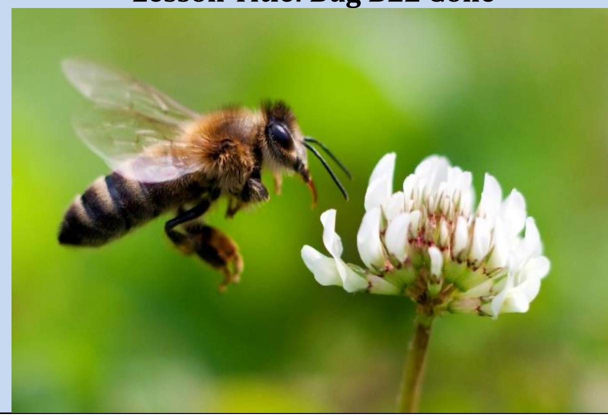
Bug BEE Gone

3D-Student Science Performance *Author: Diedre Young, Soybean Science Challenge*	
Grade: 9-12 Integrated Biology	**Lesson Title: Bug BEE Gone**
Lesson Topics: **Biodiversity** **Population Dynamics** **Modeling** **Evaluating Solutions** **Analyzing a Global Challenges** **THIS IS A MULTI-DAY LESSON!**	

Performance Expectations (Standard) from State Standards or NGSS:

BI-LS4-6: Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. [AR Clarification Statement: Emphasis on refining solutions for a proposed problem related to threatened or endangered species, genetic variation of organisms for multiple species and biodiversity.]

BI-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability and aesthetics as well as possible social, cultural and environmental impacts. (This can be a separate lesson or incorporated into this lesson). [AR Clarification Statement: Problems could include effect of logging on animal or human populations, response to invasive species, agricultural practices, creating dams, and maintaining fish populations in public lakes.]

BI-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. [AR Clarification Statement: This PE is partially addressed in this course. Examples on the impacts of human activities could include the quantities and types of pollution released, changes to biomass and species diversity, and changes in land surface (urban development, agriculture or livestock, and surface mining). Examples for limiting future impacts could range from local efforts (reducing, reusing and recycling resources) to large-scale bioengineering design solutions (altering global temperatures by making large changes to the atmosphere or ocean.)]

BI7-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. [AR Clarification Statement: Examples could include recycling, increased atmospheric carbon dioxide, ocean acidification, impacts on marine populations, increased wildfire occurrence, deforestation and overfishing.]

Connections to the Arkansas Disciplinary Literacy Standards:

RST.11-12.9: Synthesize information from a range of sources into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

WHST.9-12.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments or technical processes.

WHST.9-12.7: Conduct short as well as more sustained research projects to answer a question or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinction the author makes and to any gaps or inconsistencies in the account.

RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem.

RST.11-12.8: Evaluate the hypothesis, data analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

Connections to the Arkansas Mathematical Standards:

MP.2: Reason abstractly and quantitatively

MP.4: Model with mathematics

HSN.Q.A.1-3: Use units as a way to understand problems and to guide the solution of multi-step problems, choose and interpret units consistently in formulas, chose and interpret scale and origin in graph and data displays. Define appropriate quantities for the purpose of descriptive modeling. Choose a level of accuracy for the purpose of descriptive modeling.

HSS.ID.A.: Represent data with plots on the real number line.

Lesson Performance Expectations:

- Students will understand why honey bees are important to our ecosystems and the adverse impact various issues (such as disease, parasites, and (human activity) insecticides) have had on honey bees, thus causing a decrease in bee populations in recent years.
- Students will ask and address how local bee populations are affected by these issues, especially focusing on insecticides.
- Students are encouraged to come up with various research plans to decrease insecticide impact, using soybean plants as a source of food for local insect pests with the goal of finding viable alternatives to help lessen chemicals on crops.
- Students will run experiments based on their research plans to determine if their hypothesis is correct or incorrect in regards to alternate insecticide possibilities.
- Students will present their findings in a round robin to defend their conclusion.

Elicit: Do a KWL chart about what students know about plant growth and insect impact on plants (both beneficial and adverse). Honeybees should come up in the discussion so focus on why honeybees are important to most commercial crops. **Engage:**	**Student Science Performance** ***Phenomenon:*** **Populations of honey bees have decreased dramatically in recent years due to a variety of reasons with insecticide use being one of them. This decrease has caused a strain on farmers getting their crops pollinated. Using alternate methods of pest treatment in lieu of insecticides may help improve Honey Bee populations.** ***Gather*** *(In this section students will generally be asking questions, obtaining information, planning and carrying out an investigation, using mathematical and computational thinking, or using models to gather and organize data and/or information.)* 1. Students obtain information on how to grow soybeans without insecticide usage. 2. Students plan and carry out an investigation on how to grow soybeans with alternate methods of insecticide use. 3. Students obtain information on their alternate insecticide method by growing soybeans using this method and observing how the plants do when grown in an environment exposed to plant pests. **Preparation:** Soybean seeds take about eight to ten days to germinate in ideal conditions (kept warm and moist). Seeds can be obtained through the SSC on-line seed store (www.uaex.edu/soywhatsup). Seeds are shipped out within a week of ordering. Have the students do the planting/watering in anticipation of the lesson. By involving the students from the beginning, they will have time to brain storm what insect deterrents they will use when the plants begin to sprout. Keep the plants indoors until

Show the video "The Death of bees explained" https://www.youtube.com/watch?v=GqA42M4RtxE to show students what is possibly happening to honey bees. Go to https://www.youtube.com/watch?v=KZCTP3lyIDY to show that a loss of local honeybees means bees must be shipped around the country to pollinate important commercial crops. Shipping hives increases pest and disease on a bee population thus feeding into the overall loss of honeybees. **Explain:** Ask the class if anyone has not	sprouting then they need to go outside. **Time Duration:** From planting to presentation anticipate about four weeks although the daily time amount for plant care, checking the plants for insects/insect damage and photographing the plants will be about 10 minutes each day. Show the video "The Death of bees explained" https://www.youtube.com/watch?v=GqA42M4RtxE to show students what is possibly happening to honey bees. Go to https://www.youtube.com/watch?v=KZCTP3lyIDY to show that a loss of local honeybees means bees must be shipped around the country to pollinate important commercial crops. Shipping hives increases pest and disease on a bee population thus feeding into the overall loss of honeybees. ***Reason*** *(In this section students are generally: evaluating information, analyzing data, using mathematical/computational thinking, constructing explanations, developing arguments, and/or using models to reason, predict, and develop evidence.)* 4. Students construct an explanation as to why their insecticide alternative will work the best for soybeans. 5. Students develop an argument using evidence that supports the explanation (claim) that their insecticide alternative is the best option to chemical insecticide usage. ***Class Discussion:*** *Questions to initiate Discussion:* *Q: How do plants reproduce?* *Q: How does fertilization occur in most plants?* *Q: Are insects beneficial or an issues with plants?* *Q: Name a very important insect to farmers.* *Q: Name an important food that is produced by Honey Bees.* *Q: What do you think will happen if Honey Bees were not around to pollinate?* Ask the class if anyone has not tasted honey and offer some for a taste (barring any allergen issues). You could also offer various varieties of honey as honey tastes different based on the flowers the honey bees feed on. European honey bees (*Apis mellifera*) are actually an invasive species to North America. They were introduced to the USA in 1622. Honey bees not only pollinate plants but

tasted honey and offer some for a taste (barring any allergen issues). You could also offer various varieties of honey as honey tastes different based on the flowers the honey bees feed on. European honey bees (*Apis mellifera*) are actually an invasive species to North America. They were introduced to the USA in 1622. Honey bees not only pollinate plants but make honey, a valuable commercial crop in itself. Refer to the roles honey bees play in plant pollination and subsequent seed production of the pollinated plant. You can bring in commensalism,	make honey, a valuable commercial crop in itself. Refer to the roles honey bees play in plant pollination and subsequent seed production of the pollinated plant. You can bring in commensalism, even mutualism between plants and honey bees. Based on the videos, pests, parasites and insecticides have all taken their toll on honey bee populations. Bring in the ecological impact involved here along with the commercial impact on crops. People can help honey bee populations by lessening the insecticide load without decreasing crop production, so how can this be done? Students are separated into groups and are told they are going to brain storm a proposal about how they can grow healthy plants with less insecticide. Tell them they are going to try their ideas on soybean plants. Give the groups as much time as needed to do research into what they can do to lessen insecticide loads. Proposals should include the research question, the background into the idea chosen, and the hypothesis. ***NOTE:*** *Students should hand in proposals before planting as some students may be using beneficial side plants as their idea and will need to plant those seeds at the same time as the soybean seeds* ***NOTE:*** *Information on the experiment is in Appendix B.* ***Communicate*** *(In this section students will be communicating information, communicating arguments (written and oral for how their evidence supports or refutes an explanation, and using models to communicate their reasoning and make their thinking visible.)* **1. Students in their groups will use their data model to present an argument for their choice of insecticide alternative.** Students should now have everything needed to do a gallery walk presentation about their insecticide alternative. The following should be included: a stated research question, the background on their alternative, hypothesis, how they conducted the experiment, a created data table and graph, and what their conclusion was based on their data. Students need to also include a cost and application analysis. While using Neem Oil works well on getting rid of insects, is it really cost effective and can it be applied in a wide spread manner?

even mutualism between plants and honey bees. Based on the videos, pests, parasites and insecticides have all taken their toll on honey bee populations. Bring in the ecological impact involved here along with the commercial impact on crops. People can help honey bee populations by lessening the insecticide load without decreasing crop production, so how can this be done? **Elaborate:** Student are separated into groups and are told they are going to brain storm a proposal about how they can grow healthy plants with less insecticide. Tell	

them they are going to try their ideas on soybean plants. Give the groups as much time as needed to do research into what they can do to lessen insecticide loads. Proposal should include the research question, the background into the idea chosen, and the hypothesis. *Students should hand in proposals before planting as some students may be using beneficial side plants as their idea and will need to plant those seeds at the same time as the soybean seeds.* *The experiment:* Students are given the four containers and soil and soybean seeds. Why four containers?	

(for controls and verification). Once the seeds are planted, tell the students they will need to water their pots daily and check for plant emergence. Once the plants emerge, they need to be put outside to be exposed to insects. Plants need to be checked daily, noting plant height, number of leaves, leaf color and leaf/stem insect damage on both the control and experimental plants. If insects are present on the plants, this needs to be noted also. Students can take daily pictures of their plants to add a technology bend to the experiment. *The results:*	

Students will need to put together a data table that has a comparison of the plant height, leaf number, leaf color and insect damage. Students can choose what they would like to compare based on that list between the experimental and control plants. Data point graphs should also be done to show differences in the plants over time. * *If students do not know how to do a point graph, refer them to https://nces.ed.gov/nceskids/graphing/Classic/ and have them follow the prompts for making a graph. **Evaluate:** Students should	

now have everything needed to do a gallery walk presentation about their insecticide alternative. The following should be included: a stated research question, the background on their alternative, hypothesis, how they conducted the experiment, a created data table and graph, and what their conclusion was based on their data. Students need to also include a cost and application analysis. While using Neem Oil works well on getting rid of insects, is it really cost effective and can it be applied in a wide spread manner? Evaluation should	

be based on how well the alternative is addressed and data presentation. **Extend:** After all the gallery walk presentations are done, do a class discussion about which insecticide alternative is really feasible in a commercial crop setting. Maybe none are or maybe there are many options. Have the class come up with ways their chosen alternative could be presented to local farmers to consider using in their fields, keeping in mind cost and application issues. Have the students write a letter to a local farmer explaining what they have learned and why the farmer should consider	

trying the alternative, backing their thoughts up with their research and experiment results.	

Formative Assessment for Student Learning		
Elicit Evidence of Learning: *This box is the individual communication performance from the student prompts in appendix A*		
Evidence of Student Proficiency	**Range of Typical Student Responses**	**Acting on Evidence of Learning**
The student will come up with a valid hypothesis and will find valid research for this project. *The student will perform experimentation that will validate their hypothesis and the concepts learned will be used for critical thinking on determining alternatives to insecticide usage on soybeans.*	*Descriptors of grade-level appropriate student responses:* • *Full understanding: Student will show full understanding of the scientific method, how to scientifically approach a real world problem (decrease in honey bees) and use critical thinking to work to solve that problem.* • *Partial understanding: Student will understand the scientific method but struggles with implementation. Student has limited ideas for approach and problem solving.* • *Limited understanding: Student struggles with the scientific method and does not understand how to implement nor work to solve this real world problem.*	*Description of instruction action and response to support student learning.* • *action for student who displays partial or limited understanding: Reteach the student the scientific method using visual descriptors. Partner student with a classmate who has a good understanding of the task so they can mentor them through the project.* • *Action for student who displays full understanding: Have students come up with ways to present their findings to local farmers and ask them to consider the alternative(s), backing their request up with facts and research from their projects.*

SEP, CCC, DCI Featured in Lesson	**Science Essentials** *(Student Performance Expectations From Appendix C, D, E)*
Science Practices	• Using mathematical or computational representations of phenomena or design solutions to support explanations (BI-LS2-1) • Create or devise a simulation of a phenomena or design solution to support explanations. (BI-LS4-6) • Design, evaluate and refine a solution to an insecticide alternative based on scientific knowledge, student-generated sources of evidence, prioritized criteria and trade off
Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	

Engaging in Argument from Evidence Asking Questions and Defining Problems	considerations. (BI-LS2-7) • Evaluate the claims, evidence and reasoning behind currently accepted explanations or solutions (that insecticides are the only alternative) to determine the merits of arguments. (BI-LS2-6) • Analyze complex real world problems by specifying criteria and constraints for successful solutions. (BI7-ETS1-1)
Crosscutting Concepts Cause and Effect Scale and Quantity System and System Models	• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (BI-LS2-8, BI-LS4-6). • Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (BI-LS2-1). • Models can be used to simulate systems and interactions-including energy, matter and information flow-with and between systems and different scales (BI3-ETS1-4).
Disciplinary Core Ideas Adaptation LS4.C Interdependent Relationships in Ecosystems. LS2.A Biodiversity and Humans LS4.D Developing Possible Solutions ETS1.B Human Impacts on Earth Systems ESS3.C Defining and Delimiting Engineering Problems ETS1.A	• Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline/extinction of some species. (BI-LS4-6) • Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predations, competition and disease. This fundamental tension affects the abundance of species in an ecosystem. (BI-LS4-6) • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, over exploitation, habitat destruction, pollution, introduction of invasive species and climate change. Thus sustaining biodiversity so that ecosystem functioning

	and productivity are maintained is essential to supporting and enhancing life of Earth. Sustaining biodiversity also aids humanity by preserving landscapes or recreational or inspirational value. (BI-LS4-6, BI-LS 2-7) • When evaluating solutions, it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. (BI3-ETS1-3, BI-LS2-7, BI-LS4-6) • The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (BI-ESS3-3)

Appendices: This section contains the lesson performance that students will see during the lesson and any other resources students will use to engage in the science performances. The appendices may also contain examples of student work.

Appendix A - Student Prompts

Student Prompts for the Lesson

Phenomenon: **Populations of honey bees have decreased dramatically in recent years due to a variety of reasons with insecticide use being one of them. This decrease has caused a strain on farmers getting their crops pollinated. Using alternate methods of pest treatment in lieu of insecticides may help improve Honey Bee populations.**

Group Performances:

1. Ask questions to plan an investigation for the usage of alternative means of insect control in soybeans.
2. Plan and an investigation to gather evidence for the usage of a particular chosen alternative.
3. Construct an explanation for whether or not the researched and experimented insect control is or is not a viable alternative to commercial insecticide use (including constraints).
4. Use a model to show that the chosen researched and experimented insecticide alternative is or is not a viable alternative to commercial insecticides.

Class Discussion

Individual Performances:

5. Develop an argument for how the evidence you collected supports or refutes your explanation for the usage of a chosen alternative to insecticides in soybeans.

The student prompt can be used to engage students in science performances and typically have 3-5 group performances and one individual performance. The individual performance typically lies within the communicate reasoning part of the sequence and often serves as a formal formative assessment. Often teachers add opportunities for class discussion into the instructional sequence to discuss things like "Good Questions to Find Resources" or "Class Debate" or "Discussion of Science Language Student Should Use".

Appendix B –

Materials: Plastic containers (can be margarine tubs, yogurt tubs, cut 2L soda bottles, etc.), at least four per group of four students, soybean seeds (seeds can be obtained through the SSC on-line seed store (www.uaex.edu/soywhatsup) and are shipped out within a week of ordering), soil from the school yard (potting soil can also be used) and various products that students choose to use as a natural insecticide for plants.

Note: Suggestions would be planting garlic or onions with the soybeans or even Chrysanthemums, using Neem Oil, etc.

The experiment:

Students are given the four containers and soil and soybean seeds. Why four containers? (for controls and verification). Once the seeds are planted, tell the students they will need to water their pots daily and check for plant emergence. Once the plants emerge, they need to be put outside to be exposed to insects. Plants need to be checked daily, noting plant height, number of leaves, leaf color and leaf/stem insect damage on both the control and experimental plants. If insects are present on the plants, this needs to be noted also. Students can take daily pictures of their plants to add a technology bend to the experiment.

The results:

Students will need to put together a data table that has a comparison of the plant height, leaf number, leaf color and insect damage. Students can choose what they would like to compare based on that list between the experimental and control plants. Data point graphs should also be done to show differences in the plants over time. *

*If students do not know how to do a point graph, refer them to https://nces.ed.gov/nceskids/graphing/Classic/ and have them follow the prompts for making a graph.

Appendix C –

After all the gallery walk presentations are done, do a class discussion about which insecticide alternative is really feasible in a commercial crop setting. Maybe none are or maybe there are many options. Have the class come up with ways their chosen alternative could be presented to local farmers to consider using in their fields, keeping in mind cost and application issues. Have the students write a letter to a local farmer explaining what they have learned and why the farmer should consider trying the alternative, backing their thoughts up with their research and experiment results.