<table>
<tr><td colspan="2">Smashing Lanternflies with Raspberry Pi</td></tr>
<tr><td colspan="2">Learning Experience</td></tr>
<tr><td colspan="2">Students will develop an inquiry in which they design a trap for an invasive species (the spotted lanternfly) and use a Raspberry Pi for data collection to evaluate their designs. Students will ultimately present their findings to a local conservation organization, for the purpose of helping them to improve their lanternfly traps.</td></tr>
<tr><td>Grade: 9</td><td>Subject: Environmental Science</td></tr>
<tr><td colspan="2">Unit Length: 3-4 Weeks</td></tr>
<tr><td colspan="2">Standards
Bolded standards represent key ideas or skills. Standards in normal text are included in this unit, but are not a main focus.</td></tr>
<tr><td>Science- NGSS</td><td>Technology- ISTE</td></tr>
<tr><td>HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales

HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales

HS-LS2-6. Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem

Science and Engineering Practices:
Planning and Carrying Out Investigations
Analyzing and Interpreting Data
Constructing Explanations and Designing Solutions</td><td>1c Students use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.

3a Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits.

3d Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.

4a Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.

4c Students develop, test and refine prototypes as part of a cyclical design process.

4d Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.</td></tr>
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Asking Questions and Defining Problems
Developing and Using Models
Engaging in Argument from Evidence
Obtaining, Evaluating, and Communicating Information

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<tr><td colspan="2">Rationale for Learning Experience Choice</td></tr>
<tr><td colspan="2">Invasive species are not only a very real and looming ecological threat, but they also explain a lot of other big ideas related to environmental science (carrying capacity, environmental factors, evolution and adaptation, etc.). Therefore, asking the question “How can we best eliminate these lanternflies without harming the ecosystem?” serves the purpose of a) connecting to multiple big ideas and essential questions (Wiggins & McTighe, 2005) b) grounding our inquiry in the real-world and making learning authentic (Bucks Institute for Education, n.d. and CAST 2016) and c) providing students with opportunities to act as makers and practice the design process (Martinez & Stager, 2013)

In terms of my selected standards, I specifically chose to use the NGSS standards and ISTE technology standards because they are both sets of standards that I am not used to using. My state has still not adopted NGSS, but I have heard rumors that they may be adopting them soon, and I want to be able to practice using them as a framework in a formal lesson write-up. Similarly, I have never fully explored the ISTE standards before, so I wanted to give that framework a try as well.</td></tr>
<tr><td colspan="2">Learning Goals (SWBAT)</td></tr>
<tr><td>Science</td><td>Technology</td></tr>
<tr><td>Students will be able to…

Explain what traits make a species a "successful" invasive species
Analyze the patterns of predator/prey relationships
Analyze the results of interspecific competition
Explain how carrying capacity impacts a species
Analyze the impact that invasive species have on biodiversity

</td><td>Students will be able to…

Identify different hardware parts on a computer and their function
Install and run software
Modify existing code to perform a personalized function
Use internet affinity spaces as a resource for solving problems related to a specific technology

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Outline of Unit
This whole learning experience has been outlined below, to contextualize when innovative technology is being used in the learning process. The days needed for the design process can be shifted as needed depending on a given student population. Day 1: Students will explore why lanternflies have become so pervasive in Southeastern Pennsylvania Day 2: Students will explore other invasive species and compare them to the lanternfly. The class will discuss the ecological principles that make them so effective Day 3: Students will complete a lab on population growth and carrying capacity Day 4: Students will break into groups and research the biology of the lanternfly and existing trap methods Days 5-6: Students will design their traps and outline their plan for testing their effectiveness using remote data collecting. Days 7-8: Students will familiarize themselves with the Raspberry Pi Days 9-10: Students will configure Raspberry Pi to collect the necessary data Days 11: Students will install traps and Raspberry Pi in the field (must wait a few days for data collection) Day 12: Students will complete a lab on predator/prey dynamics and relate it to what the lanternfly is doing to agriculture Day 13: Students will complete a lab on the impacts of biodiversity on an area and relate it to the impacts of the lanternfly Day 14: Students will retrieve their devices and analyze their data Day 15: Students will revise their designs Day 16: Students will install designs back in the field Days 17-18: Students will work on presentations with initial data analysis and revisions to design Day 19: Students will retrieve their devices and analyze their data Day 20: Students will finalize presentations with new data Day 21: Students will practice presentations for classmates and be given feedback Day 22: Students will revise presentations Day 23: Students will give presentations to a local conservation organization Day 24: Students will reflect on their learning from the past unit
Innovative Technology: Raspberry Pi
Instructional Strategy Considerations for Technology
I have chosen to use a Raspberry Pi because it is a cheap and powerful computer. I intend to guide students through the use of Raspberry Pi using a Python IDE in Raspbian, because Python is more accessible to novice programmers due to the elimination of the need for code with lower processes (Kölling, 2016). Python also generally presents what it is trying to accomplish in something akin to plain English (ex: startcamera() could be used as a name for starting the camera). To explain to students why we are using Raspberry Pi, I will facilitate a discussion about the

values of remote sensing. We will discuss the power of observation in science, and then talk about what things are reasonable to observe with our own eyes (ex: how does an organism react to an immediate stimulus) versus what things would be impossible to observe with our own eyes (ex: how does an organism behave over the course of a week). Students will be asked to brainstorm with their design groups what kinds of observations they would want to make to determine whether or not their trap was effective.

Many students have not been exposed to Raspberry Pi or Python before. Thus, I will need to build in some time where I explain to students how the basics of the technology works and demonstrate how to use it. I will need to do it this way at the beginning of the exploration for two reasons: the Raspberry Pi can be damaged or stop working if it is not set up correctly (Raspberry Pi Foundation, n.d.), and people who have never been exposed to a coding language before often struggle to figure out the abstract nature of what different features of a code do to the computer (Kölling, 2016). It is also helpful to walk new learners through a model of how a computer works and connects to the code before turning them loose to code on their own (Du Boulay, 1986) Therefore, my Raspberry Pi "crash course" would look like a day or two within the unit where I would demonstrate the steps of using the device up front (installing the OS, starting a code, running a code, installing the camera, taking a single picture, etc.), and would then have students complete a challenge that would build in an exploration that would require students to use the internet to find new ways of doing things with the Raspberry Pi. For example, after showing students how to install the camera software and take a single picture, I would challenge them to make a custom photo booth by looking up different commands that they can use to change the pictures taken by the camera and experimenting with changing them. Setting up my technology introduction that way should help me to scaffold the knowledge for my students and give them whatever prerequisite skills they need to then use the Raspberry Pi as a Maker space.

Based on my specific student population and the research skills that I have observed in the past, I should also model how to find resources on the internet and recommend good starting places (ex: go to the Raspberry Pi website to get set up initially, but recommend finding other spaces to figure out how to do whatever you intend to do for data collection.)

Because the Raspberry Pi has a large number of needed accessories (and would need very specific accessories for outdoor usage), I would need to make sure that I have enough of these items on hand to provide for different design groups, plus some extra in case things break. I would also need to make sure that I have plenty of non-standard parts to give students flexibility in how they choose to utilize the Raspberry Pi (camera attachments, different sensors, etc.).

There are many accommodations that I would put in place to support the use of the Raspberry Pi in my classroom. To support emergent bilingual students and students with learning differences, I intend to provide vocabulary lists that include important words, definitions, the words/definitions in any languages that are prevalent in my classroom, and a picture. I will have different lists for the physical components of the Raspberry Pi (with actual pictures of each component) and for important programming terms. Because programming languages are only written in English, it will be important to make the meaning of different terms especially clear (CAST, 2018).

How will students design/create/inquire/play/problem solve/ evaluate? **How will students collaborate with each other and with the outside world?**
Because the driving goal of this unit revolves around using the design process to physically make something to solve a real world problem, students will be able to use a maker mentality to try and accomplish something authentic. Students will have to work together to a) research ways of capturing lanternflies b) develop and execute a design and c) come up with a strategy for using the Raspberry Pi to evaluate their design (ex: do you film your trap over time? Take time series pictures? Use a sensor to see if it works best in the light/the shade or heat/cold?). To provide accommodations during the research process, students will be reminded about and permitted to use screen reader software and translation software. Students will also be encouraged to watch and take notes on videos about the lanterfly from reputable sources (CAST, 2018). To provide accommodations during the design process, students will be given the option of doing a handwritten, typed, audio, or video design journal of their process. All journal types must still involve sketches of the design, but these sketches can be done in a variety of ways (pencil and paper, digital, dry-erase with pictures taken, etc.) (CAST, 2018).
Assessments
Students will keep a journal (either handwritten, typed, audio recorded, or video recorded) of their design process with rationale for different choices and visual representations of different design ideas. Design choices for round 2 of the design should be backed by data collected by the Raspberry Pi (ex: I saw that x percent were able to escape from my trap, so I need to make y change). At the end of the unit, students will pitch their designs to a local conservation organization to use in their own efforts to squash the lanterfly. These pitches can either be a live presentation with slides, a science fair type poster, or a pre-recorded video of their findings with some sort of visual. In between the beginning of the unit and accomplishing the end task, students will also be doing several labs and explorations to solidify understandings that are a part of the big idea.
Research Considerations

To prepare this learning experience, I first based my thinking in the Understanding by Design framework (start with the big ideas and work backwards) (Wiggins & McTighe, 2005), the TPACK framework (how can I most appropriately use technology given what I want to teach and how I want to teach it?)(Mishra & Koehler, 2006), and the Project Based Learning Framework (having students actively construct their own knowledge by trying to solve a problem) (Bucks Institute for Education, n.d.).

After receiving feedback, I worked to try and make my lesson more accessible. My lesson was especially inaccessible to emergent bilingual students and to students with reading and writing disabilities. Using the Universal Design for Learning framework, I incorporated more chances for differential representation and expression to make my lesson more universally accessible (CAST, 2018).

Because my biggest hurdle was how to actually use a Raspberry Pi in my classroom, I spent some time researching programs that taught using Raspberry Pi and guidelines for how to introduce programming to a novice population. Most of the recommendations suggested starting with a very concrete, closed exploration (looking at the parts, learning the functions, setting things up step by step), then building into guided examples, and then finally setting students free to experiment. As a result, I redesigned my introduction of the Raspberry Pi to follow a show-try-experiment pathway.

Questions That I Have

Questions in normal text are my original questions, bolded questions are the new questions that I have after re-designing this learning experience

- What is the best way to balance learning a complicated technology and exposing students to subject area content?
- Am I integrating the technology too little? I was worried about making it the star of the unit and ignoring the content.
- Do you have any logistical advice that I could use regarding using Raspberry Pi in an actual classroom?
- **Which areas near my school have the most consistent lanternfly problem and would make suitable testing sites?**
- **Are there any sorts of sensors that my students might think to use that I haven't already thought of? What do I need to buy?**
- **Which local organizations would be the best to contact for the presentation process?**
- **What materials will my students ultimately end up needing for this trap?**

References

Buck Institute for Education. (n.d.). Gold Standard PBL: Essential Project Design Elements. PBLWorks. https://www.pblworks.org/what-is-pbl/gold-standard-project-design

CAST. (2018, August 31). UDL: The UDL Guidelines. http://udlguidelines.cast.org/?utm_medium=web&utm_campaign=none&utm_source=cast-about-udl

Du Boulay, B. (1986). Some Difficulties of Learning to Program. Journal of Educational Computing Research, 2(1), 57–73. https://doi.org/10.2190/3lfx-9rrf-67t8-uvk9

Kölling, M. (2016). Educational Programming on the Raspberry Pi. Electronics, 5(4), 33. https://doi.org/10.3390/electronics5030033

Martinez, S. L., & Stager, G. (2013). *Invent to learn: Making, tinkering, and engineering in the classroom*, (pp. 31-41). Constructing Modern Knowledge Press.

Mishra, P, & Koehler, M (2006). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. Teachers College Record, 108(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Raspberry Pi Foundation. (n.d.). Setting Up Your Raspberry Pi. Raspberry Pi. https://projects.raspberrypi.org/en/projects/raspberry-pi-setting-up

Wiggins, G., & McTighe, J. (2005). Understanding By Design (2nd Expanded ed.). Assn. for Supervision & Curriculum Development.