple weed") and *Anthemis arvensis* ("chamomile"). Rose "hips" or fruits of wild roses are dried and ground then steeped in boiling water to produce a drink rich in Vitamin C. Tea has played an important role in the history and culture of China, India, Great Britain and the United States.

Plant material will come from numerous plant sources today. Each student will taste 3-4 teas at the different stations set up in lab. Then work with your lab group to determine the chemicals present and the effects of those chemicals. Note if the advertised effects and the actual effects are the same. In particular, view the Sleepy Time and medicinal tea boxes for advertising claims regarding their medicinal or health properties.

Laboratory Work

1. In each group of 3 or 4 students, fill the water kettle at your lab bench with tap water. Turn the kettle on to boil.

2. For teas with loose materials (i.e., flowers and/or leaves), place the material in a tea ball or infuser.

3. Select and try 4 different teas. Check any advertising on the package each tea came in. Place that information, along with other data, on Table 1 provided on

page 4 of the Lab Worksheet.

4. Then work with students in your lab group to complete the worksheet and answer the review questions.

LAB WORKSHEET Student Name: ______________________________

Tea Chemistry – Lab Review Questions

1. Explain what is **tea:** ____

   ____

2. Which part(s) of plants can be used to produce tea? Give at least two different examples of teas produced from different parts of plants.

   a. ____

   b. ____

3. The scientific name for the plant from which black, green and oolong teas come is:

   ____

4. Which type of plant is this? **Flower / Shrub / Tree** [circle one term]

5. Out of the 4 teas tasted, which tea did you enjoy the most? _________________

   Explain what you liked about this tea:

   ____

6. What determines the amount of caffeine that will be present in a cup of tea?

   ____

   ____

7. Compare one of the advertised effects of a tea that you tasted with the actual effects:

   ____

Table 1.
Worksheet for tasted teas

Tea Tasted	Medicinal or Health Benefit Advertised	Chemical Present	Chemical Location in Plant Body	Actual Medicinal or Health Benefit	Source of Information

Source for tea processing graphic:
http://iml.jou.ufl.edu/projects/fall05/hanna/flowchartblack.gif; accessed 02/21/15

APPENDIX G

NORTHERN VIRGINIA COMMUNITY COLLEGE APPROVAL FOR CAPSTONE PROJECT

ADMINISTRATOR APPROVAL FOR CAPSTONE PROJECT

I, Mary Vander Maten, Assistant Dean of the Department of Biology and Natural Sciences at Northern Virginia Community College – Annandale Campus, verify that I approve of the classroom research conducted by Lisa D. Williams.

Mary Vander Maten, Ph.D.
Email: mvandermate@nvcc.edu; Office phone: 703.323.3228

12/15/14
Date

APPENDIX H

NORTHERN VIRGINIA COMMUNITY COLLEGE EXEMPTION

REGARDING INFORMED CONSENT

ADMINISTRATOR EXEMPTION REGARDING INFORMED CONSENT

I, Mary Vander Maten, Assistant Dean of the Department of Biology and Natural Sciences at Northern Virginia Community College – Annandale Campus, verify that the classroom research conducted by Lisa D. Williams is in accordance with established or commonly accepted educational settings involving normal educational practices and that I approve the project. To maintain the established culture of our school and not cause disruption to our school climate, I have granted an exemption to Lisa D. Williams regarding informed consent.

Mary A. Vander Maten ______________________ 12/15/14 ______________

Mary Vander Maten, Ph.D. Date

Assistant Dean, Dept. Biology & Natural Sciences
Northern Virginia Community College
Annandale Campus, Room CS-204
Email: mvandermate@nvcc.edu; Office phone: 703.323.3228

APPENDIX I

INSTITUTIONAL REVIEW BOARD EXEMPTION FORM

INSTITUTIONAL REVIEW BOARD

For the Protection of Human Subjects
FWA 00000165

MONTANA STATE UNIVERSITY

960 Technology Blvd. Room 127
c/o Immunology & Infectious Diseases
Montana State University
Bozeman, MT 59718
Telephone: 406-994-6783
FAX: 406-994-4303
E-mail: cherylj@montana.edu

Chair: Mark Quinn
406-994-5721
mquinn@montana.edu
Administrator:
Cheryl Johnson
406-994-6783
cherylj@montana.edu

MEMORANDUM

TO: Lisa Williams and Walt Woolbaugh

FROM: Mark Quinn *Mark Quinn cj*

DATE: March 5, 2015

RE: *"The Effects of Participating in a Plants and People Course on College Student Attitudes and Interest in Plants" [LW030515-EX]*

The above research, described in your submission of **March 5, 2015**, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

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

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

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

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

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

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

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

APPENDIX J

PROJECT TIMELINE

January 10, 2015:	Instructor journal reflection initiated
January 12, 2015:	Project implementation: student survey of prior knowledge and plant interest
January 14, 2015:	Began Instruction Unit 1 – pre-intervention: basic plant structure and physiology
January 21, 2015:	Observation of teacher by colleague during lecture class
January 26, 2015:	Brief observation of teacher by second colleague during Unit 1 lab class tree and vine identification survey
January 28, 2015:	Basic plant structure homework assignment distributed
February 2, 2015	Began lab portion of treatment unit Art instructor taught basic observation and sketching techniques for portfolio of woody species Plant portfolio assignment guidelines distributed Taxonomy lab with brief view of several campus trees Instructor observation of students during lab class
February 4, 2015:	Began Plants, Soil, Water and People lectures
February 9, 2015:	Instruction Unit 1 – traditional student assessment of knowledge
February 11, 2015:	Distributed treatment unit Assignment 1
February 16, 2015:	Medicinal Plants lecture Began Antimicrobial lab – set up Lab presentation on ecology of Chesapeake Bay by colleague
February 23, 2015:	Antimicrobial lab – conclusion; portfolio check Tea tasting lab activity with instructor observation of students Distributed treatment unit Assignment 2
February 25, 2015:	Ecology lecture with plant examples
March 4, 2015:	Plant portfolio assignments collected Post-treatment tree and vine assessment End of Project Implementation

APPENDIX K

PRETREATMENT SURVEY OF CLASS AWARENESS AND INTEREST IN PLANTS

Plant Science Questionnaire

No.	Survey Statement	Response - Please circle your response or write in the blank provided				
1	Plants are important in everyone's daily life.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
2	I think that I will enjoy learning about plants.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
3	What, in particular, are you hoping to learn about plants?					
4	Scientific knowledge is useful for every student.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
5	I am confident that I understand science.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
6	I enjoy the process of learning new information.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
7	I learn course material best in a hands-on learning environment.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
8	If hands-on learning is not the best learning format for you, what is?					
9	I like to learn to identify or name things.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
10	I best learn about living organisms by:	**Observing them**	**Drawing them**	**Reading about**	**Watching videos**	**Hearing a lecture**
11	I enjoy going on field trips.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
12	What is it you do or don't enjoy about field trips?					
13	When have you grown a plant from a seed?	**elementary school**	**middle school**	**high school**	**At home**	**Never**
14	Describe your first memory of a plant:					

15 OPTIONAL: Please make any additional comments below:

APPENDIX L

PRETREATMENT PLANT IMPORTANCE STATIONS AND INTEREST RATINGS SHEET

PLANT STATIONS INTEREST RATINGS Name: ____					
LAB STATION	STATION ITEM(s)	**DIRECTIONS** – *Check off your level of interest regarding the uses of the plant-based items at each station*			
		EXTREMELY HIGH = definitely will research more on my own	**HIGHER THAN EXPECTED** = might research more about this	**SOMEWHAT** = interesting to see but won't look into this more	**NONE/NOT AT ALL** = didn't excite/interest me
1	Wooden rake, nails, mallet, broom				
2	Mulberry leaves, silk purse and scarf, silkworm images & silk road info				
3	Fern fossils				
4	Seeds (sunflower, pine tree, radish, beans, caraway)				
5	Aloe plant, lime cough drops, witch hazel rub, aspirin, citronella				
6	Corks				
7	Woven baskets and graphic of women weaving them				
8	Pollen grains, honey jars, bee & hive images; colony collapse info				
9	Incense and amber				
10	Wooden religious items – carved Buddha, various religious beads				
11	5 types of lentils and plant image				
12	Small rubber tire				
13	Environmental landscaping images				
14	Cotton items: t-shirt, socks, thread on wooden spool, images of cotton plant being picked				
15	Painting and famous artwork images				
16	Images of plants on national symbols				
17	Coffee beans, tea leaves/ "brick"; images of both plants harvested				
18	Hemp images, twine, seeds, oil				
19	Images of rituals using flowers				
20	7 world grains				
21	Hops images, beer bottles & cans				
22	Soybean images, dried beans				
23	Wooden and cotton toys				

24	7 spices – seeds or dried plant parts				
25	Wood, dried grass twist, charcoal				
26	5 types of oils				
27	Fungi of plants				

APPENDIX M

PRETREATMENT STUDENT INTERVIEW QUESTIONS

Date of interview: __________ Student Name: ______________________________

1. Besides producing oxygen, how are plants are important in your daily life? Please explain.

2. What experiences have you had with plants before this class? Can you give me some examples?

3. Have you regularly cared for plants? If so, can you explain how?

4. What was the main reason that you signed up for this second semester of the general biology course? Please explain.

APPENDIX N

NON-TREATMENT PLANT IDENTIFICATION SURVEY AND

POST-TREATMENT QUIZ ANSWER SHEET

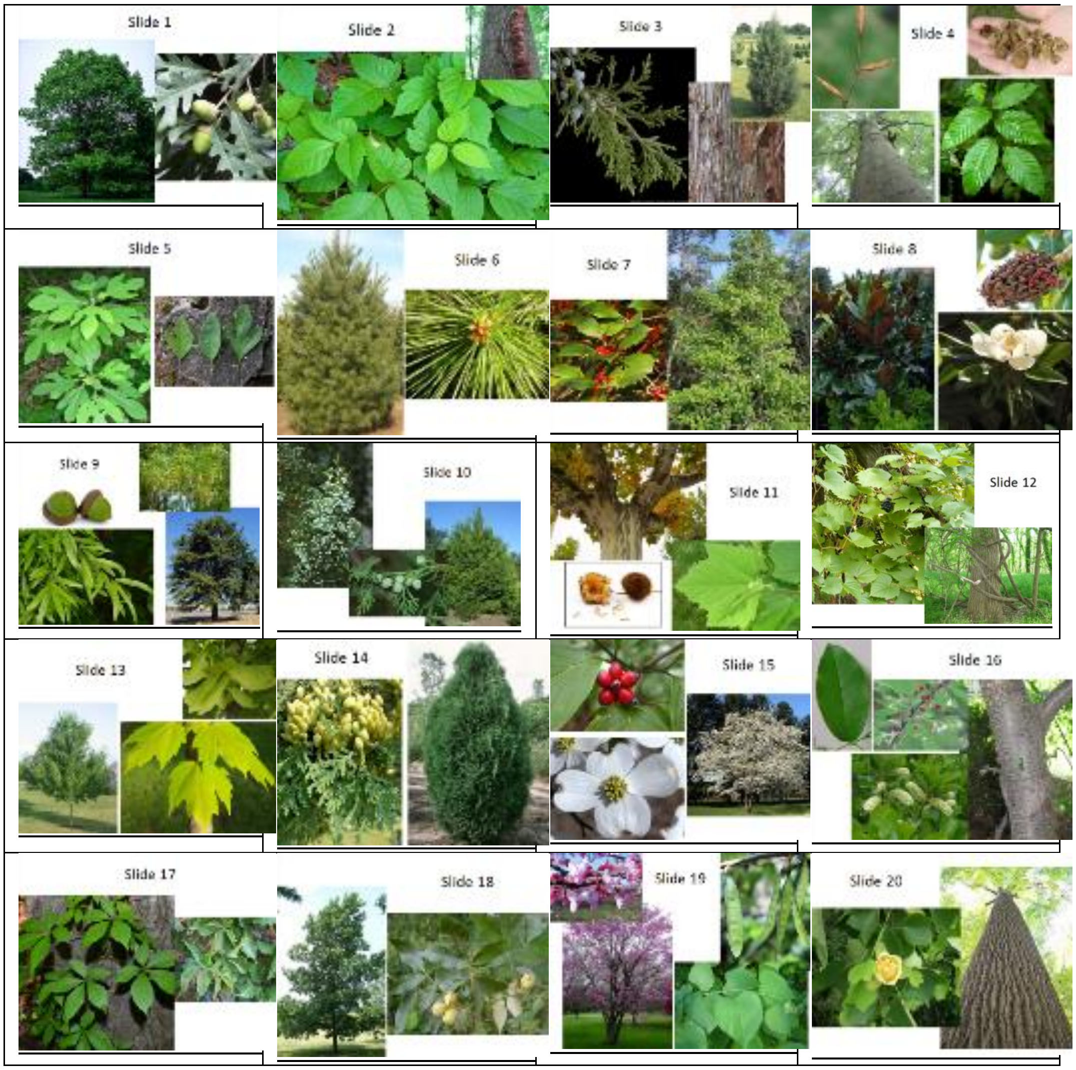
Plant Identification Answer Sheet Student Name: ______________________________

Twenty images of common local trees and vines will be displayed. Each image will be shown for 15 seconds with a 10-second delay between images. Write the name of the tree or vine below. Be as specific as possible.

1. ____ __________
2. ____ __________
3. ____ __________
4. ____ __________
5. ____ __________
6. ____ __________
7. ____ __________
8. ____ __________
9. ____ __________
10. ____ __________
11. ____ __________
12. ____ __________
13. ____ __________
14. ____ __________
15. ____ __________
16. ____ __________
17. ____ __________
18. ____ __________
19. ____ __________
20. ____ __________

APPENDIX O

NON-TREATMENT PLANT IDENTIFICATION SURVEY



ANSWER KEY

1) white oak, 2) poison ivy (vine), 3) juniper or red cedar, 4) American beech, 5) sassafras, 6) white pine, 7) American holly, 8) magnolia, 9) willow oak, 10) Atlantic white cedar, 11) sycamore, 12) riverbank grape (vine), 13) red maple, 14) eastern arborvitae, 15) flowering dogwood, 16) wild cherry, 17) Virginia creeper (vine), 18) hickory, 19) redbud, 20) tulip tree

APPENDIX P

STUDENT SURVEY AFTER NON-TREATMENT UNIT

Student Survey after Unit 1

1. Rate your interest in the course material to date:

   VERY INTERESTED SOMEWHAT INTERESTED NEUTRAL NOT INTERESTED

2. Rate the instructor's apparent interest in teaching the course material to date:

   VERY INTERESTED SOMEWHAT INTERESTED NEUTRAL NOT INTERESTED

3. What could make this course material (i.e., plants) more interesting to you?

4. Any comments on the course to date?

APPENDIX Q

POST-TREATMENT PLANT IDENTIFICATION ASSESSMENT

ANSWER KEY

1) sweetgum, 2) poison ivy (vine), 3) Atlantic white cedar, 4) American beech, 5) sassafras, 6) white pine, 7) magnolia, 8) American holly, 9) river birch, 10) sumac, 11) English ivy (vine), 12) oak, 13) wild cherry, 14) red maple, 15) honeysuckle (vine), 16) flowering dogwood, 17) hickory, 18) redbud, 19) tulip tree, 20) hop hornbeam (musclewood)

APPENDIX R

POST-TREATMENT PLANT SCIENCE QUESTIONNAIRE

Plant Science Questionnaire

FINAL Survey for Plants and Ecology Student Name: ________________________________

No.	Survey Statement	Response - Please circle your response or write in the blank provided				
1	Plants are important in everyone's daily life.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
2.	I am interested in learning more about plants.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
3.	The focus of these units has increased my awareness of the roles of plants in the environment.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
4.	Did you learn what you hoped to learn about plants? Please explain.					
5.	After this portion of the course, how important do you now think plants are in our everyday lives?	**Less than before taking this class.**	**Slightly less than before taking this class.**	**About the same as I did before taking this course.**	**Somewhat more than before taking this class.**	**Much more than before taking this class.**
6.	The most interesting thing I learned about plants this semester was:					
7.	I enjoyed learning to identify or name the trees and vines.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
8.	I found the drawing exercise helpful for creating my tree portfolio.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
9.	The antimicrobial lab increased my awareness of, or interest in, medicinal plants.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
10.	I enjoyed the tea lab activity.	**Strongly Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Strongly Agree**
11.	What is it you did or didn't enjoy about the plant and ecology portions of this course?					

OPTIONAL: Please make any additional comments below:

APPENDIX S

POST-TREATMENT INDIVIDUAL STUDENT INTERVIEW QUESTIONS

Date of interview: __________ Student Name: ______________________________

1. Which activity, or activities, helped you to understand the importance of plants in this class? How so?

2. Which was the most interesting plant exercise? Please explain why.

3. What was the most challenging part of the plant and ecology unit?

4. Is there anything that could have made the plant and ecology part of the course more interesting?