
Summer 2020
RET
Changing Learning. Improving Lives.

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Summer 2020 programming supported by:

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Roy J. Carver CHARITABLE TRUST

We sincerely appreciate the support of the Roy G. Carver Charitable Trust, Iowa State University faculty, lab mangers, post docs and graduate students who mentored their teacher-researcher this summer. A special 'thank you' to the Office of Biotechnology Outreach staff, including Lori Miller, Camie Stockhausen, and Glenda Webber for their dedication and organization throughout the summer, as well as the ISU print services staff for their high-quality production of this summer deliverable booklet. We also want to thank our guests and thought partners who have supported us this summer - Tom Jenkins, Carlos Rojas and Jeff Reed.

High School RET Teacher Participants and Contributors,

I would like to acknowledge all the effort, hard work, commitment and innovation that went into creating the reflections and activities in this booklet. Four weeks is not a lot of time to put together a healthy vision for classroom implementation, especially in a virtual environment. However, the results clearly illustrate the benefit of RET programs to the professional development of our educators and their creativity to enhance curriculum for Iowa's students.

The RET program provides teachers with research experiences and ongoing relationships with career scientists. These experiences enable teachers to share the latest developments in STEM fields with students and inspire their students to learn more about science and engineering and their related career paths.

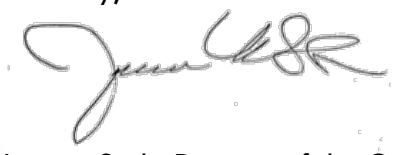
A huge THANK YOU to all the Iowa State University faculty, lab managers, post docs and graduate students who mentored our program participants and supported our programming. The RET program would not be possible without the faculty's and research teams' commitment to sharing their knowledge and skills. In the past five years alone, faculty researchers at Iowa State have collaborated with RET teachers on more than 60 research projects in the departments of agricultural and biosystems engineering; agronomy; chemical and biological engineering; chemistry, civil, construction, and environmental engineering; ecology, evolution, and organismal biology; electrical and computer engineering; genetics; development and cell biology; materials science and engineering; mechanical engineering; and plant pathology and microbiology.

In my own experience as a faculty mentor, the RET program has expanded my thinking about education and how to best serve the next generation of voters. I am proud to have worked with a fantastic and motivated teacher, and to discuss challenging topics with this year's RET cohort. I am looking forward to continuing these relationships into the academic year.

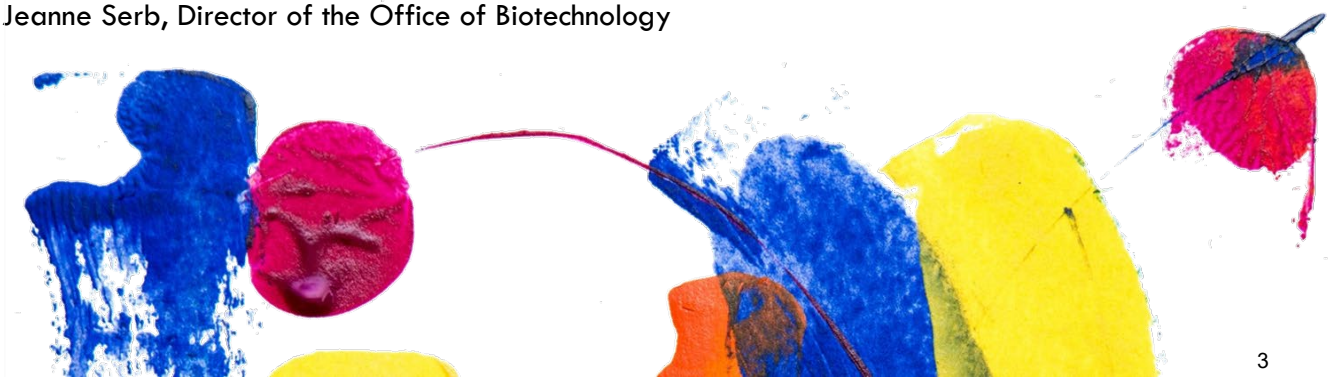
The RET program truly highlights the mission of a land-grant institution, and Iowa State University is definitely leading in this arena. The RET program provides training and equipment opportunities for STEM educators, especially those at rural and urban school districts, that their school districts could not afford. Iowa State's program positively impacts the state's workforce development by providing context and opportunities to interact with scientists in biotechnological and biomedical fields. Perhaps most importantly, collaborative, on-going relationships are being built between the state's science educators and the Iowa State research community.

Finally, I want to thank the Roy J. Carver Charitable Trust for their support of the RET program at Iowa State University. Their partnership has helped ensure that the RET program continues to grow through offering new professional development and laboratory opportunities for teachers and extending its reach to include STEM faculty university-wide.

Sincerely,



Jeanne Serb, Director of the Office of Biotechnology



RET Colleagues & Supporters,

The summer of 2020 was a challenge on so many levels for our teachers, our researchers, and the lab teams. It would have been so easy to not participate in a research experience this summer. But a fearless group of committed Iowa State research scientists and an enthusiastic group of high school teachers decided to take a chance on the idea of a virtual research experience.

Our summer theme centered on the book *Sky Color* by Peter Reynolds. *Sky Color* is about developing perspective, examining the world from varying points of view, thinking outside the box, and pushing oneself to the next level. This summer, our six teachers had 134 years of combined teaching experience. Most would think they have "arrived" as teachers. Yet, they share a belief that there is always something to learn and, in some cases, to "unlearn." We pushed them beyond their preconceived ideas about learning and asked them to use their curiosity and positive intent to help them see things with fresh eyes, dispense with mental models that were not serving them, explore racial and social injustices that exist in their buildings and classrooms, and design a better normal for students who will return in the fall. These teachers did not disappoint, nor did the dedicated individuals who supported them.

A research experience is not possible without the solid cooperation of a research scientist and a committed lab team. Our scientists went above and beyond the call of duty this summer. They accepted the challenge to learn yet another virtual platform to communicate with the teachers. In the absence of hands-on research, they helped their teacher develop an engaging curriculum unit involving their lab's research focus and the content focus of their teacher. Scientists who were having regular lab group meetings welcomed teachers into the virtual conversations for continued learning with the knowledgeable lab teams.

The summer would not have been complete without the support of Corey Welch, Surya Malapragada, Alex Walton, and Raj Raman who joined us each Tuesday for our Frontiers in Science virtual conversations. They allowed us to poke and prod them into sharing their personal stories, professional journeys, and research interests. Teachers gained another connection to the Iowa State campus for their students and the learning experiences they create daily in their classrooms.

I would be remiss if I did not give a HUGE shout-out to Lori Miller who manages to hold the Office of Biotechnology together, even during a pandemic. She never shied away from my requests, even when it involved delivering lunch to our participants who were spread from Ankeny to Colorado. Lori rocks!

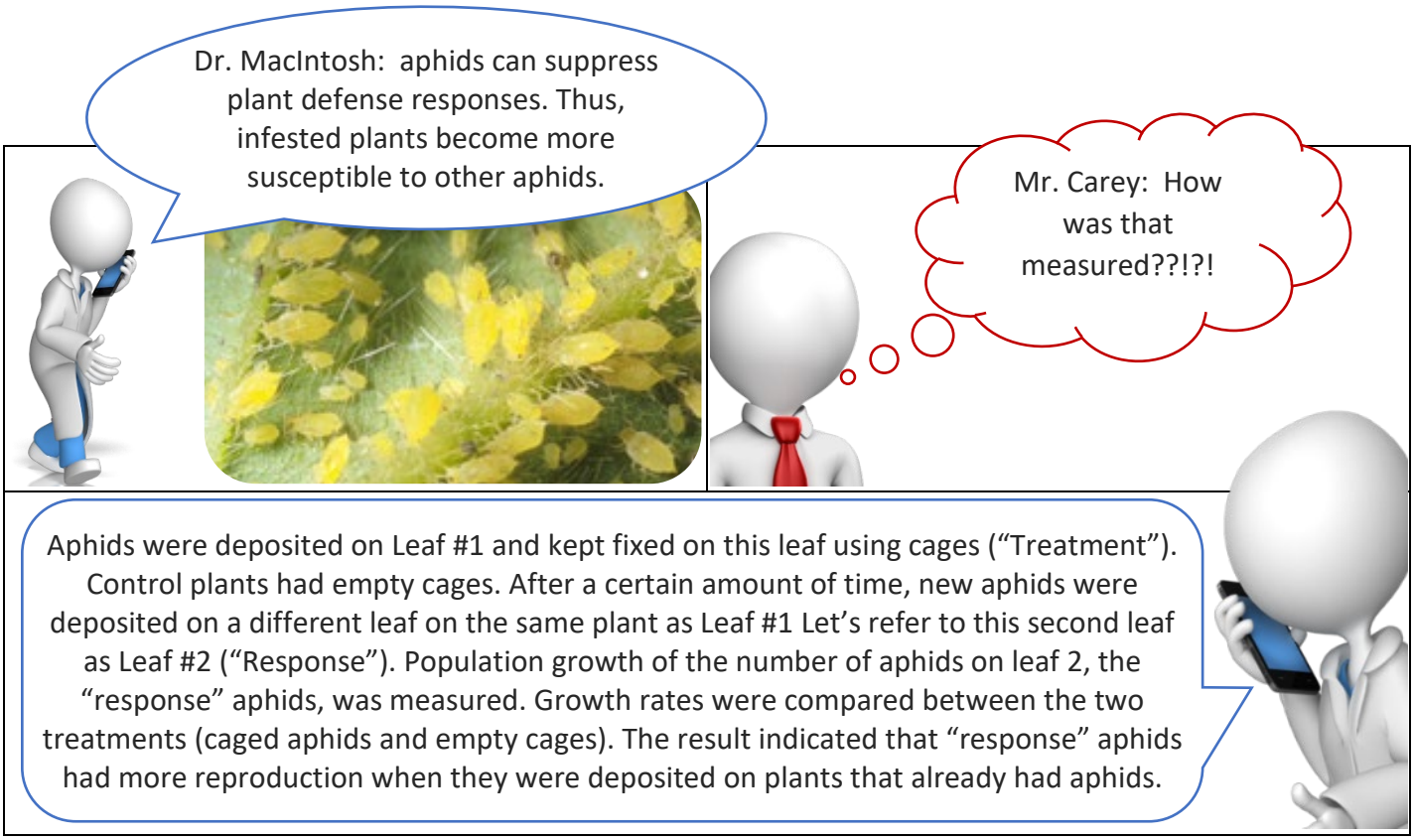
Dr. Jeanne Serb is the visionary for the RET program. Her commitment to the continuation of this opportunity for both the research scientists and teachers is unwavering. Her team successfully secured a grant from the Roy J. Carver Charitable Trust a year ago, and she continues to explore, challenge, and support ideas to make this program a beacon for Iowa State University.

Finally, this summer's research experience could not have happened without the genius of Eric Hall, my co-lead for the professional learning components, a technical guru, and creative thought leader. This program exists because of his willingness to take my wild ideas and package them in a way that can be consumed by our teachers. He grounds me, keeps our group focused, and always has his eye on the prize.

With my sincere thanks to all –

Maureen Griffin

RET Program Coordinator



Next Jyll and Jakk hypothesized:

Jyll:

Aphids had a saliva component ("effector") that can block defense responses. Therefore, more aphids or more time on the plant results in more effector being introduced in the plant. Therefore, she believes the rate at which an aphid population on leaf #2 grows is related to the total number of aphid hours spent on leaf #1.

Jakk:

Once aphids are present, the plant's defenses are compromised. Therefore, the rate the aphid population on leaf #2 grows is strictly a function of time. He believes the growth in aphid population on leaf #2 is related to the presence of aphids on leaf #1 not the number of aphids on leaf #1.

Student instructions:

Create a report for the scientist at Iowa State that shows differential equations that model each of these views with the justification for each. Show how to solve these differential equations, create possible tables of values the scientist at Iowa State could use to determine which person's thinking is more descriptive.

Photo credit: Pixabay.com

Connecting with Iowa Standards

DISCIPLINARY CORE IDEAS- COURSE CONTENT

1. Limits & Continuity
2. Differentiation: Definition & Fundamental Processes
3. Differential: Composite, Implicit & Inverse
4. Contextual Applications of Differentiation
5. Analytical Applications of Differentiation
6. Integration & Accumulation
7. Differential Equations
8. Applications of Integration
9. Parametric Equations, Polar Coordinates, and Vector valued Functions. (BC only)
10. Infinite Sequences and Series (BC only)

SCIENCE & ENGINEERING PRACTICES-

1. Asking Questions and Defining Problems
2. Developing and Using Models
3. Analyzing and Interpreting Data
4. Using Mathematics and Computational Thinking
5. Engaging in Argument from Evidence
6. Obtaining, Evaluating, and Communicating Information

Mathematical Practices for AP Calculus MPAC's

1. Implementing Mathematical Processes
2. Connecting Representations
3. Justification
4. Communication and Notation

CROSSCUTTING CONCEPTS-Big Ideas

1. **Change**
2. **Limits**
3. **Analysis of Functions**

Assessment Summary

Students will be formatively assessed based on the rubric shown.

Beginning-Represents the two situations using understandable but incorrect differential equations.

Progressing-Represents at least one of the two situations correctly using a differential equation

Meeting-Represents both of the situations correctly using a differential equation.

Exceeding-In addition to satisfying the "Meeting" requirement, correctly anticipates what a table of values would look like under each of the situations.

Recommended Use

This could be used in unit 7 (Differential Equations) in either AP Calculus AB or AP Calculus BC.

Jyll's Position

Recap: The greater the number of aphid hours on leaf #1, the greater the rate at which the number aphids on leaf #2 increases.

Considerations: Jyll's statement seems to imply linear growth in the rate of number of aphids on leaf #2. Jyll's idea may need to be expanded to consider the possibility of the rate growing in a non-linear fashion.

Conceptual Understanding: A soybean plant's defense mechanism is degraded more as the aphids inhabiting leaf #1 on the plant increases.

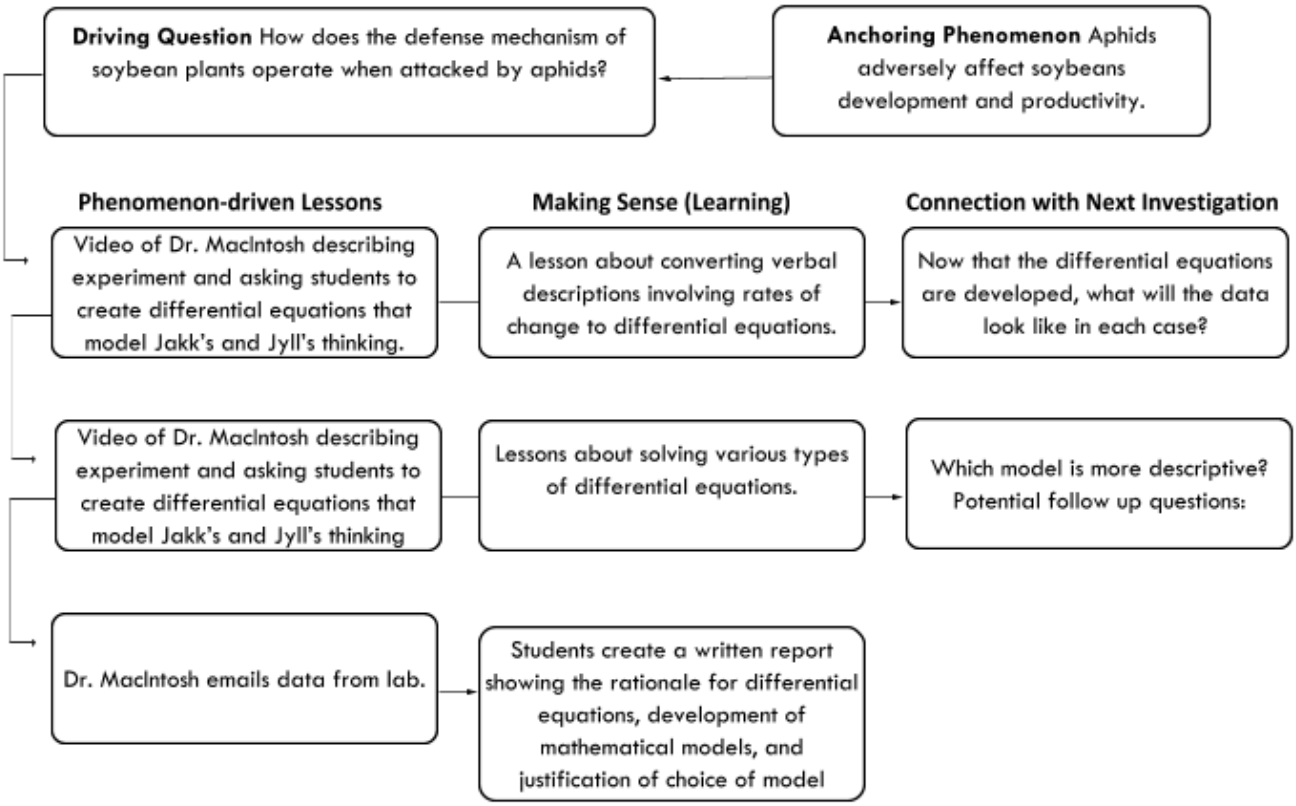
Jakk's Position

Recap: The presence of aphids on leaf #1 inhibit the defense mechanism of the soybean plant from performing effectively.

Considerations: There may be some threshold number of aphids that must be placed on leaf #1 prior to degradation of the soybeans defense mechanism degrading.

Conceptual Understanding: The presence as opposed to the number of aphids is what inhibits the soybean plants defense mechanism.

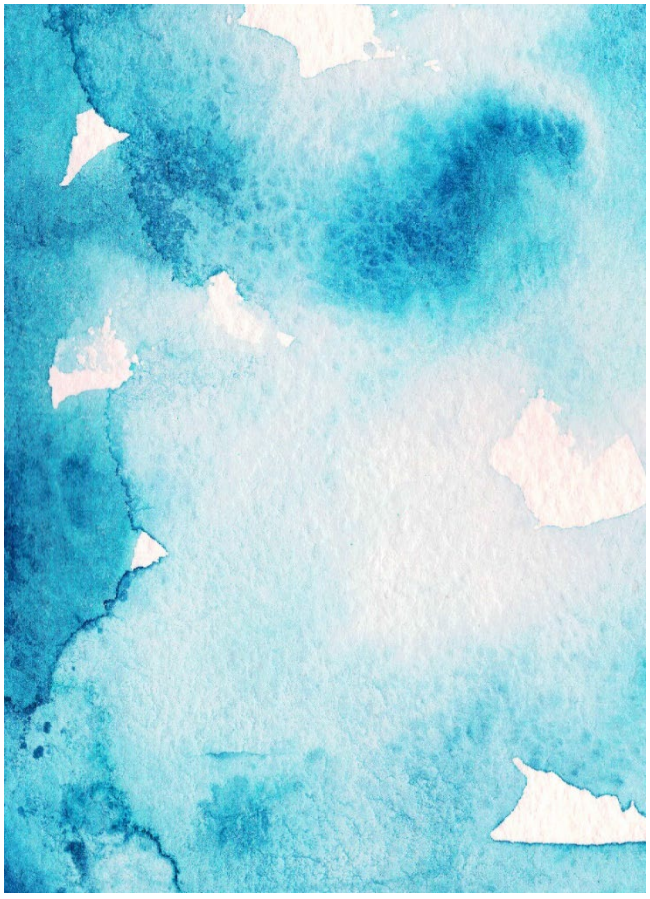
Unit Storyline



Program Reflection

Shades of Equity
I look forward to implementing the equity strategies gleaned from this and previous summers in the RET program in the 2020-2021 school year. The opportunity to have my students directly hear the story of Dr. MacIntosh and indirectly learn the stories of the researchers who participated in the Frontiers in Science portion of the program will allow me to have authentic stories centered around the idea of equity.

A Canvas of Teaching & Learning
The modeling of teaching and learning in an online environment will be particularly useful as we enter an academic year that will probably be affected by COVID-19. Regardless of interruption to the usual delivery mode. I have gained a grown a great deal in my ability to use technology to leverage deep and rich understanding of the curriculum I'm charge with exploring with my students. Someone in our group this summer said, "Never waste a big crisis." Our current crisis requires rethinking of how teaching and learning happens. This is a great responsibility and opportunity.



Brushes with Research
The opportunity for students of mine to contribute to a researcher's work is a great benefit. In the past when students were aware their work would have an audience outside the classroom in a very real way, the ownership and concern for quality work have increased greatly. The chance to help Dr. MacIntosh answer a very real questions about how soybean plants respond to aphids will be very empowering.

Colors of Classroom Implications
I came into this summer aware of the benefits of grounding students learning with experiences. Two resources that I find very helpful in doing this on a day to day basis are the Calc Medic and Stats Medic websites. The mantra they've developed is experience first, formalize later. It has been abbreviated as the EFFL approach. This summer has strengthened my belief in this approach to education in addition to adding some great experiences to my list. The Jakk and Jyll though experiment is another great way to set this stage of rooting the learning of students in an authentic situation.

Joe Carey, Ankeny CSD

Jakk & Jyll

Think about:

Suppressing Genetic Mutation

Jakk thinks:

Scientists should not suppress genetic mutations in the human genome because it would prevent nature from taking its course preparing the human genome for evolutionary changes. The majority of mutations are neutral until exposed to a particular stimulus or inhibitor and do not cause significant disease or disorders. Studying these mutations can cause advancements in technology that would allow scientists to make further advancements in medicine and potentially change the human population by eliminating harmful mutations.

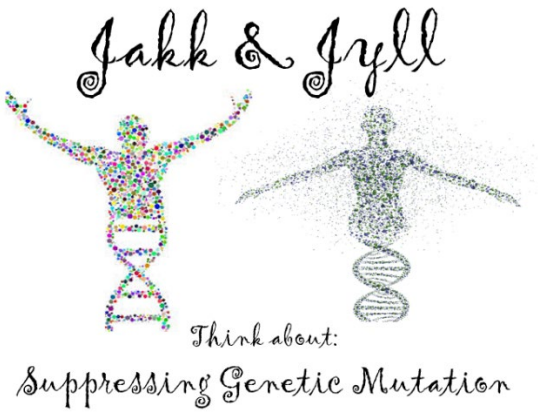
Jyll thinks:

The suppression of genetic mutations in humans by scientists should be allowed because it would reduce the psychological and financial burden of parents with offspring who suffer from disorders and diseases such as: Hurler Syndrome, Sickle Cell Anemia, and Tay Sachs. The suppression of harmful mutations like these, however, could lead to discrimination by employers and insurance (health and life) companies. Although advancements in technology that could allow people to screen for these mutations, they could also lead to the creation of bioweapons.

Student instructions

Using what you currently know about genetics and mutations, decide who you agree with more – Jyll or Jakk. Providing evidence of your choice is important and will help you build an argument for your decision.

1) Individually and based on your current knowledge and understanding decide who you agree with more - Jyll or Jakk. Provide evidence by making connections to experiences you have had (on your own or in class) or to content we've covered in class to start building your argument for your stance.
2) In groups, you will use Google Scholar to find at least two articles to help support your perspective. (Remember that credible evidence is important for building and defending your argument.)
3) One article should have the same perspective as you.
4) One article should have the opposing perspective as you.
5) As a class, we will then continue to build and defend our perspectives as we discuss content.



Assessment Summary

Helping students assess their thinking sometimes requires new and innovative techniques. Thought experiments not only allow the teacher to assess students' thinking, but also the students themselves. This method presents two similar, yet different, perspectives (answers) to a question. As students process through new information, they may often find themselves creating a new perspective tied to their own mental model.

In this Jakk and Jyll thought experiment students are asked to evaluate two different perspectives surrounding the suppression of genetic mutations in humans. This assessment should be used to evaluate and support student learning related to these questions:

- What is the genome?
- What are mutations?
- What is evolution by means of natural selection?
- What were to happen if genetic mutations were suppressed?

As students work together to analyze research articles they will build and support an argument for their chosen position (Jakk or Jyll). As they build their argument, they may find themselves creating their own position. Students may continue to modify their evidence and reasoning as class discussions occur during the unit. The students will present a final position to their peers (and teacher) to allow for progress evaluation of the intended goals and understanding of the previously stated questions and skills associated with effectively communicating their position (research and presentation skills).

Recommended Use

Mental Model Manipulation

Students often need time to reflect on where they are in their knowledge and understanding of material. Allowing students to decide and articulate where they are in their thinking (mental model) before researching, discussing, and learning material can provide students with the opportunity to engage more deeply with the phenomena and authentic problems being presented. Thought experiments like this one can help students move beyond autonomous responses into deliberate responses by having them use (and develop) evidence-based reasoning at grade-appropriate levels by integrating multiple sources of evidence to develop their argument. In other words, they will be using SEP, CCC, and DCI elements of the NGSS.

Structured Discussion

Discussions can take many forms and have many different outcomes; so it is important to consider the purpose of the discussion before deciding the type of discussion that will occur with the students.

In this particular Jyll and Jakk, students engage in structured discussion as they work together to find and analyze different research articles. They also will engage in structured whole-class discussions as content is covered and their dilemma is referenced. As the unit ends the students will also present their final position on the dilemma and engage in peer-review. These structured discussions present opportunities for the students to

- reflect on their personal autonomous sources of knowledge (instinct, faith, preferences, culture, etc.)
- stretch their mental model and move from autonomous responses to deliberate responses.
- take risks with new language
- use community-based linguistic practices to support their learning (use scientific communication strategies)

(STEMTeachingTools.org, Brief #35)

Each phase of the exercise allows students to reflect, and potentially revise, their reasoning resulting in a stronger evidence-based argument through discussion.

- explain their thinking - students explain their perspective to their partner/group as they listen and take notes

- collaboration - student groups review their notes and then work together to find articles to help build their individual arguments
- presentation - peer-review of final Jakk and Jyll position.
- debate - groups have a structured debate

Visible Thinking
Students and teachers both want students to be able to demonstrate their growth of knowledge and understanding toward desired standards. So the question is when do we allow this demonstration to occur and in what method? Limiting it to a single assessment may limit students' abilities to fully demonstrate their understanding. This is where visible thinking comes in. Visible thinking allows teachers to see the process that students are taking to process and learn the information.

Visible thinking, like structured discussions, can take many forms based on student preference and lesson outcome. A Jakk and Jyll thought experiment can lend itself to many forms of visible thinking.

- pros/cons t-chart
- agree/disagree t-charts
- concept maps
- graphic notes (Zing-like)
- written text (sentence/paragraph)
- structured verbal communication
- posters
- outlines
- collages

These are only a few ideas. Visible thinking is any communication strategy that will allow the teacher, or peer, to make unbiased observations of a student's progress.

Connecting with Iowa Standards
The connections presented in this section are starting points. As students engage in research and discussion, it is likely that they will also engage in additional standards or aspects of the standards.

SCIENCE & ENGINEERING PRACTICE

Engaging in Argument From Evidence
Students will engage in reasoning through discussing research to provide credible evidence to support their chosen position - Jakk, Jyll, or their own.

Obtaining, Evaluating, and Communicating Information
Students will develop their communication skills as they obtain and evaluate information to help them support their position.

CROSSCUTTING CONCEPTS

Cause and Effect: Mechanism and Prediction
Understanding the various reasons for genetic mutations can affect the human genome, humans, and technology can help students understand and explain the various effects of those causes.

Stability and Change
This Jakk and Jyll will help students understand and articulate how natural and artificial changes in a population can lead to stability and evolution.

DISCIPLINARY CORE IDEAS

LS3: Heredity: Inheritance and variation of Traits
LS3.A: Inheritance of Traits
LS3.B: Variation of Traits

LS4: Biological Evolution: Unity and Diversity
LS4.A: Evidence of a Common Ancestry and Diversity
LS4.B: Natural Selection
LS4.C: Adaptation
LS4.D: Biodiversity and Humans

Jyll's Position
Recap: Jyll thinks that suppression of genetic mutations in humans should be allowed. She believes that it will have a positive effect on society's mental and financial health. She is concerned that the suppression of mutations could lead to discrimination and unethical advancements in biotechnology.

Considerations:
Students that think similarly to Jyll most likely believe that most mutations negatively affect humans and if scientists are allowed to suppress them, the implications will be positive on society.

Students that reason with Jyll may have a harder time recognizing the long-term effects of controlling a population by limiting (or eliminating) certain mutations. They may also not recognize that since mutations occur naturally, even though scientists are suppressing them, nature will still take its course by adapting and evolving the genome.

Students who align themselves with Jyll way of thinking may be directly impacted by the negative effects of some of these mutations or know someone who is.

Conceptual Understanding:
Jyll's thinking, and students that think like her, will be relying on the results of applied science and research to show that suppression of mutations can improve the lives of many. They may rely heavily on case studies or on investigations involving gene therapy.

Students may choose to use graphs to show correlations between mental health and diseases caused by mutation or financial implications of caring for people with these mutations. Students may also use testimonials and interviews with medical personnel to help explain their position.

Jakk's Position
Recap: Jakk thinks that since genetic mutations in humans occur naturally and can be beneficial to the population that the suppression of these mutations should not be allowed. He recognizes that studying these mutations will most likely lead to advancements in technology; but is concerned that these advancements will eliminate certain mutations from the human population.

Considerations:
Students that think similarly to Jakk will most likely appreciate his idea that the suppression of mutations will not prevent mutations from occurring as they occur naturally. Students may also recognize that in the anchoring phenomena - The Plague - the people that survived had a genetic mutation.

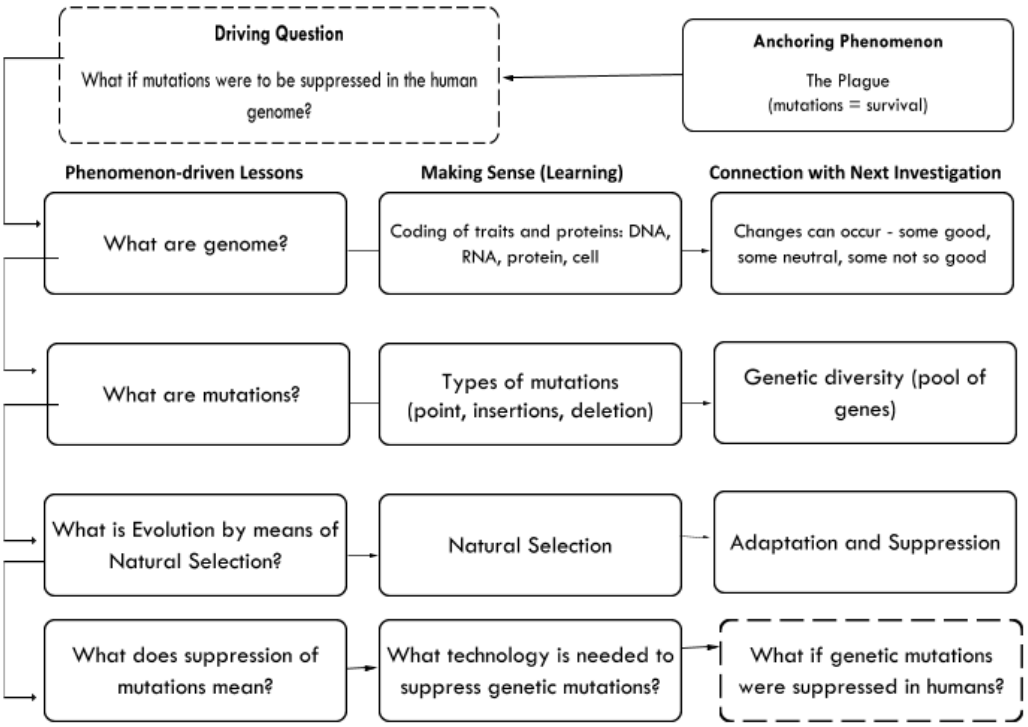
Students that align their thinking with Jakk may have a hard time empathizing with effects that these mutations may have socially on a population or may have religious beliefs that overpower the science in their reasoning.

Conceptual Understanding:
Jakk's thinking, and students that think like him, will be relying on the results of applied science and research to show why nature should be allowed to do its thing. They may rely heavily on scientific research that shows how a given mutation in one environment may be "bad" but in a different environment is "good". They may also rely on research to show how studying mutations can help find other mutations and may also explain why a particular response is happening.

Students may choose to show their understanding through specific examples in the human population where mutations have helped move society forward - through reproduction or in technological advancements.

Regardless of whose thinking students align with - Jakk, Jyll, or something new - having a fundamental understanding of how changes in an environment cause adaptations which create variation within a genome that is then passed from parent to offspring resulting in evolution by means of natural selection of a population.

Unit Storyline



Program Reflection

Shades of Equity

"Miss, why hasn't anyone ever talked to me about this before? And why are you doing it now?"

I was asked these questions by a student this spring during a tutoring session. As I responded with, "Well, because people are afraid they're going to say the wrong thing, "step over the line"; and I'm tired of it, I'm tired of perpetuating the cycle that this system created."

Reflecting on conversations I have had (inside and outside of the RET program) my response comes from the observation that people are afraid to confront their internal biases and the realization that those biases may be influencing their students in the classroom. It is easier to ignore a problem than admit that one might need to change in order to help solve a problem.

So, how can I help facilitate the conversation and be a part of the change that I (and so many others) want or need to have happen? I can create a safe place, that is welcoming and without judgement for my students, peers, and community members. I can educate myself through self-directed research, classes, and programs. I can ask questions for clarification. I can create lessons that include all voices, ensure that my students can see themselves in our work, and stretch their mental model.

The theme for this summer was inspired by the book *Sky Color*. This story provided us with the model outlined in the following text. This model can help me stay focused on making sure equity and equality are found in my classroom for years to come.

A Canvas of Teaching & Learning

Reflecting on this summer, the *Canvas of Teaching and Learning,* includes things like our: Jakk and Jyll Thought Experiment, conversation with Carlos and Jeff, and System model.

The Jakk and Jyll Thought Experiment presented difficulties for me as I had to think about the discussion that would be taking place in my classroom. Typically, I would let the students' questions drive our discussion and research rather than "my answer - Jakk and Jyll" drive the conversation. Using the Thought Experiment will help me bring equity, equality, and structure to our class discussions.

Carlos and Jeff talked about creating a "better" normal instead of going "back" to normal." This idea really resonated with me and conversations that I have had since the pandemic started. Going back to normal for me means that our students return to an educational system with deeply rooted systemic problems and the cycle continues. Creating a better normal, in my opinion, means that changes can, and will, occur in our system so that all of our schools can ensure all students are successful through equitable practices that create equality opportunities.

The Thought Experiments presented this summer combined with the conversation with Carlos and Jeff and all the other RET experiences have caused me to reflect on my System Model and reevaluate what is truly necessary for my system to provide students with the best experience possible.

Brushes with Research

Using our *Sky Color* model, some of our brushes were our: curriculum topic study, meetings with our mentor(s), Frontiers in Science lunches, and mini-consultancies.

This year I worked with a new mentor (David) and a fellow RET teacher. This experience provided me with ideas for curriculum topic studies (beyond the Jakk and Jyll presented), deep conversation, and new opportunities for collaboration. Working with a fellow RET teacher who already had a great rapport with the mentor helped me feel more at ease with the research and provided some solid teacher mentoring. David's thought-provoking questions, scientific knowledge, and research experiences were fundamental to the work that my fellow RETer and I created this summer. Together the three of us were able to have thoughtful, meaningful, and in some cases evidence-based, dialogue that allowed us to grow as scientists, researchers, and educators.

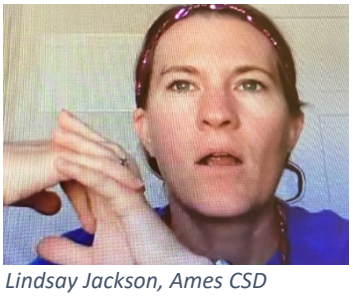
Participating in the Frontiers in Science lunches and Mini-Consultancies with my peers provided additional insights into some of the same aspects of science, research, and education I was having at my mentor meetings. The dialogue during these lunches and peer-review sessions allowed me to use strong objectivity while developing this Jakk and Jyll Thought Experiment and as I think about how to build equity into other lessons and my classroom as a whole.

Colors of Classroom Implications

Sticking with our theme, the *The Colors of Classroom Implications,* is exactly what it sounds like - how the events and experiences of this summer may find their way into our classrooms. *The Colors…*

- The relationships that are cultivated through the experiences that students have in my classroom.
- The stretching of students' mental models through reflections and thought experiments.
- The visible thinking that occurs during discussions and activities.
- The reassurance, and for some the realization, that they matter because they can see themselves (their culture, their history) in what we're doing.

These are the colors I want my students to paint with in my class. I want them to have opportunities to collaborate with people they may not have ever worked with, I want them to embrace and grow from each other's perspectives. I want them to see and talk about the science that is all around them in their everyday life. I want them to reason with evidence-based research. I want them to be confident in who they are and build each other up. I want them to help each other release the idea that failure is bad. And I want them to realize that the only way to get from the person they are to the person they want to become is constantly reflect and make changes for what we do in life is one, giant science experiment - asking questions, collecting observations, testing a hypothesis, analyzing data and research, making conclusions, and - collaborating and sharing our knowledge with others.



Lindsay Jackson, Ames CSD

You see, the *The Colors of Classroom Implications* isn't just about the colors that I provide to the students. It's about me helping them understand how to apply my paints to their paints so they can come up with a masterpiece that makes my "normal" better.

Jyll thinks:

Bio-based fuels need to be developed, industry is slow in making that change it is time for consumers to drive the change by refusing to purchase petroleum-based energy and shift towards bio-based fuels. Energy powers our world and finding cheap, environmentally friendly and easy to access energy is becoming a main priority. Difficulties remain as petroleum-based fuels still dominate the market even with environmental concerns that come with them. These concerns may push consumers to demand products that are bio-based and replace petroleum.

Jakk thinks:

The time has come for energy companies to find greener energy sources that can power our energy needs. Fossil fuels are not going to run out anytime soon, but they do come with environmental consequences. These companies have a societal and environmental responsibility to commit resources to research, develop and produce fuels that are bio-based and replace petroleum-based products.

Student instructions:

Read and decide which viewpoint you feel you agree with the most. Find a scholarly article that supports your viewpoint on google scholar that you can use in argumentation of your viewpoint.

Photo credit: www.ipwatchdog.com

Assessment Summary

This thought experiment would be used to get students to argue the from two different viewpoints about the responsibility of developing bio-based fuels or energy sources that replace petroleum.

Students will have to look and decide who ultimately is going to drive the decision-making process that delivers alternative energy sources. Not necessarily knowing all of the consequences or difficulties that the process entails. Which would also lead to additional discussions and potentially students changing their decision once more information is given to them.

Recommended Use

Student Discussion and Debate:

I really want students to be able to argue their points and use data to defend their decisions in class. This would be used to set up a small group discussion that would get kids to think about who makes this happen and why this hasn't happened yet. I am also going to ask students to find a scholarly article that supports their viewpoint. This ties in to what researchers do in trying to find out what's been done before, and the complications that have already arisen to the dilemma that was presented to students.

To build a classroom culture where other students' opinions or viewpoints may be different than their own but listening to others views and respecting their opinions in a courteous and respectful manner.

Connecting with Iowa Standards

The connections presented here are merely suggestions. Depending on how you structure the Jyll & Jakk thought experiment, students may – and likely will – engage with additional or other aspects of the Standards.

SCIENCE & ENGINEERING PRACTICES

Engaging in Argument from Evidence

Students will need to provide evidence for why they support either Jakk or Jyll and present their evidence and reasoning to the class.

CROSSCUTTING CONCEPTS

Consideration of energy and matter inputs, outputs, and flows or transfers within a system or process are equally important for engineering.

DISCIPLINARY CORE IDEAS

Conservation of Energy and Energy Transfer

PS3.BH-2 Energy cannot be created or destroyed
PS3.B-H4 The availability of energy limits what can occur in the system

Jyll's Position

Recap: Jyll feels it is the consumers responsibility to push industry to find alternatives to fossil fuels. If consumers are willing to purchase bio-based fuels industry will move to fill their needs.

Considerations: Students who choose Jyll's viewpoint make assumptions that these bio-based fuels are abundantly available, ready to use and would solve our dependence on fossil fuels. Students may not understand that this isn't as easy as a plug in and replace and consider other problems associated with finding energy alternatives.

Conceptual Understanding: Students who align to Jyll's thinking may not understand what the actual cost to produce and sell bio-based fuels compared to petroleum-based fuels. Thinking that there may be small differences that the consumer can ultimately afford where that may not be the case.

Students may not understand the environmental impact the production of fossil fuels has. Also, the environmental impact of finding the resources to grow, additional crops for fuel and the cost increase to edible food as a result of reduced land use for food.

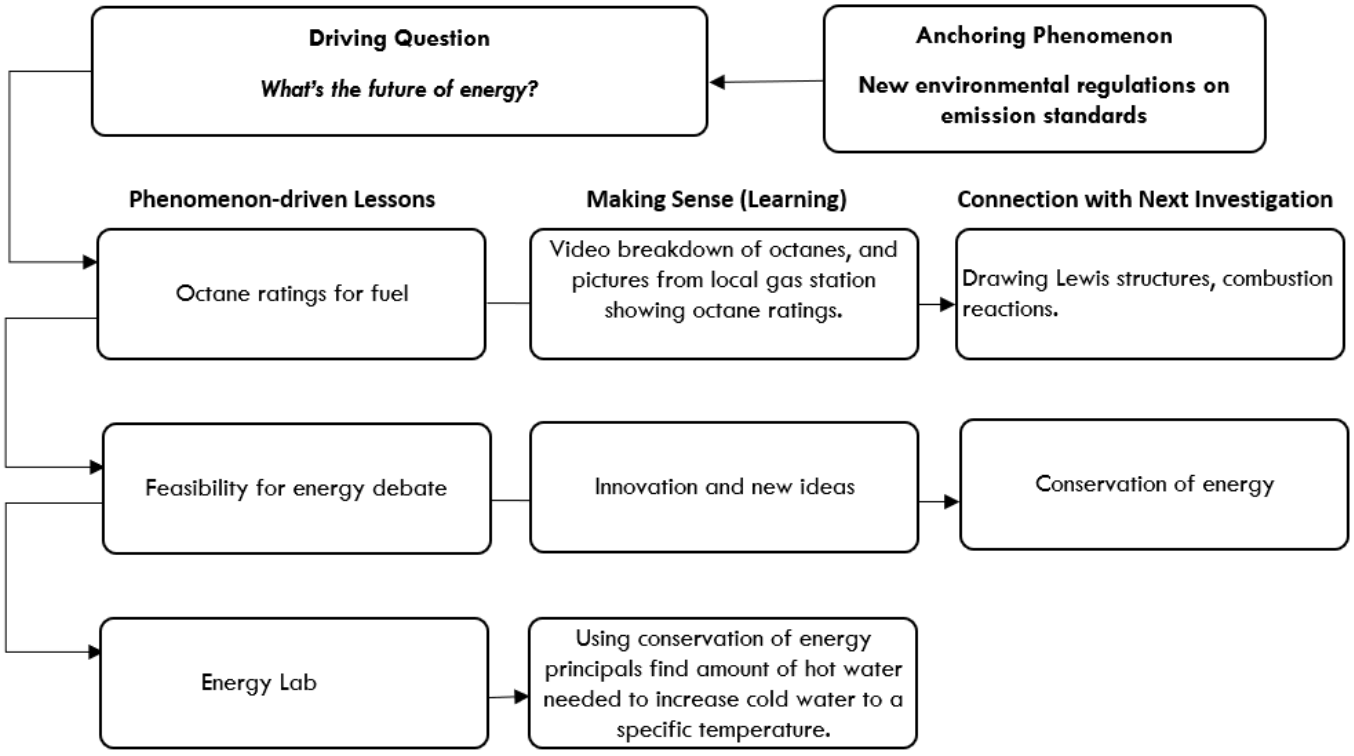
Jakk's Position

Recap: Jakk feels that industry has a responsibility to find alternative fuels that are cleaner and environmentally friendly compared to fossil fuels. These companies have an obligation to society and others to find cleaner and greener ways to provide energy to society.

Considerations: Students may choose Jakk as it takes the control out of their hands and places it on industry to solve the problem. It is often easier to look at others to solve the problem than to try to solve it themselves.

Conceptual Understanding: Students may think that making bio-based fuels is easy to produce and has the same economic payday as petroleum. Students may not understand the costs of production and effects on the environment that producing bio-fuels has.

Unit Storyline



Program Reflection

Shades of Equity

Every student has self interest in energy, their cell phones, cars and houses all require some level of energy. To take this discussion to another level the disparities amongst other countries and the resources that they may have available may provide a broader scope of what is discussed and get them to think outside of the United States to see a picture bigger than themselves. And to look at the disparity of resources when looking at other countries. This can also be done distantly if need be, our district is one to one with I-pads, and set up local hotspots for internet access.

A Canvas of Teaching & Learning

Modeling and creating a culture within a classroom that is positive and respectful of others opinions, background is important to create a feeling of safety for students. This dilemma helps set that stage for students to be able to express their viewpoints on a topic that is open for debate. Having students being able to express their argument and feel empowered and their voice being appreciated sets a tone in the class that pays dividends the rest of the year.

Content specific reading is important for all students to have access to and practice. Finding scholarly articles and breaking them down in understandable components is something teachers need to be able to do to provide students with difficult content reading.

Providing opportunities for virtual learning as well is important in the upcoming school year. Engaging students with the content from a distance can be challenging so preparing for lessons that provide an experience that can be done either in person or virtually to keep students engaged with the topic and collaborating with their peers.

Brushes with Research

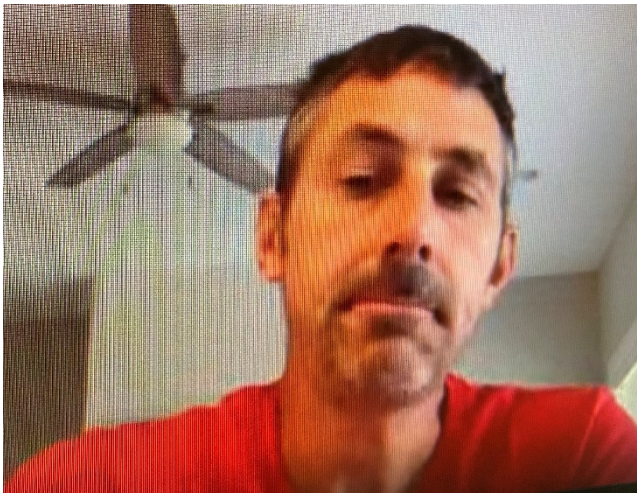
My research has ties to finding alternative uses for petroleum-based products as an additive for anti-wear and corrosion. These synthetic bio-based additives could be used to improve performance within the engine and provide an environmentally friendly alternative to other oil additives. Looking at cost effective ways to utilize bio-based products that are better for the environment.

Looking at the both sides of the conversation is also important as well. My research was driven by industry to find better additives to increase anti-wear and corrosion which provides one angle that Jakk argues. But provides context to the dilemma in that this does happen outside of the classroom.

Colors of Classroom Implications

Students will have the opportunity to voice their rationale behind the decision that they made and support that decision to their peers. Either in small groups to start and move to whole class discussion about how each viewpoint is valuable even though it may be different than theirs. Students will also utilize a scientific article to support their decision and utilize their content specific reading skills in the classroom.

This also provides some level of collaboration depending on the use of the Jakk and Jyll if students with similar opinion are put together, they can use either article to support their argument. This also has the ability to be used in a virtual classroom as well and have breakout rooms ready for kids to join and have their discussions as well.



Brandon Kleve, Johnston CSD

Jyll thinks…

Cotton is king and should be!

There's a reason that cotton has been used to make clothing for thousands of years, it is the best possible option available! There has been a significant amount of cotton domestication including selective breeding and GMOs. There is already a streamlined supply chain in place. There are alternatives, but they are limited to nylon, polyester, and spandex. And in the end, it would be extremely difficult to shift resources to cotton alternatives.

Jakk thinks…

Cotton's reign as king needs to end!

The production of clothing needs to be significantly shifted to include a much higher percentage of alternative sources as well as reusing/recycling old clothes. Cotton is grown using harmful industrial agricultural practices. There are plenty of other innovative textile options that can be used such as hemp, bamboo, and flax. Clothing made from cotton is not as durable or comfortable as other options. And more importantly, the continued use of cotton as the main clothing textile option is not sustainable.

Student instructions:

Using what you know about the production of cotton, its use as a textile in clothing, and alternatives to cotton, decide who you agree with more - Jyll or Jack. You will then go through a process of using logic and evidence to build an argument that will support your decision

Assessment Summary:

A written argument will be produced by each student that will include the student preference as well as a logical argument supporting their preference and an evidence-based argument supporting their preference.

A written evaluation will be done by a student with the opposing view (when possible) that will focus on an evaluation of the evidence and not the viewpoint.

It is important to note that there is not a correct standpoint to have. What is important are the argument and evaluation pieces. During the development of the argument, it is important that the students provide logic and relevant evidence including mathematical data. During the evaluation process, the purpose is to critically evaluate the sources used to support the person's position, not the person's position itself.

Recommended Use:

This can be used as a standalone activity related to developing, supporting, and evaluating an argument and/or a platform to investigate and evaluate industrial agriculture and its alternatives.

The written argument should include at least 4 parts:

1. The student's preference statement
2. 1 paragraph that supports their preference based on their own current knowledge (logic)
3. 1-2 paragraphs that support their preference using no fewer than 3 sources of evidence they researched. (evidence)
4. A detailed/linked list of the resources used.

The students should critically evaluate the evidence resources by utilizing some standardized method of the teacher's choice. The CRAAP method from UCSC is included below as a possible option. (https://guides.library.ucsc.edu/writing/evaluate)

Currency: the timeliness of the information

- How recent is the information?
- Can you locate a date when the page(s) were written/created/updated?
- Based on your topic, is the information current enough?

Reliability: the importance of the information

- What kind of information is included in the Web site?
- Is the content primarily fact, or opinion? Is the information balanced, or biased?
- Does the author provide references for quotations and data?
- If there are links, do they work?

Authority: the source of the information

- Can you determine who the author/creator is? is there a way to contact them?
- What are their credentials (education, affiliation, experience, etc.)?
- Who is the publisher or sponsor of the site? Are they reputable?

Accuracy: the reliability, truthfulness, and correctness of the information

- Is it accurate? Is it supported by evidence?
- Is the information balanced or biased?
- Was it peer-reviewed?
- Can you verify the information from another reliable source?
- Are there spelling, grammar, or typographical errors?
- Can you determine who the author/creator is? is there a way to contact them?

Purpose: the reason the information exists

- What's the intent of the Web site (to persuade, to sell you something, etc.)?
- What is the domain (.edu, .org, .com, etc.)?
- Are there ads on the Web site?

- How do they relate to the topic being covered (e.g., an ad for ammunition next to an article about firearms legislation)?
- Is the author presenting fact, or opinion? Who might benefit from a reader believing this Web site?
- Based on the writing style, who is the intended audience?

If this is used to serve as a platform to learn about industrial agriculture and its alternatives. Questions that should be investigated include:

- What are the inputs and outputs of industrial agriculture (IA)?
- What are the environmental impacts of IA?
- What role do GMOs play in IA?
- What are the limitations and obstacles of alternative agriculture practices including organic farming?
- How can current/novel agricultural practices be more sustainable and have a smaller environmental impact?

Connecting to the NGSS

Science and Engineering Practices:

- Analyzing and interpreting data
  - Students will analyze and interpret data from a variety of sources either researched by the student or provided by the teacher.
- Engaging in argument from evidence
  - Students must decide who they agree with more - Jyll or Jakk - and then use logic and evidence to support their viewpoint
- Obtaining, evaluating, and communicating information
  - As part of the argumentation, students will produce a written document that communicates their view in a clear, concise, and organized method.

Crosscutting concepts:

- Patterns
  - Patterns related to environmental impacts and agriculture practices will undoubtedly arise.
  - Additionally, the CRAAP method will allow students to find patterns used in both reliable and unreliable sources.
- Stability and Change
  - Biodiversity is an important aspect of stability in ecosystems. Agricultural practices impact this stability should be a part of any argument presented.
- Cause and Effect
  - Agriculture has significant inputs and outputs that involve a myriad of causes and effects.

Disciplinary Core Ideas:

- ESS3.C: Human impacts on Earth systems
- ESS3.D: Global climate change

Position Narratives

Jyll's Position

Recap:

Jill believes that cotton as a textile is the best possible option for clothing. It has been perfected over thousands of years, has the agriculture and infrastructure already in place, and mitigates environmental impacts through modern agriculture practices and a reduction in petroleum products.

Considerations:

Students that agree with Jyll likely feel strongly about one of two things:

1. using petroleum-based products for textile production is worse or
2. the alternatives cannot fulfill the demand for clothes in a cost-effective way that significantly decreases environmental impacts.

Conceptual understanding:

Students will need to research and include specific points within their argument including the following:

- The domestication of cotton, selective breeding, sustainable agriculture practices, and GMOs have significantly mitigated one of the big concerns of growing cotton: its ecological footprint.
- A streamlined supply chain allows for high quality and low-cost options to fulfill one of human being's basic needs: clothing.
- The current synthetic alternatives such as nylon, polyester, and spandex are petroleum-based which significantly

contributes to environmental impacts such as air pollution, water pollution, and climate change.
- Shifting resources to other options would be costly, slow, resource-intensive, and provides no guarantee that a better, more sustainable, economically viable, and versatile option will be adopted by the people of the world.

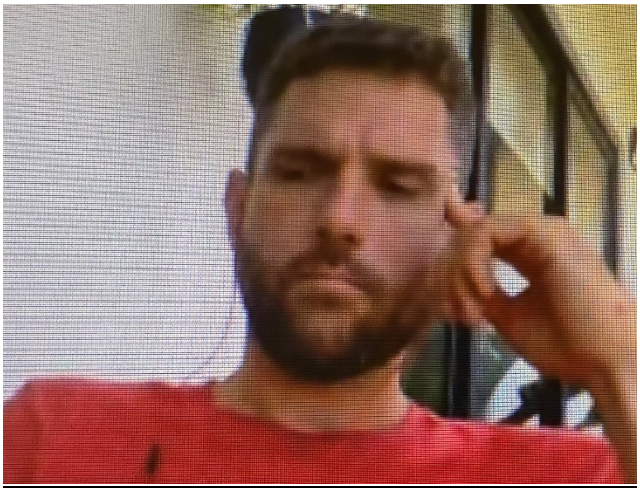
Jakk's Position
Recap:
Jakk believes that while cotton is a piece of the clothing industry that there are better (smaller environmental impact, more versatile) alternatives that should be included as options. Further, these alternatives not only have merit in themselves but can eventually become economically viable to the general public and therefore should be encouraged. He understands the negatives of synthetic fibers but supports their use as a piece of the clothing puzzle due to their durability, comfort, and versatility.

Considerations:
Those that agree with Jakk likely feel that Jyll's standpoint is too absolute and other alternatives should be investigated and encouraged. They will likely see things in a puzzle format and try to find a balance of where each piece can fit.

Conceptual understanding:
Those that agree with Jakk will need to investigate things more from a whole life-cycle analysis rather than just the economics of the production and consumer ends.
- The current industrial agriculture practices that are used to grow cotton continue to significantly contribute to environmental impacts including biodiversity decline, water resource depletion, water pollution, and soil salinization.
- Other less harmful options such as hemp, bamboo, flax, or smaller closed-loop production processes are becoming more popular and economically viable.
- While synthetic fibers like nylon, polyester, and spandex are made from petroleum, they are more durable, comfortable, and versatile than cotton.
- A measured approach of using synthetic fibers, recycling/reusing old clothing, and switching to alternative textile sources will create a more sustainable clothing industry.

Unit Storyline:

Driving Question: Cotton is king! Should it be?		**Anchoring phenomenon:** T-shirt survey and data collection
Phenomenon – driving question	**Making sense**	**Connection with next investigation**
What is industrial agriculture?	Inputs and outputs Environmental impacts Limitations and obstacles	Current and future agricultural practices are dependent on sustainability practices. How are those being included in industrial agriculture processes?
What are the alternatives to industrial agriculture?	Options Sustainability practices Yield concerns Limitations and obstacles	Are alternative agricultural practices feasible on a world scale? How can alternative agriculture practices be a larger piece of the ag puzzle?



Josh Mangler, American School of Puerto Vallarta

Jyll & Jakk

Think about:

Research Funding

Jyll thinks:

Since the money to do research is limited, it should be spent on applied research. While no research can guarantee a product, the focus of this type of research is a product that directly benefits a specific group of people in the relatively near term. This makes it easier for potential investors to justify risk of investing. Besides, our learning of new things should be focused on things we already know we want and/or need.

Jakk thinks:

Pure science provides the foundational knowledge from which new products and technologies are developed through applied research. However, it is less likely to produce a directly useful result in the near term which is riskier for those investing in this type of research. Also, more groups of people are likely to benefit from the knowledge produced through pure research since there is no defined group that it is being produced for.

Student instructions: Based on what you heard from each of the guest scientists, decide who you agree with more – Jyll or Jakk. Providing evidence of your choice is important and will help you build an argument for your decision.

1. Based on your **current** knowledge base decide who you agree with more - Jyll or Jakk. Provide evidence (make connections to things you heard our guest speakers say or specific research you are familiar with) to start building your argument.
2. Use a credible source such as Google Scholar to find at least two articles to help support your point of view **AND** at least two that support the other point of view. (NOTE: It may happen that as you do your research that you change your point of view. This is completely acceptable as long as you provide evidence to support this change.)
3. Prepare a presentation of your thinking (oral or written) in which you defend your final position. Include not only the evidence that supports your claim, but also address why the counter arguments do not hold up.

Jyll & Jakk

Think about:

Research Funding

Assessment Summary

There is a purposeful attempt to keep this thought experiment at the broadest level and not to pit any one example of each type of research against each other. In fact, as students research both types of scientific work, they are likely to come across examples of each that they either question the value of or see tremendous value in. This gets at the core notion that this cannot be an "either/or" situation as presented in the original positions.

This Jyll and Jakk centers on the question of how limited research funding should be allocated. The assessment should be used to evaluate and support student learning related to these questions:

1.) How are pure science and applied science dependent on each other?
2.) What are the benefits to society from each type of research?
3.) What are some potential harms that may result from focusing too much on either type of research or the other?

Each student will develop an argument for a position they choose...either Jyll's, Jakk's or some combination of the two that could be in a variety of forms, but preference is to written and/or oral. Ideally, these arguments will not only be presented to peers but to an "expert(s)" who are in a position to make these types of decisions in real life (such as representatives from the National Science Foundation or other large funding institutions). This process will allow for feedback to students regarding their thinking and allow for evaluation of their understanding of the questions above, their progress toward learning goals, and their ability to effectively create a well-developed argument based on evidence.

Recommended Use

Considerable time should be given upon introduction of this thought experiment for students to reflect individually. After sufficient individual processing time, a whole group discussion should follow which allows further awareness on the behalf of students about specific research they might not have become familiar with during their research. Additionally, it would be beneficial to use this Jyll and Jakk to lead into a broader question of equity framed around the following questions: Who is funding the research? What is/are their goal(s)/agenda? Who benefits from this research? Who is harmed by this research?

Consider a discussion format that lends itself to starting from one of only two positions, but that leads to the possibility of a "middle ground" . Students should end up with an understanding that it cannot be an either/or situation and an appreciation of the difficulty of arriving at any specific ratio of spending. Rather, they should recognize and appreciate the ways in which the two kinds of science complement each other.

The choice of written versus verbal elucidation of each student's evidence-based argument could depend on teacher preference. If the choice is written, it is strongly encouraged that the teacher make an attempt to develop this as a cross-curricular assignment with the English department. This will help provide the necessary support to students to ensure their writing accurately reflects their thinking and will assist the science teacher with assessing the technical writing standards.

Connecting with Iowa Standards

SCIENCE & ENGINEERING PRACTICES

Engaging in Argument from Evidence

Students will need to provide evidence for the position they choose. Their argument must also address their evaluation of the counter arguments (evidence) proposed by the other viewpoint.

Obtaining, Evaluating and Communicating Information

Students will have to gather and evaluate scientific information from a variety of authoritative sources. In the process, they will need to assess the evidence and usefulness of each source.

CROSSCUTTING CONCEPTS

Stability and Change

Part of the students' argument should include discussion of whether the current funding model (which heavily favors applied science) is creating stability or producing change in the research being done and its effects on society.

DISCIPLINARY CORE IDEAS

CONNECTIONS TO ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE

ETS 2.A: Interdependence of Science, Engineering, and Technology

Students will have to address how the knowledge produced by pure science provides the foundational knowledge used by applied scientists (and engineers).

ETS 2.B: Influence of Science, Engineering, and Technology on Society and the Natural World

Students will have to explore how decisions made by society regarding funding of research influences the progress of science. At the same time, they will need to address that society is dependent on the practical uses of the knowledge it produces.

Jyll's Position

Recap: Jyll's position is based on the belief that the greatest benefit comes from outcomes that produce the greatest direct benefit (usually financial and/or quality of life).

Considerations: Students who agree with Jyll's position may not appreciate the need for pure science to produce the foundational knowledge for them to build on.

Conceptual Understanding: Jyll's position is founded in a belief/opinion that the "best" research benefits the greatest number of people. In some cases, they may be worried that money will be "wasted" doing research that doesn't benefit the greatest number of people if this is not the case. However, they may have never considered that because of who controls the majority of funding (i.e. the dominant group) that many perspectives are not being included in current research.

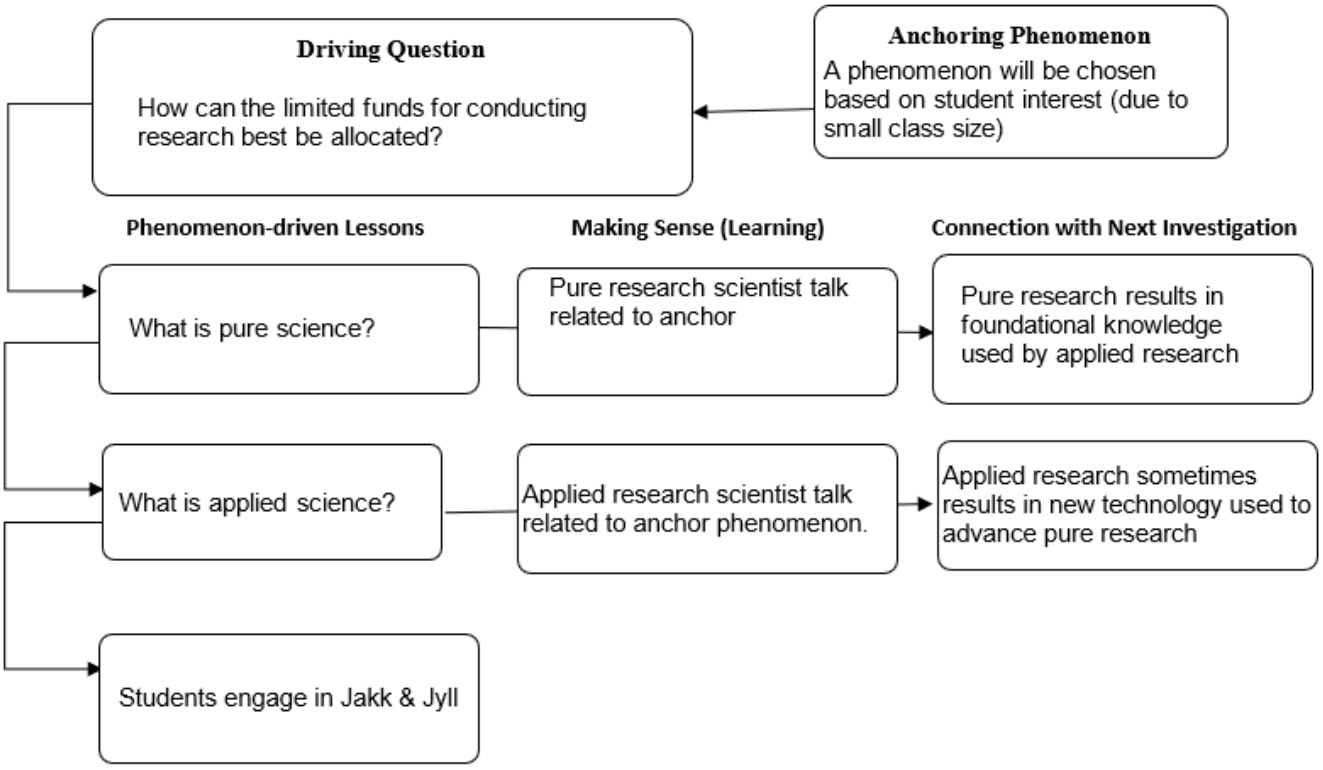
Jakk's Position

Recap: Jakk's position is based on the fact that pure science provides the foundational knowledge that applied scientists need to produce the benefits demanded by society.

Considerations: This position may be difficult for some students who are not as interested in "knowing for the sake of knowing" and, thus, are less able to see the value of the results of pure science at face value.

Conceptual Understanding: Students who align with Jakk are likely to hold that limiting research to that with immediately obvious practical application will severely limit the kinds of knowledge that society may eventually benefit from . These students may also be more interested in both the work in and outcome of science being more equitable to all members of society.

Unit Storyline



Program Reflection

Shades of Equity

The intended purpose of this Jyll and Jakk is to lead to a deeper discussion of equity and inclusion in science. This was born out of the work done around the zine, "Science Under the Scope" (Sophie Wang, 2020). This was probably the biggest personal learning that resulted from the RET. There now exists a keener awareness of the implications of the status quo in how and by whom science is currently conducted. Further, a sense of urgency has developed to enlighten others and to affect change.

The thought experiment itself was left sufficiently broad that each student could choose to explore both pure and applied research that was most relevant to the group that they identify with. In fact, it is hoped that as those research examples are discussed during this activity that members of the dominant group begin to develop an awareness and appreciation for the kinds of research relevant to the under-represented groups.

A Canvas of Teaching & Learning

Carlos Rojas and his team continue to provide some of the most impactful and, in this time of COVID, timely learning about the opportunities that exist in disruption. As previously mentioned, the learning centered around the work of Sophie Wang also had a big impact on my approach to how to help people interact with science in a more equitable way. As always, new teaching techniques are seamlessly modeled through the skilled teaching provided by the RET staff. The RET experience continues to be the most well-designed and artfully presented professional development I have ever attended. The relationships built with other RET teachers also reaps positive benefits.

Brushes with Research

Being able to facilitate the development of a relationship between an RET teacher who was new to the mentor with whom I have a long-established relationship was both effective and efficient. The lines of communication opened quickly and future collaboration between this teacher and the mentor is highly likely. The opportunity to share the deep personal relationship I have developed with David with a fellow RET teacher was certainly a highlight of this year's experience. David's knowledge

base, willingness to engage in thoughtful dialogue about the intersection of his work and the field of education, along with his friendly and approachable nature are a tremendous asset to the RET program.

While the opportunity for hands on research was not available, this simply focused the work with the mentor more squarely on the deliverable. Fortunately, the lab work developed in prior years will continue relatively seamlessly in the coming year based on the work already done in the previous year and the relationship (both personal and professional) that I have with David. I facilitated a discussion around how he might help support the other RET teacher in the implementation of hands-on learning experiences related to her Jyll and Jakk. As always, David offered several ideas and ways he could help.

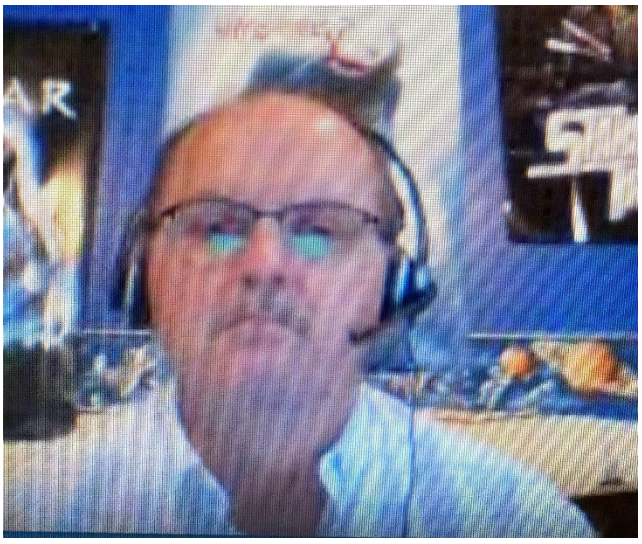
Colors of Classroom Implications

While certainly the equity piece will be incorporated to some extent into my work with students in the No Boundaries program, the use of the pedagogical techniques modeled for us during the RET will likely be limited to the very brief amount of more traditional teaching done at the very beginning of the year during the onboarding process.

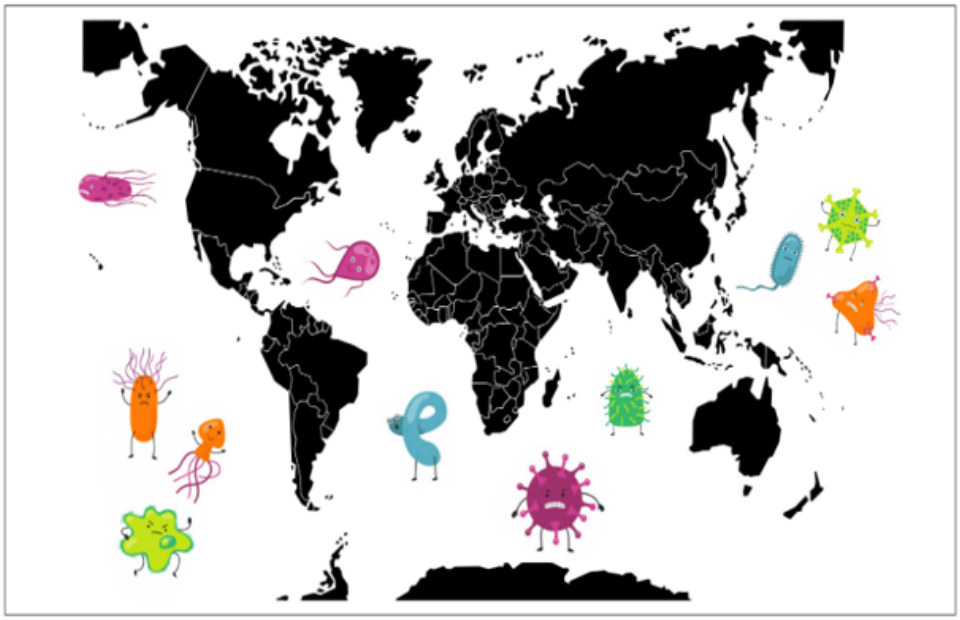
The greatest impact of this summer's RET experience will be in my work as a master teacher as I design and implement professional development for both GT and RA school districts as well as coach a handful of individual teachers. Some ideas (such as the "box" and the Science Journal app) have already been shared with the leadership team. I will be presenting a session on Science Journal at PD in August designed to help district staff be in a better position to provide virtual learning opportunities (regardless of which Return to Learn model we end up using). Techniques such as the walk and talk, Discovery Challenges, mini consultancies and others will be presented to teachers through modeling as content is delivered during professional development.

As a result of our work with Carlos, I have already communicated with our admin and leadership teams regarding the opportunities to re-define teaching and learning that the disruption caused by COVID are providing. I have already received support in this thinking from the superintendent. An important part of this work with the admin and the leadership team will involve an awareness of mental models and the need to rise above the levels of belief and opinion to be sure the models we operate under as individuals and as a district are based on evidence that is supported through practice. I am again re-inspired to be the voice that challenges the status quo so that better alternatives can be discovered and implemented.

I also mentor a high school math teacher who has the desire to improve his teaching to make it more engaging and relevant, but lacks some of the skill set. And though we have worked together to make some improvements, I am excited that Joe Carey has offered to serve as a virtual mentor. This should be more effective as Joe will better understand his struggles and be better positioned to offer subject specific strategies that have been field tested.



Marc Benedict, Graettinger-Terrill CSD



JYLL & JAKK: PATHOGENS AND PANDEMICS

Jyll thinks:

The spread of pathogens around the globe will be more accelerated if the pathogen is transmitted through the air we breathe. Humans are frequently in close proximity to one another as they go about their days. Whether they are shopping, dining, working, learning, humans spend a lot of time together, breathing in and out the same air molecules. Many people spend this time enclosed in planes, busses, offices, and classrooms. Restaurant and entertainment venues often bring people even closer together as they pack in to see a favorite performer or get a seat at a new or exclusive establishment.

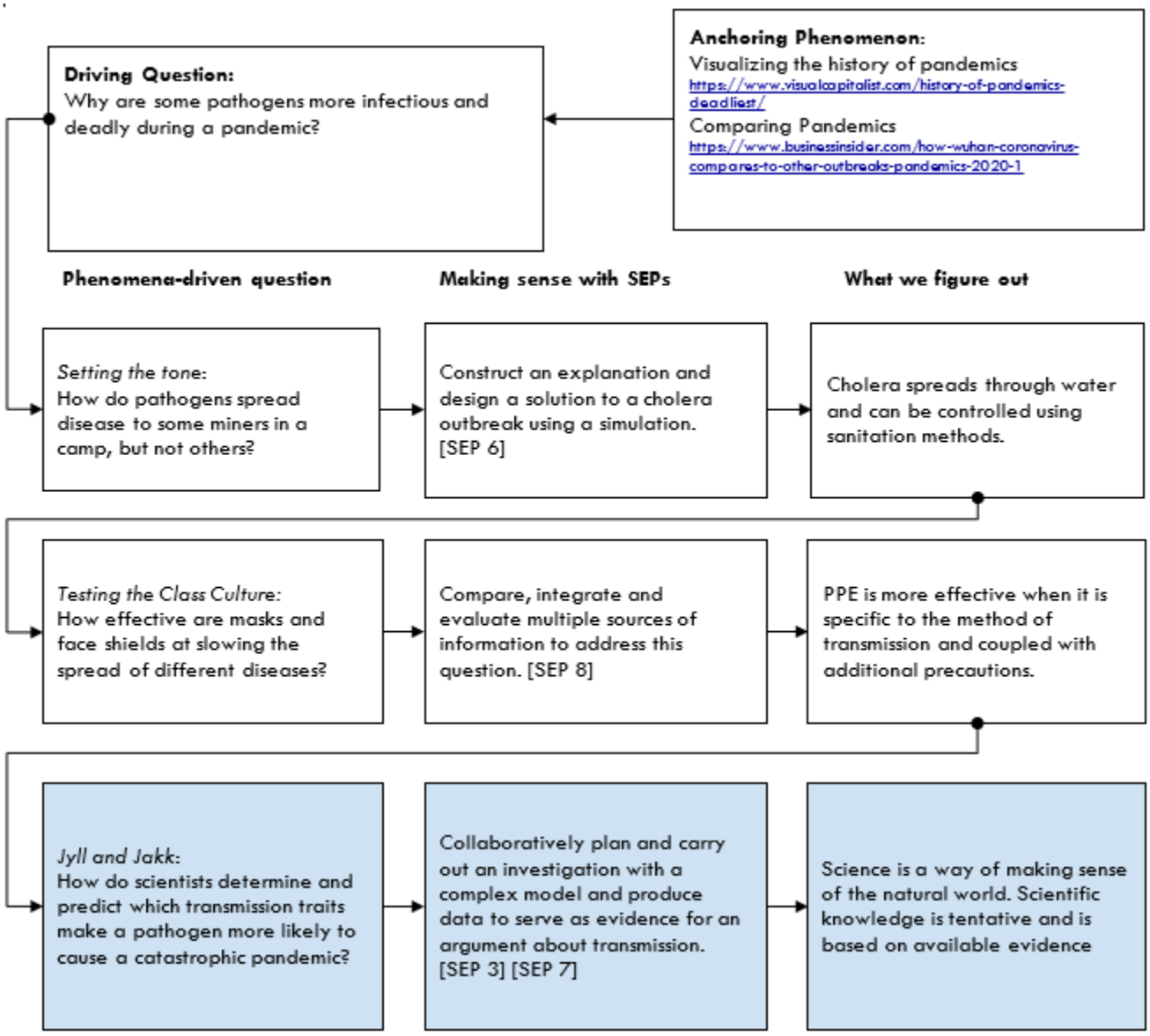
Jakk thinks:

Water transmission accelerates the spread of disease more, regardless if people are close together or distant. Water is a huge component of every person's life. We drink it constantly, we require it for bathing, industrial processes, and many recreational activities take place in or on water. We even carry water with us as we go about our day. Pathogens like water too. They survive better when wet than dry. We humans can transport contaminated water, we can find ourselves swimming or floating on contaminated water, and because water is fluid it allows pathogens to flow freely all over the planet, from stream, to river, to lake, or even to the oceans.

Student Instructions:

1. Working with the whole class, learn how to use a computer gaming model to run simulations. Practice with the team and/or individually to experience the model and simulation.
2. Run the tutorial for practice, simultaneously collect data to practice that skill during the tutorial.
3. Collaborate to create a fair comparison of the two ideas presented above. In other words, the team will plan and carry out a scientific investigation to support either Jyll's or Jakk's position.
4. The team will use the simulation to generate data as evidence to support Jyll or Jakk.
5. Teams present a supported (yet tentative) claim, as well as the evidence and reasoning behind the claim. In a whole-class discussion. We will evaluate one another's ideas and reconcile differences.

Unit Storyline



Summary

In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon (NSTA Quick Reference Guide to the NGSS, High School 2015, p.56)

This performance assessment is an opportunity for students to engage in multiple science and engineering practices as they use a complex model to run simulations and generate data as evidence to support their conclusions.

Students will explore the question: How do scientists determine and predict which transmission traits make a pathogen more likely to cause a catastrophic pandemic?

Students will collaborate to plan their investigations and after collecting data individually, will collaborate to develop tentative, reasoned and supported explanations from evidence. They will evaluate and reconcile differing claims in a whole-class discussion.

Summarizing Perceptions About Knowledge in Scientific Argumentation

Scientific argumentation requires that students and teachers perceive and treat the scientific knowledge as something that

- can be used to explain and investigate natural phenomenon,
- is worth questioning,
- can and should be improved as new information (e.g., evidence) is collected, and
- can be constructed.

Figure 1: Adapted from Helping Students Make Sense of the World Using NGSS Practices 2017, P 253

Engaging in arguments about pandemics and pathogens will help students develop a deeper understanding of what science is and how it works as they attempt to make sense of the simulated results. In addition, this exercise promotes a specific classroom culture based on this understanding of science. Students should be developing the perceptions described in figure 1 above.

Recommended Use

Setting the tone

Sharing of anchoring phenomena (appendix) with students and asking what they notice and what questions that come to their minds will lead to an opportunity to introduce a specific case study about cholera. An online simulation that explores a cholera outbreak should be assigned to pairs of students. Specifically, the cholera outbreak simulation in chapter 21 of the online edition of Miller and Levine's **Biology** (2019 bee cover), published by Savvas (formerly Pearson). Screenshots have been included in the appendix.

Working through the simulation, students will:

- Describe how they think cholera spread through the community.
    - Teacher interrupts the case to point out that students have made a tentative claim supported by their observations. Teachers point out that an explanation is their reasoning, and their explanations should be logical.
- Collect virtual data from various water samples around the simulated mining camp.
    - Teacher interrupts the case to point out to students that they have used new evidence to evaluate their original claim, this new data can improve and change their claim.
- Students will suggest a solution to the cholera outbreak of their own design.
    - Teacher wraps up the case by pointing out that students are using logic, reasoning and evidence from the simulation to learn about natural phenomena and are actually engaging in arguments from evidence to suggest their designed solutions. Each pair of students should be asked to prepare a whiteboard to share their claim, evidence and reasoning along with their solutions. A few groups can present a CRE whiteboard and explain what evidence they have to support their solutions to the cholera outbreak.

After the simulation, teachers post figure 1 above and ask students to reflect individually and then share their responses to these prompts in small groups (or online discussions):

1. What are some possible ways we might construct scientific knowledge?
2. How much or how little do you agree with the idea that scientific knowledge is worth questioning? Explain why you agree or disagree.
3. Describe what value may exist in evaluating scientific knowledge when new evidence is presented.
4. Thinking about figure 1, what are some possible ways that these perceptions about scientific knowledge can lead to productive *scientific arguments?*
5. How might *scientific arguments* differ from the arguments we have with friends, foes, and even family?

Teachers should share the reflections they collect from students and discuss their own hopes for how these perceptions will impact the culture in the classroom. Specifically, the teacher should discuss how scientific argumentation can help creating a culture of learning from one another by respectfully evaluating one another's arguments.

Teachers ask for ideas from the students, as co-designers of the culture, "***What will help ensure we maintain a culture of learning and respect in our classroom?***"

Testing the classroom culture

After discussing the effectiveness of their solutions to stop cholera transmission, the next phenomena to address are the masks and face shields that we will be wearing in school (or when we go shopping in the event we are not face-to-face). The teacher may pose these two questions to bridge the two lessons: *How effective might the students' solutions be for the simulated miner camp? How effective are the methods we are using to slow the spread of Covid-19?*

This learning opportunity will continue with a quick reading assignment: **Remdesivir may work even better against COVID-19 than we thought.** Students complete a think, pair, share. Questions for the students to consider as they read, discuss and share with the class include:

1. What can we notice about the evidence? How might this impact the quality of the evidence?
2. Does the logic and reasoning presented in the article strongly or weakly support the claims made in the headline?
3. What are some reasons the title of this article contains the word, "may"?

Link to article:
https://www.sciencenews.org/article/remdesivir-covid-19-coronavirus-pandemic-gilead?utm_source=Editors_Picks&utm_medium=email&utm_campaign=editorspicks071920

After the students have a chance to make their ideas public, the teacher should take a moment to share the following page from Science for All Americans:
http://www.project2061.org/publications/sfaa/online/chap12.htm#11

Students should take a moment to look over the reading and decide if the Remdesivir article has any of the indicators of a weak argument. Students can work in small groups to share their ideas before the teacher asks for a few groups to share out.

The teacher needs to take some time here to discuss what just happened, reinforcing that students can successfully evaluate scientific arguments. In this case the arguments are being presented by an outside source (Science News). Teachers should ask ***"What additional care might we need to take when we are evaluating one another's arguments?"*** revisiting the classroom culture discussion from the previous lesson.

Students are then asked to make their own tentative supported claims about the effectiveness of masks and shields with regard to slowing the transmission of the coronavirus. Students are free to use any outside sources as evidence. They will be asked to develop their arguments individually, then collaborate to present one argument from each group of four students. Each group will be given time to evaluate their argument using the page from Science for All Americans after they have prepared a draft.

Each group will be given a short amount of time to present their ideas. If there are differing claims, time will be spent reconciling and practicing respectful evaluation of one another's arguments.

Jyll and Jakk

The next learning opportunity involves two science practices. Students will be planning and developing an investigation and engaging in scientific arguments from evidence. Their goal is to collect and present robust data (similar to the Science News article) as part of their scientific argument.

The first phenomena for this learning opportunity is a mathematical model showing hospital beds used, and projected to be needed, in the current pandemic. This graph will be shown alongside the flattening of the curve graph from the CDC, and a table showing how the projected number of deaths changes over time during a pandemic. Comparing these models and discussing them, the students will be asked what they notice and what questions they have.

- https://covid19.healthdata.org/united-states-of-america
- https://www.nytimes.com/article/flatten-curve-coronavirus.html
- https://www.thinkglobalhealth.org/article/uncertainty-and-covid-19-pandemic

The teacher will discuss how these graphs are made and how models have predictive power, and that they also have inherent uncertainty. To experience what we mean by this we will work together to try to answer the Jyll and Jakk question.

The teacher explains that a complex model has been constructed that we can use to simulate what might happen in a single pandemic. We will need to realize that any single simulation alone may, or may not, be a reliable indicator of what will actually happen. However, aggregate data from multiple simulations can help us predict an outcome. This is why uncertainty needs to be both acknowledged and tolerated.

Students will be introduced to the game Plague Inc (for phones) or Plague Inc. Evolved (for PCs). Students will watch a video tutorial as the teacher describes the basics of the simulation.

Students will be provided with a method for data collection during the tutorial so they can begin to

understand how to keep track of this complex scenario. They should be encouraged to collect data during the tutorial. Following the demonstration, the teacher will share a list of simulation variables with the students. If students are struggling to understand their task at this point, it may be useful to share some example data.

Students will then be given work time in their groups to determine their plans for collecting data to support their final claim. The teacher should explain that they are to keep in mind our perceptions about scientific knowledge discussed in earlier lessons. The teacher will display figure 1 for the students as a reminder.

The teacher will circulate to each group asking students to consider whether or not they have a plan to collect evidence that will make their final argument strong. Some students may not be able to decide if they agree with Jyll or Jakk and the teacher should point out that this not a problem. Not every investigation starts with a hypothesis. They can determine their hypothesis after collecting data. The teacher will also be asking students to consider whether or not it is fair to compile and/or compare data from their different runs of the simulation.

Given time to plan and complete the investigations, students will prepare a short presentation to their peers. Each team will present their claim, evidence, and reasoning using a white board and template. A whole-class discussion will follow the presentations in order for students to reconcile differences. This may involve more data collection before everyone is ready to agree.

Connecting with Iowa Standards

SCIENCE & ENGINEERING PRACTICES

Developing and Using Models

Students generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

Planning and Carrying Out Investigations

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence.

Engaging in Argument from Evidence

Respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence.

Obtaining, Evaluating, and Communicating Information

Obtain information that is used to evaluate the merit and validity of claims.

CROSSCUTTING CONCEPTS

Patterns

Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them. Empirical evidence is needed to identify patterns

Cause and Effect

Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. Changes in systems may have various causes that may not have equal effects.

DISCIPLINARY CORE IDEAS

(see conceptual understanding below)
LS1: From Molecules to Organisms: Structures and Processes
A. Structure and Function (DNA/genes carry instructions for proteins that do the work of cells
LS4: Biological Evolution: Unity and Diversity
B. Natural Selection- the traits that affect survival are more likely to be reproduced and thus are more common.

Jyll's Position

Jyll thinks that human diseases will spread more quickly if they are transmitted by air. She thinks that because humans are in close proximity and often share air that they are breathing, this will be a faster method of transmission.

Jakk's Position

Jakk thinks that human diseases will spread more quickly if they are transmitted by water. He thinks that because water is likely a hospitable environment for microbes, they will be able to travel near and far with humans, carrying the disease to uninfected humans at both small and great distances.

Considerations: Both explanations are viable and can be supported with data. From a quick look back at the pandemic data reviewed in

earlier lessons, students will see both types of transmission have created pandemics.

Student groups that create successful arguments will find that, when all other variables are equal, a pathogen will infect more people over a shorter period of time. Depending on the symptoms, faster transmission may also be indicated by a larger number of deaths in a shorter period of time.

To make a fair comparison between the two different methods of transmission students will need to collect data from repeated trials and control other simulation parameters to the best of their ability. Students may struggle to control variables given the random nature of the pathogen's evolution included in the model.

Some students may be unable to accept any uncertainty in their claims and this is an excellent teachable moment. Teachers need to anticipate that these students may wish to ignore data, and should discuss the inevitability that random events will be interjected into the simulations.

Students with a rich understanding of ratios may use the rates of transmission as a means to make fair comparisons when pandemics last different lengths of time.

Conceptual Understanding: The emphasis in this lesson is not to understand evolutionary processes or the role of DNA in natural selection. Rather, it is to see that DNA has a role in determining pathogen traits, that evolution happens to pathogens, and that humans are impacted by the evolution of these microbes. In terms of Disciplinary Core Ideas, this experience is a phenomenon in and of itself. The primary goal of these lessons is for students to experience science as a way of knowing and to strengthen a classroom culture that emphasizes sense making through scientific argumentation, modeling, and investigation. The disciplinary core ideas referenced above will be explored in more depth in the next unit of study.

Shades of Equity
In a typical biology lesson, the students who are perceived as the leaders are generally very good at school, and may lack experience playing video games. This lesson turns that paradigm on its head. Students with gaming experience are going to be able to contribute to their teams in a way that they may have not been able to in the past.

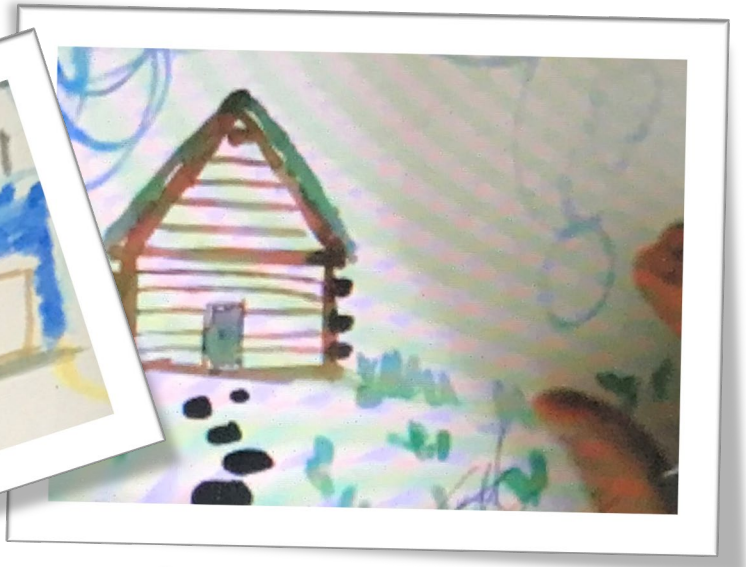
For any student without a phone, there will be pre-recorded games online which they can access through their school-issued computer. The district is working hard to make sure all students have access to Wi-Fi at home.

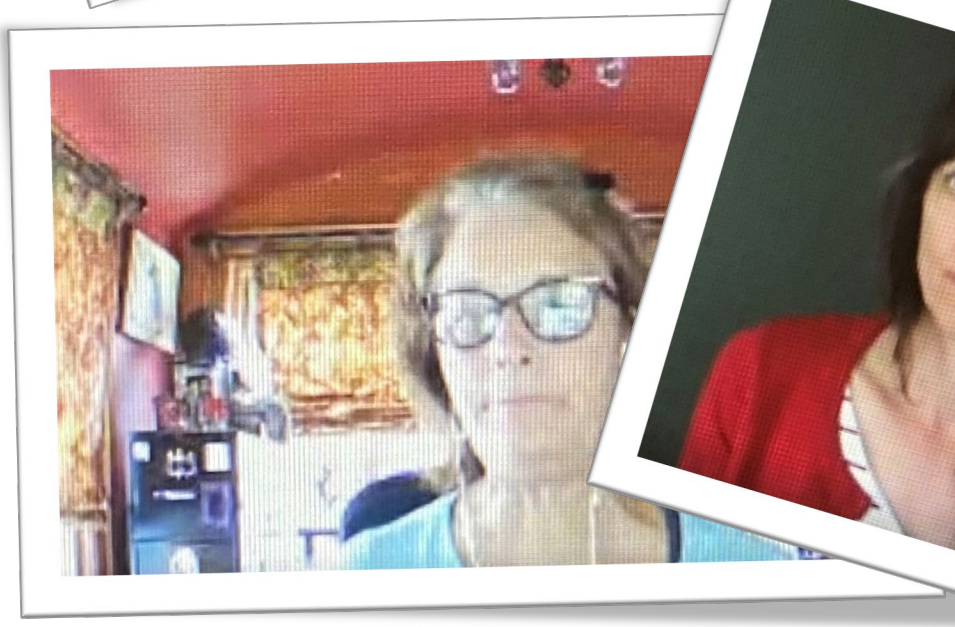
A Canvas of Teaching & Learning
Unlike a thought experiment, this set of lessons culminates in a true experiment that can be designed by students. Students may choose to test a hypothesis, but it's not necessary in this case. Some students may simply choose to collect data to see what occurs and use the patterns they observe to come to a hypothesis.
This is an opportunity for students to do a "hands-on" experiment without expensive equipment and it is an activity that we will be able to reference in future lessons about DNA and evolution.

Brushes with Research
Engaging students in science practices as they make meaning of concepts and ideas is at the heart of the NGSS and also an important component of any research experience. This set of lessons takes advantage of current events and primes student engagement prior to learning about DNA, genes, natural selection and evolution; the concepts underlying the research in the Serb lab.

Colors of Classroom Implications
Developing a classroom culture that has relationships, respect, and learning as its pillars is a primary goal of this series of lessons. The implications of successfully creating this culture cannot be overstated. Perhaps the biggest implication for the classroom will be the teacher's perception of knowledge. If the teacher holds onto the perceptions of scientific knowledge described in figure 1, it will impact every lesson and the students will take on this perception as they learn by doing science on a regular basis.

Craig Walter, West Des Moines CSD






CARLOS ROJAS


Marc Benedict