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Furthering Entomological Outreach and Education for High School Aged Students with Madagascar Hissing Cockroaches

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This project was designed and conducted as an entomological educational outreach program for high school students. I was given access to an environmental science class at Kaiserslautern High School (KHS) under the guidance and supervision of a licensed teacher. Environmental Science is an elective class that fulfills the course requirement at the school for a science course with a laboratory component. I was given three groups of students, and I taught four classes to each of these groups. Each class had students in their freshman, sophomore, and junior years. During these class periods, I composed a food preference experiment that involved Madagascar hissing cockroaches (MHCs). This experiment drew heavily on my own experiences during my studies (i.e., ENTO 115 at the University of Nebraska, Lincoln). This project aimed to increase entomological education at this school. Lastly, I highlighted the use of technology in the classroom to better assist the instructor.

Background

My name is Robert Guy Lefevre, and I am currently in my 17th year of active-duty service in the United States Army. I have served as an artilleryman, a transportation coordinator, and a bandsman. I am currently serving as a guitarist in the U.S. Army Europe Band and Chorus garrisoned at Sembach, Germany, and I am currently a Staff Sergeant. I hold a Bachelor of Arts in History from California State University at San Bernardino. I was accepted into the Master of Science in Entomology program at UNL in 2015. I can attest that crossing over from the arts side to the science side of campus was a particularly arduous undertaking. In this paper, I further expand on how my experiences as a soldier and an academic greatly facilitated my connection with the students in such a short timeframe.

My sponsor teacher was Ms. Nancy Hoehn. Ms. Hoehn holds a Bachelor of Science in Food Science from Purdue University and a Master of Arts in Human Relations from the University of Oklahoma. She is credentialed in Texas as a licensed physical science teacher and is currently employed by the Department of Defense Education Activity (DoDEA) as an environmental science and physics teacher. Ms. Hoehn has been recognized as a National Geographic Certified Educator, a NASA Solar System Ambassador Master Teacher, and is a Google Certified Educator (Level 1). It cannot be expressed how her experience and education aided this project, particularly her Google certification.

Kaiserslautern High School is a secondary education facility that is in the Kaiserslautern military community. It is located on the United States Army Garrison Rheinland-Pfalz, Vogelweh. Vogelweh, as it is colloquially known, serves the greater Ramstein Airbase community. This area of Germany has approximately 30,000 American uniformed personnel and their families. Kaiserslautern High School is one of two DoDEA high schools. Kaiserslautern High School has a student body population of approximately 550 students. It is the newest school to be built in the DoDEA Europe area.

Timeline

This project began in July 2019 with an initial proposal to the board of advisors at the entomology department at UNL. Upon approval of the proposal by the board, I began to seek the approval of KHS. I had to formally present my proposal to KHS administration. In September 2019, I presented my proposal to the KHS principal, assistant principal, and Ms. Hoehn. I was granted line-of-sight volunteer status. I was allowed access to eight class periods with the caveat that I take on all three environmental science classes rather than only the one I was seeking. The KHS administration and Ms. Hoehn were very excited to have me. It was agreed that Ms. Hoehn and I would meet on Thursdays beginning in September so that she could assess and critique my plans.

September 2019 was dedicated to procuring materials and constructing MHC enclosures. I was able to source two different breeders of MHCs. Other materials required were 18 individual enclosures and an environmentally controlled locking cabinet to house the enclosures and MHCs. I provide a comprehensive list of all materials and constructed items later in this paper.

Early October 2019 was dedicated to writing curriculum and designing assessments. It was at this time that Ms. Hoehn introduced me to Google for Educators and the entirety of the Google Suite. Ms. Hoehn provided me with several web resources for writing effective lesson plans. I used the lesson plan generator at teach-nonogy.com (teAchnology 2019). Later in this paper, I expand further on the ease of use and the synergistic effect that the Google Suite played.

It was agreed that I would be in the classroom on the 17, 21–25, 28, and 29 October, 2019. Kaiserslautern High School has an alternating schedule that allows for 90-minute periods, with red days comprising periods 1 through 4 and white days comprising periods 5 through 8. My three environmental science classes were periods 4, 5, and 6; see Figure 1. This meant that I had two white day classes and one red day class. While I was scheduled for eight academic days, the red and white schedule meant I only had four class sessions to conduct all instruction, assessment, and laboratory work. Each class session was composed of instruction, laboratory work, and assessments.

Regular Daily Schedule

Red Periods	Times	White Periods
1	0820-0945	5
2	0950-1115	6
Lunch	1115-1200	Lunch
3	1205-1330	7
4	1335-1500	8 *Seminar

Day 1	17 Oct Red, 21 Oct White	Introduction	Lab setup
Day 2	22 Oct Red, 23 Oct White	Anatomy & Taxonomy	Trial 1 start
Day 3	24 Oct Red, 25 Oct White	Invasive Species & Pests	Trial 1 end, Trial 2 start
Day 4	28 Oct Red, 29 Oct White	Conclusion	Trial 2 end

Figure 1

Kaiserslautern High School is on a two-semester academic calendar, with each semester divided into two quarters. My time with the students coincided with the end of the first quarter of the first semester of 2019; 5 November marked the beginning of the second quarter of the first semester. The week of 28 October through 1 November was assessment week. I had planned on providing instruction on integrated pest management on Day 4, but time constraints did not allow for this. I was, however, utilized well as an in-class subject matter expert for the environmental science class's assessments during Day 4, as their assessments were centered around insects in the environment.

Materials

Materials were gathered throughout the month of September 2019. Kaiserslautern High School mandated strict guidelines for keeping and maintaining live specimens. The overall experiment also required that each group's specimen be housed individually to avoid interfering with other groups' experiments. A suitable enclosure was constructed from wood and 3mm plexiglass. The enclosure is fully lockable and contains environmental controls to ensure suitable living conditions for the specimens. The enclosure maintains an internal temperature of 25°C. Humidity is maintained by hand-spraying water into the terrariums. The total cost for the enclosure was €88 (USD$97), and it took three days to build, see Image 1. The terrariums contain coconut substrate, two feeding trays, a water source, and a cardboard tube, see Image 2.

Image 1

Image 2

This is a detailed list of items sourced from Amazon.de along with their corresponding links:

- Coconut substrate
- BraPlast terrariums
- Cardboard tube
- Food trays
- Water gel
- Trixie thermometer / hygrometer
- Lerway heating mat

The roaches were sourced from a local breeder near Frankfurt, Germany named MD-Terraristik.

Experiment Setup

As previously stated, this project was designed for entomological outreach and education. The goal was to foment an interest in biology, zoology, and entomology through hands-on experience and experimentation. I drew on my undergraduate experience and settled

on a food preference experiment. However, it was not enough to simply run a food preference lab. I wanted to gauge students' interest, knowledge, and comfort levels with insects. I also wanted to determine which pedagogical methods were most effective in the instruction of students when pertaining to entomology. In order to determine interest, comfort, and knowledge, I used a simple questionnaire at both the beginning and the conclusion of my time with the students.

I used a traditional lecture method and then contrasted it with a student-guided research assignment. After each class period with the students, I conducted a formative assessment to test content knowledge. It must be noted that only formative assessments could be conducted with the little time I had with the students. A summative assessment was conducted by Ms. Hoehn and served as the students' end-of-quarter assessment; my role in that was only as a subject matter expert. During the students' end-of-quarter assessment, Ms. Hoehn guided and mentored me in her best practices for guiding and inspiring the best critical thinking methods (i.e., using the Socratic method to prod students with questions and lead them to a desired outcome). Below are links to presentations, lesson plans, forms, and tabulated data used in these classes.

Google Docs Lesson Plans

Google Docs served as my main word-processing program. This paper was written with Google Docs. Google Docs has full interoperability with other programs in Google's suite and can be exported to Microsoft Word. With the *share* feature, I can send or share this work with anyone who has the link. Lesson plans were generated by an online template generator (teAchnology 2019).

Day 1 lesson plan

Day 2 lesson plan

Day 3 lesson plan

Google Forms Assessments

Google Forms is the oddity in the suite because it does not have an analogous Microsoft product. Google Forms makes quizzes, surveys, and other data-collection media. As with all programs in the Google Suite, the interoperability, collaboration, and sharing functionality of Google Forms streamlined and synergized this project. As an added bonus, Google Forms creates a response section that illustrates collected data in graphs and charts.

Registration

Day 1

Day 2

Day 3

Day 4

Google Sheets Responses

Google Sheets is analogous to Microsoft Excel and offers compatibility with it. These are raw data as collected from the Google Forms assessments. These data were generated from an automated action embedded within their corresponding Google Form.

Registration responses

Day 1 responses

Day 2 responses

Day 3 responses

Day 4 responses

Google Slides Presentations

Google Slides is analogous to Microsoft PowerPoint and offers compatibility with it. This was used to create my multimedia presentations for instruction, links for assessments, and sample lesson plans sent to Ms. Hoehn in advance so that she could place links to these documents in her Google for Educators area for the students to use and review.

Day 1 presentation

Day 2 presentation

Day 3 presentation

Day 4 presentation

These are videos of my lectures uploaded to YouTube

Class

Lab

Google Drive Links to Videos

These are standard mp4 video files of class and lab recording taken on my smartphone.

Class

Lab

Methodology

The methodology was very straightforward. I had four class periods to increase students' knowledge, make them more comfortable with insects, determine which pedagogical approaches work best in certain situations, and guide students through a hands-on experiment. This data was collected from students' self-reports and through individual assessments. The formative assessments given at the end of each day allowed me to demonstrate which pedagogical approaches were successful; a traditional top-down approach was used for Day 2 and a more student-guided approach for Day 3. I relied on three questions on the Google Forms titled "Registration" and "Day 4" to assess student knowledge of and comfort with insects; see Figure 2.

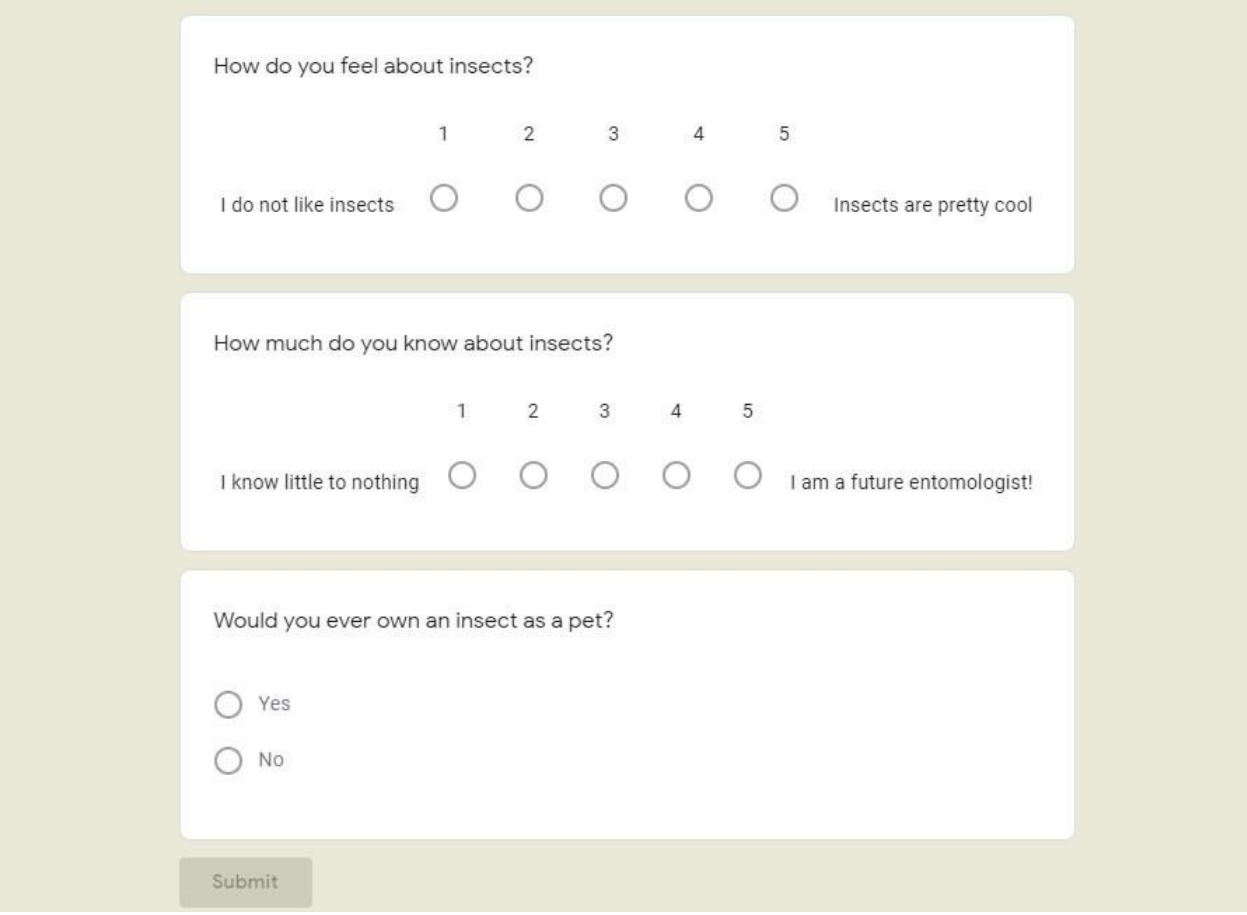

Figure 2

Day one consisted of an introduction to the MHCs and the food preference experiment. The "Day 1" presentation served as the media presentation for this block of instructions.

Groups were assigned specimens and terrariums and chose the food to experiment with. Students were given instruction on the MHCs and completed an assessment via the “Day 1” form. It was during this time that the “Registration” form was administered.

Day two consisted of beginning Trial 1 in the lab. Students brought in their experimental food, took measurements, and made observations. Instruction was given via the “Day 2” presentation. Day two instruction covered taxonomy, insect anatomy, and lifecycle in a traditional lecture format. All lab data and assessments were collected and conducted using the “Day 2” form. I used the “Is a Hotdog a Sandwich?” thought exercise to get students thinking about parameters and definitions (The Cube Rule 2019).

Day three consisted of concluding Trial 1 and beginning Trial 2. This was done at the suggestion of Ms. Hoehn. She told me that these students were familiar with lab experiments, but something such as this lab experiment should have a more forgiving approach to allow for human error and general unpredictability. Student groups tabulated data and made observations. Instruction was given via the “Day 3” presentation. The block of instruction covered “What is a pest?” and “What is an invasive species?” Instruction was given using two stories of insects from entomological history: the cottony cushion scale in California and the dung beetle in Australia. The student groups were then assigned one of the following invasive species:

Team 1 – Asian longhorned beetle (*Anoplophora glabripennis*)

Team 2 – Spotted lanternfly (*Lycorma delicatula*)

Team 3 – Khapra beetle (*Trogoderma granarium*)

Team 4 – Emerald ash borer (*Agrilus planipennis*)

Team 5 – Brown marmorated stink bug (*Halyomorpha halys*)

Team 6 – Red imported fire ant (*Solenopsis invicta*)

Each group investigated their species and used the “Day 3” form to guide their inquiry. The “Day 3” form, like the previous days’ forms, also served as a lab results record and assessment.

Day four consisted of concluding Trial 2 and the food preference experiment as a whole. When data and observations were recorded via the “Day 4” form, a short thank-you was given via the “Day 4” presentation. It was at this time that Ms. Hoehn administered end-of-quarter assessments, and I remained in class to serve as a subject matter expert. Their end-of-quarter assessment was to write a proposal for an experiment that tested the environmental impact of governmental policies and insects on a chosen environment.

The students’ food preference lab was set up into two trials. Each student group identified a food to experiment with. This was then compared to a known food source for the MHCs. In this experiment, the control food was store bought dog kibble. Trial 1 went from class session two till class session three. Trial 2 went from class session three till class session

four. The trials were nearly identical in procedure, but differed on time. Trial 1 lasted 48 hours, and trial 2 lasted 96 hours. The usage of two trials was Ms. Hoehn's recommendation. She was concerned that students would make mistakes and she didn't want that to affect their experiments. Furthermore, the usage of two trials allowed for Ms. Hoehn to show the students what to do when something doesn't go as expected.

Discussion

As previously stated, the goals of this project were entomological outreach and development of insect knowledge. After spending four class sessions with students, I am confident that one week is the optimal time for a unit on insects in a high school class. I am basing this on my observations and interactions with the students and the high operational tempo of the academic school year. However, four class periods spanning 10 days offered more time for the MHCs to perform for the student's experiments. If this project had been on a block schedule, the experiment for the students would have been conducted in a singular trial. Setting up the student's experiments with a first and second trial allowed for simple errors committed in the first trial to be remedied in the second; I am referring to Group 5, Period 4. Group 5, Period 4 failed to record their initial starting weight of their control in Trial 1. With only one trial, this group would have had to repeat the experiment altogether. With the ability to conduct a second trial, Group 5, Period 4 was able to learn from their mistake and get something out of the experiment.

I encountered problems with the terrarium setup. The small containers compounded with the locked cabinet made for an environment that was too humid and that fomented high mold growth in both the experimental foods and the control foods. Mold was not apparent in Trial 1 because it spanned only 48 hours. This is not to say that Trial 1 was not affected by the overly humid environment. The students quickly realized that their control foods had increased in volume. Since the control food was dog kibble, it was annotated in their notes. I quickly adapted the Google Forms to include a direct-observation entry for the students to annotate inconsistencies and unexpected results. It cannot be understated how easy Google Forms made this process. While in class and with students, I could log into my Google account and make the necessary changes to the Google Forms on the spot. Trial 2 spanned 96 hours, and mold was immediately noticed; however, the students were able to notice bite marks in the food and were able to obtain weights of the food that showed a preference; most groups had to rely on direct observation to draw any conclusions.

Another problem encountered was assessment. From the onset of the project, I was unsure how to conduct assessments. My initial plan was to use paper handouts and collect them. After Ms. Hoehn showed me Google Suite, I quickly abandoned paper for technology. A problem encountered with the Google Forms assessments was the matching exercises, as shown in Figure 3.

Check on Learning

Match the following

	Endo-	Ecto-	Ventral	Dorsal	Proximal	Distal	Anterior	Posterior	Apter
Pertaining to the hind end	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pertaining to the abdomen OR the lower side of the body	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pertaining to the head end	☐	☐	☐	☐	☐	☐	☐	☐	☐
Outer, outside	☐	☐	☐	☐	☐	☐	☐	☐	☐
Away from the middle of the body	☐	☐	☐	☐	☐	☐	☐	☐	☐
Does not have wings	☐	☐	☐	☐	☐	☐	☐	☐	☐
Pertaining to the back OR the upper surface	☐	☐	☐	☐	☐	☐	☐	☐	☐

Figure 3

When this matching exercise was made a requirement for proceeding to the next section of the Google Form, the students quickly noticed that they had to provide only the correct answers in order to proceed. This negated the assessment because there was only the possibility of getting it correct and proceeding or not completing the assessment; wrong answers were not permitted to be recorded. This was inexperience with Google Forms on my account. Knowing this, I can better design challenging and thought-provoking assessments in the future.

Walking into a high school class with roaches is a bold move! Students showed keen interest and great trepidation. Drawing from my military background, I understood the impact of appearing as an authority to the students. In the army, we wear our rank in the open, and that affords us a certain level of respect and responsibility. The students are very familiar with the military uniform and military culture, as most of their parents are either serving or working for the US Military, and that is why these students attend KHS. You will notice that I chose to wear a white lab coat for all my interactions with the students, see Images 1 - 6. I had a vision for how I wanted to be perceived. I wanted to have a uniform like and professional appearance. I sincerely believe that my attire added greatly to my overall presence and impact. Furthermore, I used accurate scientific language followed by either the scientific definition or the colloquial expression. I was adamant about getting the students to internalize this language. I stressed brevity at all times and assured the students that scientific language allowed for more accurate descriptions of concepts while cutting down on ambiguity and fluffy language. Toward the middle point of the project, I began referring to the specimens as the students' "lab partners" and to the students as "future entomologists." I wanted the students to buy what I was selling, and I can claim success overall.

Image 3

Image 4

Image 5

Image 6

Image 7

Image 8

The Google Suite, Google for Educators, the technology in the classroom, and a well-funded school all played an integral part in this project's success. Ms. Hoehn is a Level 1 Google Certified Teacher. Kaiserslautern High School is a well-funded and technology-forward campus. All aspects of her classroom are connected through an internal network that provides access to the Internet. Furthermore, the classroom has a Smart brand presentation device (Smart Board) with touchscreen, and this device functions as a connected computer. I was able to be seamlessly integrated into the classroom and present my lessons from this board with ease. The students all have access to laptop computers, and they use their student DoDEA accounts to log into the internal network. These DoDEA accounts serve as login credentials for homework, grading, counseling, and attendance. I kept track of the students through their DoDEA accounts. If I had stayed with the class for a longer period, I could have used their student accounts for individual help and communication. Building upon the students' accounts, KHS employs the Google for Educators suite, which allows the students to own and use a Google account that is not tied to their personal accounts. This ensures that neither students' personal identifiable information nor their personal electronic devices are used or compromised.

The KHS classroom is an ideal environment to teach in. This type of classroom is often found in higher income communities in the civilian sector. The military community is often unaware of how the DoDEA schools are funded and this is easily taken for granted.

The KHS administration raised a concern about students handling live specimens.This concern was so prevalent that I was asked to alter the "Day 1" presentation to show that MHCs were not being held or handled by a human hand. After further discussions with the KHS administration, it was decided that students would not be allowed to handle the MHCs. I sought advice from my graduate advisor. My graduate advisor suggested that I explain the University of Nebraska department of entomology's experiences with using MHCs for educational outreach with students and suggested a possible compromise of using latex gloves when working with MHCs. This was rebuffed outright by the administration, due to allergens on the MHCs and their feces in the terrarium. The KHS administration was not willing to accept unnecessary risk, no matter what myself, my graduate advisor, or the University of Nebraska department of entomology had to say. Furthermore, the KHS administration cited a 2008 paper from Ohio State University PhD candidate Joshua Benoit, who with his team showed elevated mold levels from 14 different mold species that are associated with MHCs, all shown to induce an allergic reaction in a small percentage of the population (Ohio State University 2008). Conversely, Benoit and his team also showed that beneficial symbiotic mites functioned to remove debris and pathogens on the MHCs, but this information was not taken into consideration by the administration. This was a case of “Dr. Google” rearing its ugly head. The safety of the students is paramount, but it is possible to be too cautious. This is a perfect opportunity for further research to be conducted into the health aspects of keeping MHCs as pets and lab specimens.

Conclusions

The primary goal of furthering entomological education was shown to be a success. A comparison between the initial three questions and the end set of questions shows a marked increase in self-reported comfort with and knowledge of insects. Furthermore, the raw data from the assessments show that student knowledge of entomological concepts is sound, with most students answering correctly and showing thoughtful written responses.

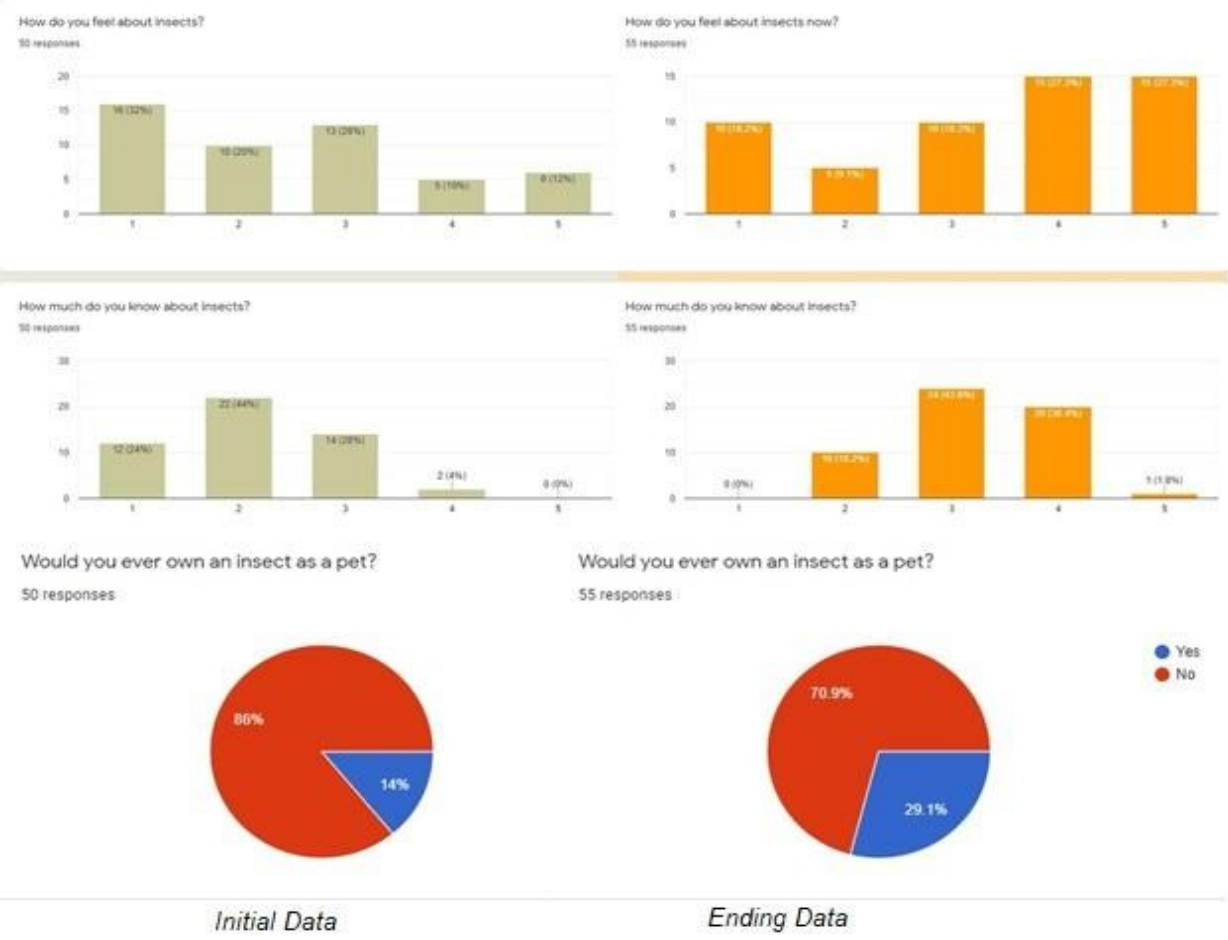

Figure 4

The comparison of pedagogical approaches is less conclusive. It is better described as mixed. Day 2 instruction and assessment produced the intended results of the traditional approach, with the instructor directly imparting knowledge and the student receiving the message and internalizing it. This implies that the traditional method is best when the primary objective is to provide a necessary groundwork of incontrovertible facts required to progress further in the study. This allows for an authority to serve as the bulwark of the students' continued progression in their studies. During the Day 3 block of instructions, the more student-guided approach showed excellent results when allowing the students to learn a new concept and then use this concept to conduct research. The Day 3 assessments show several thoughtful answers that demonstrate a depth of knowledge that not only showcases what was learned in Day 2 but also shows a critical thinking process that demonstrates proper internalization of the subject matter. Without a direct comparison between the class periods and pedagogical approaches, I can only provide my best interpretation.

Acknowledgments

I would like to acknowledge KHS and the DoDEA for allowing access to three of their environmental science classes. I would also like to further acknowledge and thank Ms. Nancy Hoehn for her personal guidance and expertise in teaching and technology. Truly, this project would not have been as successful without her. Mr. Maximillian Curtner was instrumental in helping me construct and design the locking cabinet that housed the specimens. His expertise in woodworking provided me with the tools needed to complete this project. Lastly, I would like to acknowledge the United States Army Band, the Europe Command Team of Major Randal S. Bartell, and Sergeant Major Lori Nix for allowing me the time to work on this project without taking leave. Without their willingness to allow me to complete this project during work hours, I would not have had access to the students or to KHS.

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