Summer 2021

RET

Changing Learning. Improving Lives.

Classroom Materials & Participant Reflections

IOWA STATE UNIVERSITY

Roy J. Carver CHARITABLE TRUST

NSF

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 staff 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.

Cover photo by:

Emily Chappell

Summer RET logo by:

Connie Wilson Design

Photo credit: Iowa State University

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. Six weeks is not a lot of time to put together a healthy vision for classroom implementation, 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 70 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.

Photo credit: Pesels.com


PROGRESS,
NOT PERFECTION

RET Colleagues and Supporters,

The pandemic has been a challenge and a blessing on many levels for our teachers, researchers, and lab teams. It would have been so easy for teachers to take a much-needed break this summer and for our researchers to decide it was time to focus on making up for lost time in the research lab. Instead, a fearless group of committed scientists and an enthusiastic group of industrious teachers decided to jump into the research experience with both feet and make the most of an opportunity to impact the lives of their students.

Our summer theme centered on the book Ish by Peter Reynolds. Ish is about the transformation of a young boy's relationship with his art and his outlook on life. The book's central topic is the concept of perfection, both as it relates to realism and the nature of perfection as a worthy motivation or achievable goal. This summer, we had 11 teachers whose teaching experience ranged from a first-year teacher to a teacher of 35 years. Everyone came to this experience eager to learn more and share their knowledge with one another. 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, practice their skills to improve themselves, and seek enjoyment as motivation for learning. We challenged them to grow some mystery seeds and connect that experience to the ideas shared by Beronda Montgomery in Lessons from Plants. They designed a learning experience their students would remember 20 years from now as expressed in the Power of Moments by brothers Chip and Dan Heath. We nudged them with a tool called the Habit Builder to test the idea that by shaping the environment, you can influence the likelihood that individuals will choose one option over another. 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 and their teams went above and beyond the call of duty again this summer. They accepted the challenge to support their teacher in developing an engaging curriculum unit involving their lab's research focus and the content focus of their teacher. Teachers were welcomed into lab group meetings each week and expected to contribute like any other team member.

The summer would not have been complete without the support of Ted Willard, Page Keeley, Raj Raman, Alicia Carriquiry, Don Sakaguchi, Yanhai Yin, Michelle Guo, Rox Pals, Chris Groscurth, and Christine Her who joined us for virtual learning during the summer with our teachers. These professionals allowed us to poke and prod them into sharing their personal stories, professional journeys, and research interests. Teachers gained another connection to the campus and local community for their students and the learning experiences they create daily in their classrooms.

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 in 2019, 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.

Maureen Griffin

by Todd Boender

Jakk thinks:

All varieties of Arabidopsis plants will die at the same rate when water is withheld. Jack knows that water is a key raw material in photosynthesis and without it the plants will not survive.

Jyll thinks:

Through the science of genetics, plant stress resistance has become better. Selective breeding, genetic engineering, and research have made improvements in plant genetics. Making some plants better at surviving drought. So, the plants without water should die at different rates.

Student instructions:

Using your knowledge of plants and genetics, decide who you agree with more Jakk or Jyll. Each day school is in session, you will use your iPad and take a picture of the flat of plants receiving water and the flat that is not receiving water. When the experiment is over, you will put together a time lapse video to show if your hypothesis is correct or not.

Assessment Summary

Each student will develop an argument why Jakk or Jyll's viewpoint is better and give example of real world examples of the argument they think is correct. Each groups of students will present to the class their findings. The flats of plants will be introduced to the students showing the different varieties of Arabidopsis. The students will write a paragraph describing the differences among plants. As the experiment progresses and comes to an end, I will have the students look back at who they thought had a better idea about drought stress. I will have the students write a paragraph explaining why their hypothesis was right or wrong.

Connecting with Iowa Standards

MS-LS3-1 Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

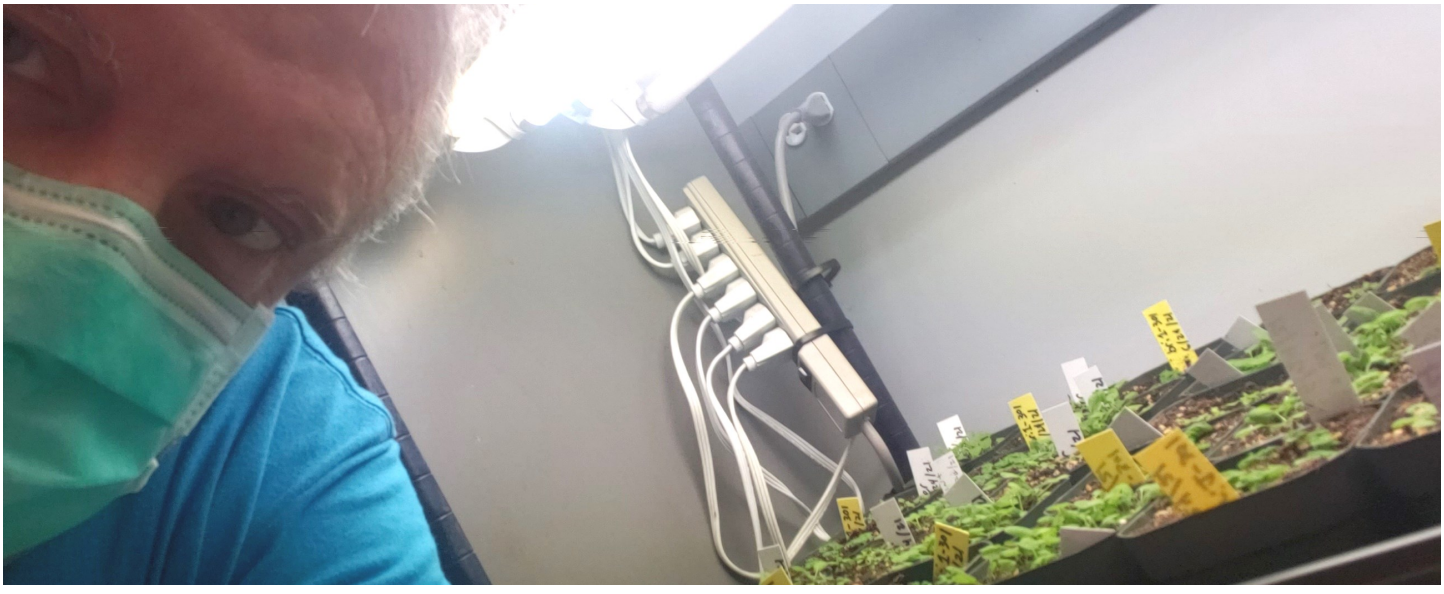
NGSS Science and Engineering Practices

DATA-M4 Analyze and interpret data to provide evidence for phenomena.

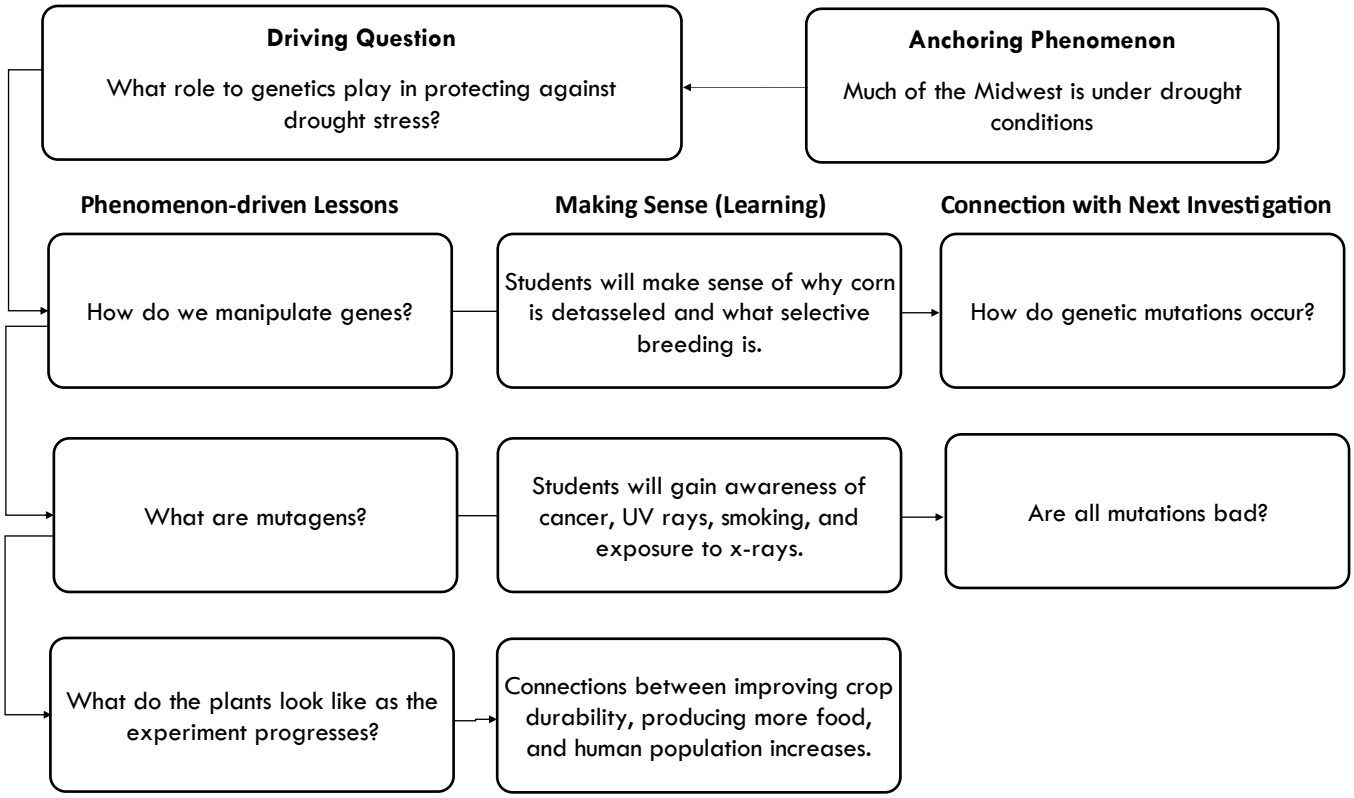
NGSS Crosscutting Concepts

PAT-M3 Patterns can be used to identify cause and effect relationships.

PAT-M4 Graphs, charts, and images can be used to identify patterns in dats.



Unit Storyline



Program Reflection

Equitable Moments – "anytime, anything, anywhere"

I learned that I have some things I can work on and get better when it comes to equity. RET has made me more aware of equity through the different professional development meetings. I truly believe that everyone has science potential if they are supported, encouraged, and can have fun while learning about science. I am ready for school to start

Enjoyment as Motivation – Impact on Teaching and Learning

I really like spending my summer's learning new things. I have learned a lot about a plant I didn't really know anything about. (Arabidopsis) I have gained lab skills and learned how scientific research actually works. I have gained a lot of new friends who will hold me accountable and make me a better teacher. I will never forget how Dr. Yin and Dr. Guo welcomed me into their lab. What a great experience!! I also learned how great Iowa State University is. I am definitely going to steer my students to look into going to Iowa State. So many great programs and great people. My batteries have been recharged because of this program and I'm excited to start my 30th year teaching middle school science.

Goals of Doing – Engagement with Research

I learned Arabidopsis is the perfect plant to use in a middle school classroom. It is easy to grow, has a short lifespan, and there are many free resources to help teachers. ABRC at Ohio State offers free seeds and has many lesson plans for teachers. I have gained confidence in my lab skills. The first week I didn't want to attempt anything, now I help with the genotyping process about every day. My team inspired me to get better and put up with my millions of questions. My team made me a better teacher

Perfection and improvement – Classroom Culture Shifts

I made a lot of mistakes this summer. That is part of learning to do something for the first time. I learned from my mistakes and have gotten better as a scientist. There have been tons of mistakes in science that have done good things. Everyone makes mistakes, the key is learning from them. I tell my kids to be better today, then they were yesterday, and be better tomorrow then they were today. I hope someday they figure out what I am talking about.

Thoughts from Todd's Lab

Why do you believe it is important to partner with the Office of Biotechnology and offer research experiences for K-12 science teachers?

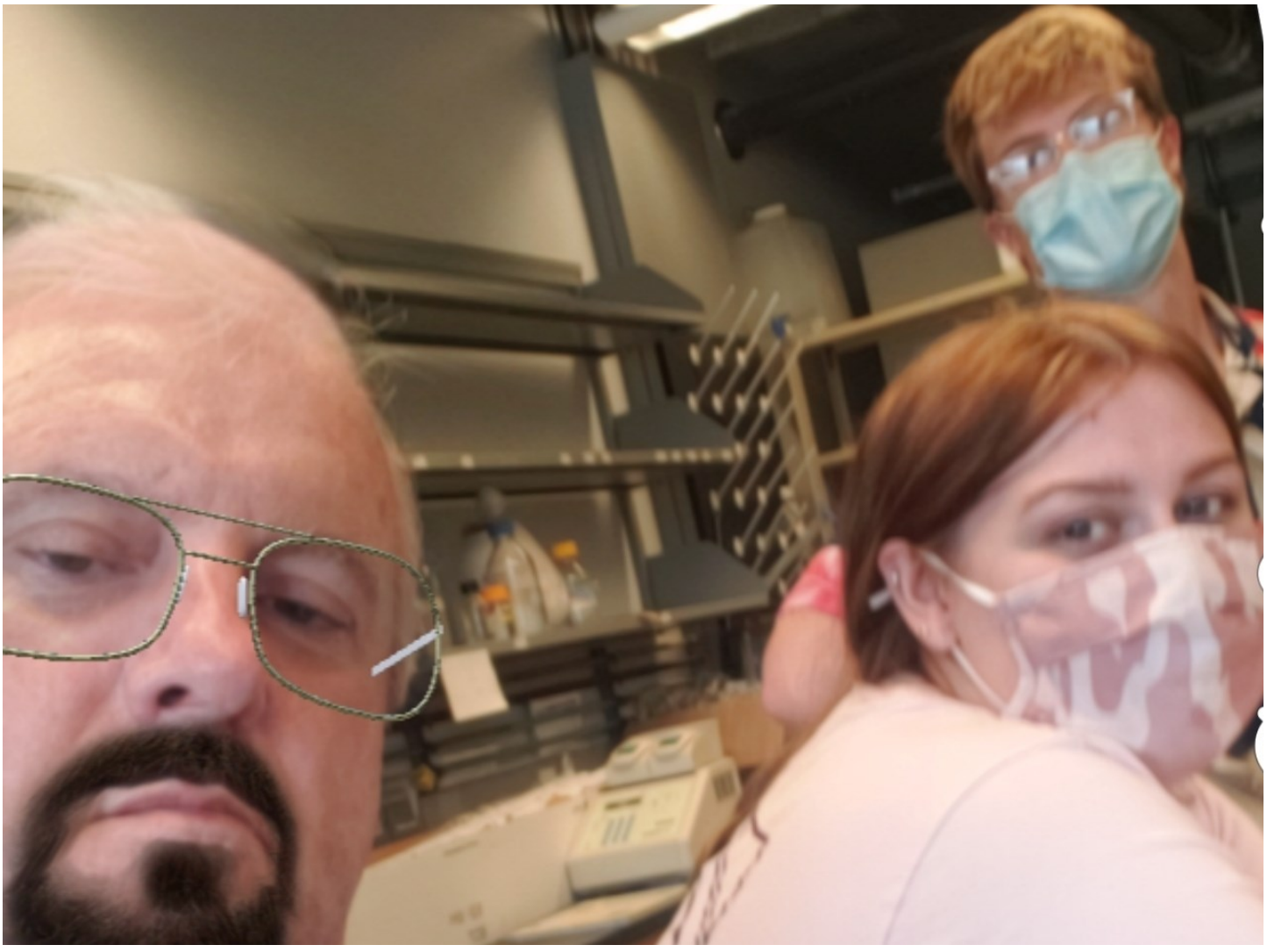
The Office of Biotechnology provides important resource for us to connect with RET teachers; and the RET teachers bring a different perspective of scientific research to the lab and the experiences the teachers gained in the lab will be brought back to the classroom in middle/high schools, which is helpful for the science education.

In what ways has your RET teacher grown most over the summer?

I think Todd has become more comfortable to do bench work in the lab.

How do you plan to continue the partnership with your RET teacher and their students during the upcoming school year?

We will send seeds with Todd to his classroom for the students to observe how plants respond to drought conditions.



Can information from markings on bullets be used to keep innocent people from being wrongfully found guilty of a crime involving bullets?

by Joe Carey

After reviewing data from the Innocence Project, Jakk and Jyll are concerned about the number of people who are wrongfully found guilty of crimes. They hope that analyzing markings on bullets can provide accurate evidence that will lead to correct decisions by juries. Grooves on a bullet are called striea. These are created when a bullet is fired from a gun. Can these be used to indicate a suspect's gun was likely the one that fired the bullet? Images of striea are shown here:

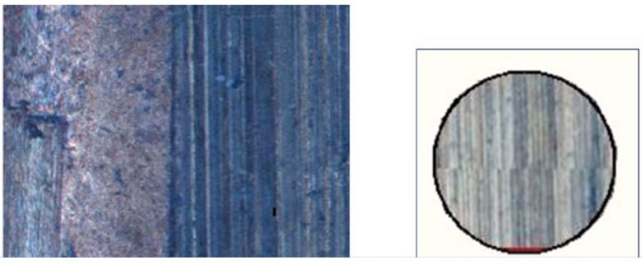


Photo from: https://slideplayer.com/slide/1677084/

206 comparisons of striea from two bullets was done by Li (https://shareok.org/handle/11244/324718). The table below shows the maximum number of consecutive matching striea (CMS) for 146 pairings in which the two bullets were known to be fired from the same gun and 60 pairings in which the bullets were known to be fired from the different guns. Let's assume this sample is representative of all bullets with regard to the relationship between CMS and firings of matched vs non-matched guns.

Maximum # of CMS	2	3	4	5	6	7	8	Total
Both bullets fired from the same gun	55	54	23	11	2	0	1	146
Each bullet fired from a different gun	48	11	1	0	0	0	0	60

Jyll thinks:

Jyll believes it would be appropriate to decide whether a pair of bullets are shot from the same gun because the number of CMS (consecutive matching striae or grooves) being greater than or equal to four is dependent on whether or not they were known to be shot from the same gun. She believes this because she thinks 37/146=25.3% and this differs from 146/206=70.9%.

Jakk thinks:

Jakk believes it would not be appropriate to decide whether a pair of bullets are shot from the same gun based on the number of CMS because the number of CMS being greater than or equal to four is dependent on whether or not they were known to be shot from the same gun. He believes this because he knows P(Same Source |CMS>4) =37/38=97.4% and this differs from P (Same Source) =146/206=70.9% .

Student Instructions:

When I am making an argument, instead failing to communicate using appropriate mathematical notation and connect the mathematics to the question at hand I will make a clear argument which is connected to the question at hand and use appropriate notation in doing so.

Assessment Summary Levels of Understanding

Level 1: Student exhibits an understanding of the concept of independence in the context of the situation using a verbal justification.

Level 2: Student uses appropriate notation to communicate understanding of the concept of independence.

Level 3: Student comes to a correct justification for dependence/independence but does not apply this concept to reach an appropriate conclusion about determining same source.

Level 4: Student justifies the response using data with appropriate notation and correctly applies the concept of independence/dependence to the situation about determining whether two bullets were fired from the same source.

Recommended Use

I plan to use this in the Probability Unit of AP Statistics. In particular, the part of that unit that deals with conditional probability and its uses in determining independence and dependence of events. This activity could also be used in a non-AP introduction to statistics course.

Connecting with Iowa Standards

This activity is design to align with the Iowa Math Standard S-CP.A.3: Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.

SCIENCE & ENGINEERING PRACTICES

Analyzing and Interpreting Data

CROSSCUTTING CONCEPTS

Cause and Effect

DISCIPLINARY CORE IDEAS

From the AP Statistics Course & Exam Description: Var-4.D Calculate conditional probabilities and

VAR-4.E Calculate probabilities for independent events and for the union of two events.

Jyll's Position

Recap: Jyll correctly uses the comparison of a conditional process to a probability based on the entire set of data to justify her position that there is a dependent relationship between the number of CMS and whether or not the two bullets were fired from the same weapon. She also correctly identifies that because dependence between these variables exists, it is appropriate to use the number of CMS to determine if the same gun fired both bullets.

Considerations: Jyll's argument lack some notation P (CMS$\geq$4|bullets were fired from the same gun) = 37/146=25.3% and this differs from P(CMS $\geq$ 4)= 38/206= 18.3%.

Conceptual Understanding: Jyll correctly computes the conditional probability of the probability of 4 or more consecutive matching striea given the pair of bullets came from the same gun. However, she incorrectly compares this to the probability of selecting a pair of bullets that are known matches rather than the probability of obtain a pair of bullets with 4 or more matching striea.

csafe
Center for Statistics and Applications in Forensic Evidence

Jakk's Position

Recap: Jakk correctly believes the relationship between the number of pairs of bullets with 4 or more matching striea and whether or not the bullets were shot from the same gun is dependent and justifies this conclusion using

Considerations: Jakk's notation is correct and his computations and justification for dependence.

Conceptual Understanding: Jakk's argument incorrectly concludes that dependence indicates using bullet pairs where CMS≥4 to predict whether is not the two bullets were fired from the same weapon is not appropriate. Jakk understands the theoretical idea of independence. However, he doesn't apply it to this situation correctly.

Thoughts from Joe's Lab

Why do you believe it is important to partner with the Office of Biotechnology and offer research experiences for K-12 science teachers?

K-12 science teachers educate the kids that we will eventually see in Iowa State University. Their work is critically important, so anything we can contribute to help them widen their students' horizons, encourage learning, and increase student interest in STEM fields will result in better prepared, more curious college students.

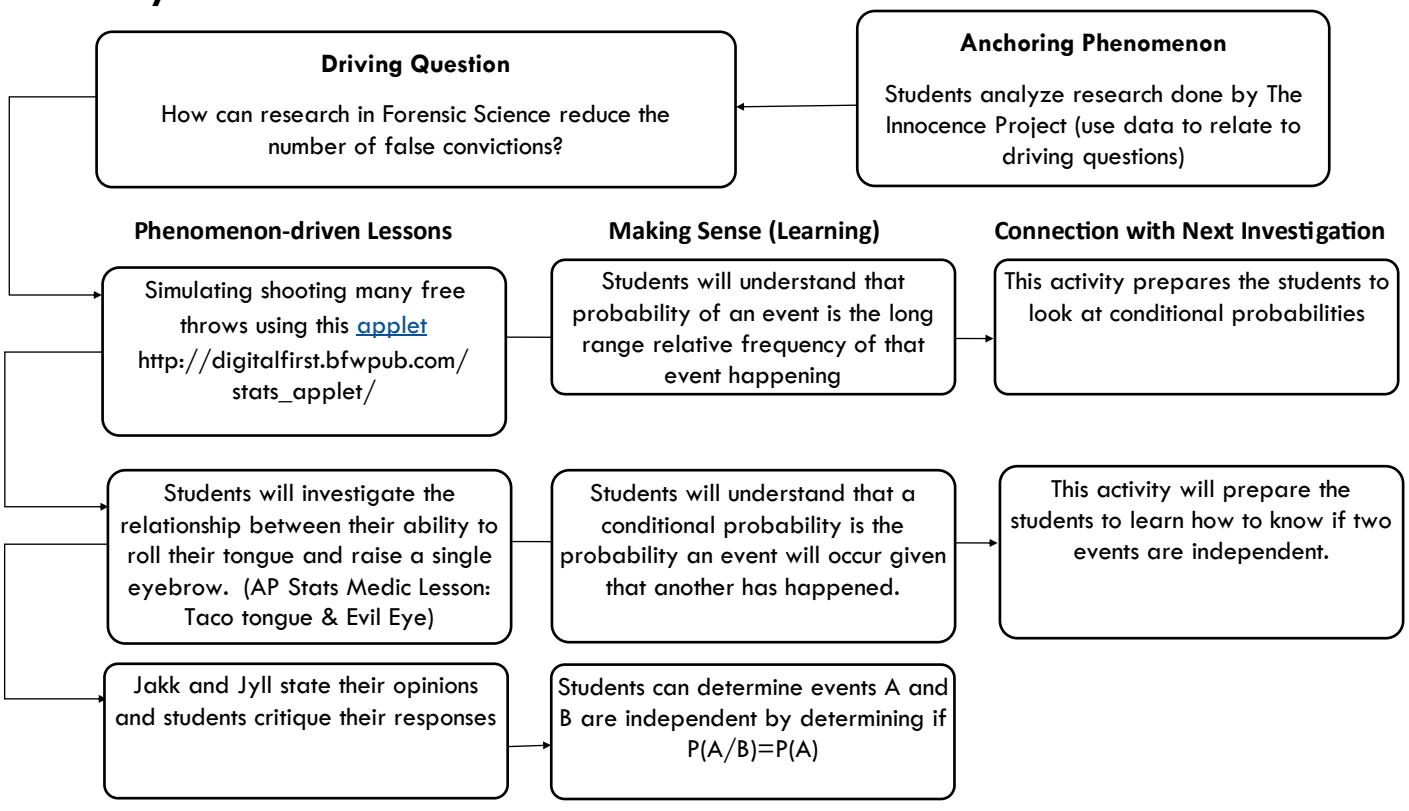
In what ways has your RET teacher grown most over the summer?

Joe was an active participant in CSAFE activities all summer. He was constantly thinking about his kids, and how to distill ideas, examples, problems to increase their interest in the mathematical sciences. I think that Joe himself was surprised by the central role that statistics, math and computer science can play in problems that have a direct effect on people's lives. At CSAFE, we develop statistical methods to improve the practice of forensic science and contribute to reduce the chances that individuals will be convicted of crimes they did not commit. Joe had the chance to see the very practical side of the abstract concepts that we learn in school and in the university, and will be able to use this new knowledge to make math and stats living sciences, that have an important role in the well-being of society.

How do you plan to continue the partnership with your RET teacher and their students during the upcoming school year?

We are hoping that Joe will include us in his classes. All of us, students and faculty in CSAFE would love to visit Joe's class and talk to the students about our work and some specific projects. We are open to thinking of specific research problems that Joe can bring to the K-12 students.

Unit Storyline



Program Reflection

Equitable Moments – "anytime, anything, anywhere"

Completing the geography of identity and seeing the other teachers in the RET program do the same was very revealing. It was very clear to me that many of the teachers I have worked with throughout my career have access to power and privilege that not all of our students do. This fact can be overwhelming.

James Clear's s book titled Atomic Habits provides hope for me. Progressing through the stages of noting, wanting, doing and liking by making daily incremental improvements of 1% per day to amass amazing results is motivating. The geography of identity activity aided in my noticing. Asking the questions of what physical environmental changes need to occur will be my focus between now and the start of classes so that the doing phase can begin when school starts.

Through my research experience I became aware of The Innocence Project. Their work will serve as a leverage point for discussions around equity in the criminal justice system.

Enjoyment as Motivation—Impact on Teaching and Learning

There were many times this summer when I struggled with software used in the lab. This lead me to draw on the expertise of others. This was usually done through e-mail. The responses I received were thoughtful, swift, and welcoming. This experience reminded me of the importance of carefully crafting my email responses to students and parents as a way to strengthen relationships with learners and their families.

These experiences will go back my classroom with me. Sometimes being chided by a student at 8 AM for not replying to an email sent at midnight the night before makes this form of communication seem like an inconvenience. However, my experience this summer has reminded me of the need for replies that are swift and let the students know of my support for their learning.

Goals of Doing—Engagement with Research

The opportunity to work in a research lab that works with developing best practice in analysis of forensic evidence has thrust me in the role of the learner. One of the great benefits of this summer has been the renewed experience of being a total novice. Reliving that type of experience reminds me what students in my classroom experience each time a new concept is encountered.

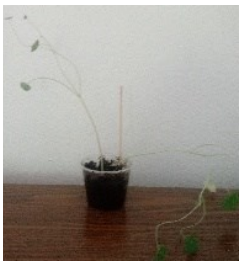
This allows me to more clearly put myself in the shoes of my students. It solidifies my belief that learners need to have shared experiences that helps them contextualize major themes for the course. These shared experiences will hopefully provide reference points that can be drawn on when confusion arises.

Perfection and Improvement—Classroom Culture Shifts

Growing plants from seeds this summer has prompted some thoughts that will color the way I view my classroom and my role in supporting students' learning. One of the readings we did this summer was an excerpt from Lessons from Plants by Beronda Montgomery. I have often thought about the similarities between farming and teaching but this reading helped me make some new connections.

Viewing the classroom as an environment is not new to me but the parallels to the environment of a plant were particularly helpful and challenging. When leaves of a plant become wilted, the plant isn't blamed. Something different is done for the plant. In the same way, when students in my classroom are "wilting" they are communicating something to me. I need to remind myself and other adults with whom I work our students deserve the same analytical patient approach our plants experience.

Transitioning from this ……



to this….

...happens through many small changes.

by Melissa Greene

Jyll thinks:

That we should focus on the six row barley phenotype. Jyll believes that for food security within their community this is the correct path because of the high-yield potential and, in turn, higher protein in their diets.

Jakk thinks:

That we should focus on the resistance to powdery mildew, a plant pathogen that steals nutrients from the barley and severely decreases yield. Jakk agrees that high-yield is necessary for community survival, but if powdery mildew isn't addressed, the amount of rows won't matter.

Student instructions:

Using what we know about our end of the world community scenario, decide who you agree with more – Jakk or Jyll. You will then create an argument using evidence to support your decision and, ultimately, come to a community consensus on which to pursue first.

Assessment Summary

An argument based on evidence will be produced by each student that includes their choice of Jakk or Jyll. The argument will need to be logical and evidence-based.

An evaluation will be done by a student with the opposite view that will focus on the evidence, not the perspective of the other student. The goal of this exercise is for students to learn to support their arguments with data and evidence, therefore there is not a correct answer or standpoint.

During the production of their argument development, students need to provide logical, relevant, and accurate evidence that includes mathematical data. When evaluating the arguments, it is important to critically evaluate the evidence used to support a position, not the student's position itself.

Recommended Use

This can be used as a standalone project in the end-of-world case study or as a lead-in for the iTAG lab protocols. The community consensus reached would then determine which exploration activity they will pursue, *Vrs1* or *mla*.

The written argument should have, at minimum, 4 parts:

- Which perspective is chosen – Jyll or Jakk
- Logical support of their perspective – the knowledge they currently possess
- 3-4 pieces of evidentiary support from solid, verified sources
- A detailed listing of all sources used with hyperlinks.

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 engage in rational discussion of their perspective using mathematical data and strong evidence.

Analyzing & Interpreting Data

Students will analyze and interpret information from a variety of credible sources that are researched by the student.

Obtaining, Evaluating, & Communicating Information

Students will enrich their ability to communicate through obtaining and evaluating scientific information and data to support their perspective.

CROSSCUTTING CONCEPTS

Patterns

Patterns related to inheritance and how alleles are passed from generation to generation.

Stability & Change

Genetic change happens over time, it is not a rapid process.

Students will understand how natural and artificial changes can lead to stability and evolution.

Cause & Effect

Selective breeding can lead to significant causes and effects in a population.

DISCIPLINARY CORE IDEAS

HS-LS3-1

How are DNA and chromosomes involved in the traits passed from parents to offspring?

HS-LS3-2

Make and defend a claim based on evidence on contributing factors to inheritable genetic variations.

HS-LS3-3

Use concepts of statistics and probability to explain the variation and distribution of traits within a population.

Jyll's Position

Recap: Jyll believes the community should pursue cultivating six row barley, which is a recessive phenotype of the gene *Vrs1*. She holds this position because she believes the opportunity for high-yield is most important.

Considerations: Students who choose Jyll's perspective are likely the students who are focused on yield instead of longevity. Students in this position may struggle with long term implications of no powdery mildew resistance and/or understanding powdery mildew's impact on yield.

Conceptual Understanding: Jyll's perspective lies heavily on the agricultural mindset of high yield being the ultimate goal. In a market system where higher yield equals higher profit, other implications and consequences are pushed aside and dealt with when they become an issue. Students may also struggle to understand the disease triangle.

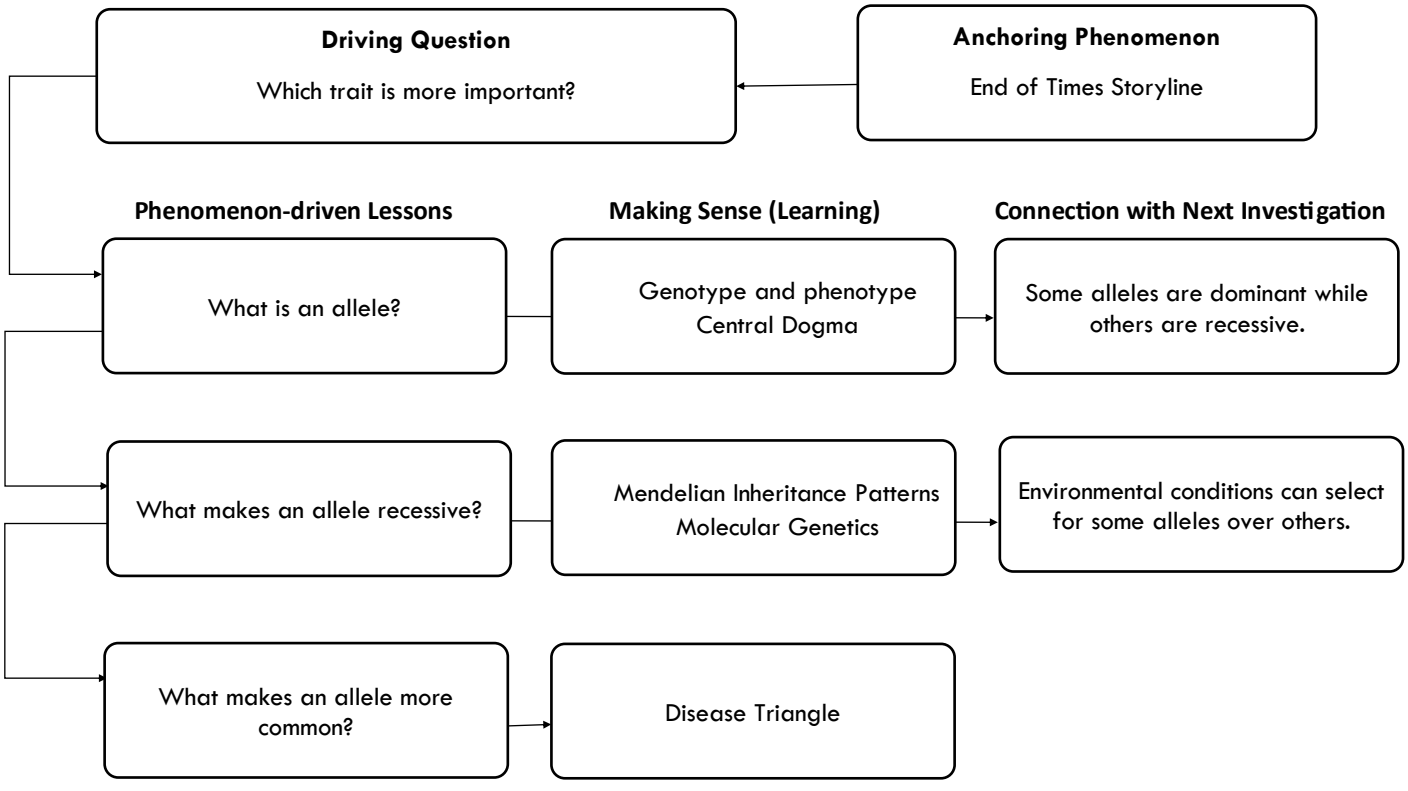
Jakk's Position

Recap: Jakk agrees with Jyll that yield is important, but believes that it should be a secondary consideration. Jakk believes that we should work on finding barley strains that confer resistance to powdery mildew because in strains that have no resistance, yield is negatively affected.

Considerations: Students who opt for Jakk's perspective are probably the students who are focused on the long term and consider multiple sides of a situation. They may struggle with understanding the immediate need for crop production and may struggle with formulating an immediate plan.

Conceptual Understanding: Jakk's mindset is of longevity over expediency. Students will most likely grasp the concept of the disease triangle and why powdery mildew resistance is important. Students may get bogged down in the process of discovery and lose the urgency outlined in the case study.

Unit Storyline



Program Reflection

Equitable Moments

Argument is something that makes most humans uncomfortable. It is analogous to conflict in most minds, therefore in most circumstances it is avoided. To not teach our students how to engage in an argument from evidence is a disservice to them and to society.

When students are allowed to choose a position, research their evidence, and formulate their talking points it levels the field in some ways. The students who are "good" at school don't have innate knowledge that isn't accessible to others, no one perspective is more correct than another, and with only two options the probability that a student will stand alone is not great.

Things to consider in this exercise for creating equity:

- Do not make engaging in verbal discussion a requirement or grade on it – not all students are comfortable sharing out loud.
- Attempt to be objective in the assessment of an argument; consider all viewpoints a student makes even if their perspective is outside of the norm.
- Differentiate as needed for different ability levels.
- Be acutely aware that this will bring a level of vulnerability to the class that will bring fear with it. Be prepared to support students in the struggle.

Enjoyment as Motivation

This activity will bring out the "-ish" for students. There will almost certainly be students who want to exist in the space between Jyll and Jakk's perspectives. It is so important that we ask students to embrace uncertainty, embrace the feeling of "-ish," and choose a perspective.

Students have the opportunity to drive their own learning in this dilemma. The discussion around Jyll and Jakk's views will need to end in a consensus which will decide which iTAG lab is done with students. This will create ownership and buy in for the lab. It also allows students to practice equitable collaboration and learn to appreciate diverse perspectives.

Goals of Doing

The largest brush with research that this experience will bring is its parallel to the work of the Dr. Roger Wise lab and the importance of barley. The reality is that Jakk and Jyll are both correct in their positions – yield and disease resistance are equally important in the cultivation of any crop.

Through use of the iTAG program, students will have the opportunity to learn about genomics, genetics, and phenotypic diversity. It also allows hands-on use of equipment not readily available to most high school students.

Perfection and Improvement

This activity allows students to share their voice in a safe, secure environment. It also allows students to practice finding evidence and data to support their perspectives and engage in respectful discourse with those who do not agree with them. By progressing from individual work to small groups and, ultimately, whole class work students are allowed to exist on a plane where they feel safest in their vulnerability and still be heard.

By engaging in argumentative discussions students learn the value of credible evidence and also how to value a perspective different than theirs. This project also allows students to collaborate and come to a consensus. It is important to their future to cooperate, even when there isn't agreement. It will also allow students to experience the discomfort of unknowing, finding a solution(ish) to their dilemma as a whole.

Thoughts from Melissa's Lab

Why do you believe it is important to partner with the Office of Biotechnology and offer research experiences for K-12 science teachers?

Exploring research programs at the college level provides unique learning experiences for both the visiting teacher and the host lab. Establishing strong inter-connectivity between K-12 teachers and the college laboratories helps bridge the gap in understanding the learning needs of the students we educate. They have created infrastructure over the years that is an asset for recruiting teachers, and taking care of them while they are here.

In what ways has your RET teacher grown most over the summer?

Melissa has shown great interest in examining how this research program could be used in her classroom for student inquiry based learning. Together we have developed and tested several hypotheses; Melissa has been instrumental in all of the progress we have made on our experiential lab research project.

Melissa did a great job in helping us to update and re-develop our iTAG / iPath curriculum, with which she will engage her students in the coming school year.

How do you plan to continue the partnership with your RET teacher and their students during the upcoming school year?

We are going to continue to work together in developing and disseminating our research project. Melissa's students will take the framework we have built this summer and they will further develop the ideas using their insights and interests. I am going to virtually meet with her students at each step of the project and discuss the the science behind, and real world applications to, the discoveries they make. We are planning to celebrate the student research findings with a field trip to Iowa State University and a tour of the campus and research laboratories.

Engage with them and the cohort of previous RETs that we have trained to continue our iTAG genetics curriculum.

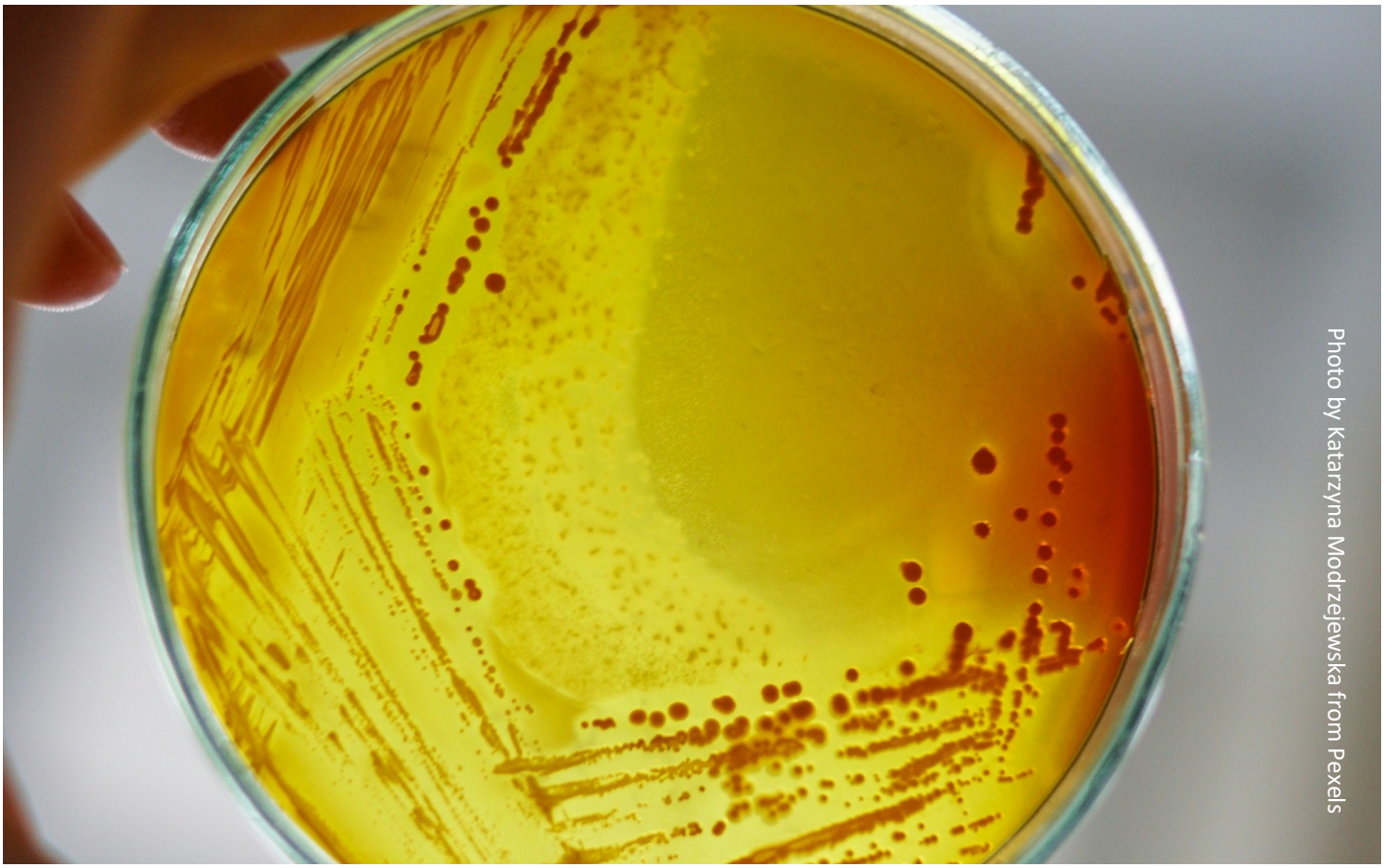


Photo by Katarzyna Modrzejewska from Pexels

Office of Biotechnology

K-12 Education and Outreach Impact Framework

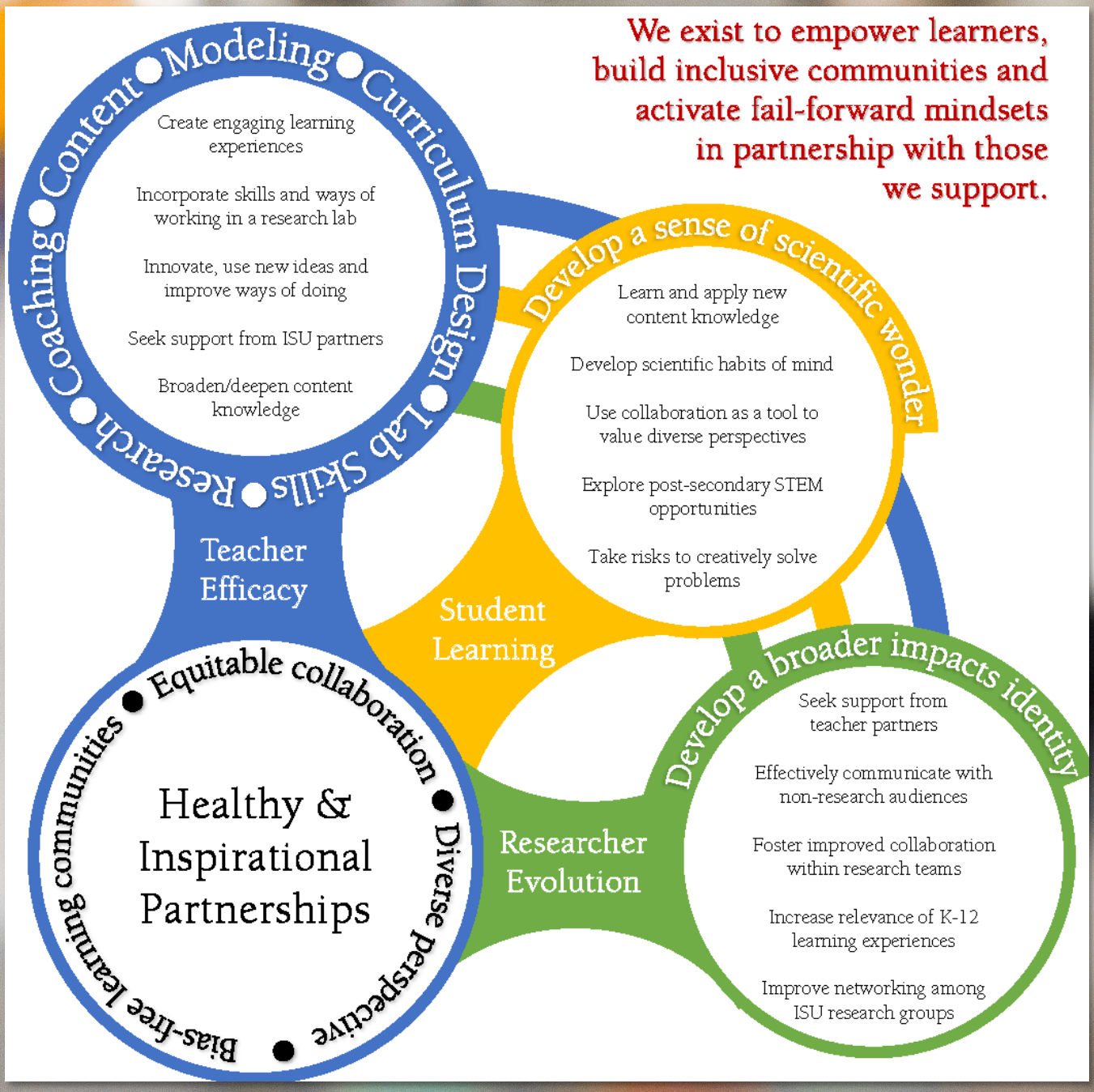


Photo credit Martin Lopez from Pexels

by Katherine Hanson

Jyll thinks:

Several years ago, a global group of meteorology and climate scientists gathered to discuss developing and building a new satellite that could gather precipitation, wind, and sea surface temperature data every several hours rather than daily or monthly. This new data would improve the ability for scientists to model climate and weather on Earth. Organization A, a leading member of the scientific community, chose to not attend as they were not interested in paying to fund this new satellite. Now, the satellite has been launched and is providing an abundance of data. We should allow Organization A to access this data even though they didn't help pay for the satellite. There is only one planet, so we all need to work together to preserve it. Organization A made a mistake in not helping fund the satellite, but not letting them have the data harms everyone. If Organization A can develop the best model, we need them to use the best data available. If we need to, we could charge Organization A to have access to the data for each piece they want and make a profit on the satellite that way.

Jakk thinks:

Organization A wasn't willing to attend a meeting about developing and building the satellite. They don't want to share their ideas and strategies of how they are getting the best climate models. Now that Organization B is developing models really close to the level of Organization A, Organization A wants the data because they can tell it is really beneficial to accurate climate modeling. We should not allow Organization A to use the data because they didn't pay for satellite. If they wanted to keep having the best model in the world, they should have helped with the financial costs. Organization A makes a lot of money selling their model predictions to other companies that use the oceans for trade and business. Even though Organization A would likely be able to generate the best model using this new data, Organization B deserves a chance to become the leader since they chose to fund the research project. It may take longer to generate better models without Organization A, but their success isn't our problem as science researchers. If they want better data, they can build and launch their own satellite.

Student instructions:

Read both Jyll's and Jakk's position statements above. Decide which one you agree with the most. Be prepared to support your side with additional arguments from our learning in class so far.

Assessment Summary

With a shift in educational practices to align to research-based approaches such as student-driven, guided-inquiry, phenomena-based learning assessment practices of students learning must also shift. As a result, this activity can be used as an informal formative or summative assessment.

In this argument, students are evaluating the tradeoffs of developing a better model with the financial requirements to generate better data to create an improved model. It is noteworthy to include that neither Jakk nor Jyll's position is the correct opinion. Students use of scientific reasoning, discussion of developing and using models, and explanations of energy transfer should be used in evaluating students learning. Students can side with either Jakk or Jyll, use strong scientific reasoning, and successfully show their learning through argumentation.

Recommended Use

When presenting the dilemma of Jakk and Jyll to students, provide students with an initial opportunity to read and reflect individually. Direct students to reflect on their learning so far from the unit to consider what evidence from class learning they can use in articulating their support of either Jakk or Jyll's position.

For classrooms where students may need additional support with reading, using a group or partner reading strategy such as "Read and Restate" where Partner A reads and Partner B restates to Partner A what was just read can support students in hearing and making sense of the opinion statements from Jakk and Jyll. Then, have students switch roles reading a paragraph at a time.

Once students are done reading and reflecting, students should engage with one another in discussion. To support students taking a stance, have students tally on the board the side they are taking – either Jakk or Jyll. Then, students should group by their common sides and share their thinking to strengthen their arguments.

Rejoin the two groups and hold a class-wide discussion. It is best when students are able to lead and self-regulate their discussion. A strategy for success is to have students call on the student who is raising their hand and spoken the least. For example, if Student A is going to call on a peer and has two choices: Student B who has spoken once and raises their hand with one finger up and Student C who has spoken three times and raises their hand with three fingers up, Student A would call on Student B.

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

Developing and Using Models

During this Jakk and Jyll dilemma activity, students will consider the source of developing better models that can be used for scientific endeavors and subsequent societal impacts. Students will be engaged in using data to create and improve models.

CROSSCUTTING CONCEPTS

System and System Models

During this Jakk and Jyll dilemma, students will be considering the system of science and funding. Students will be engaged with the benefits and challenges of the funding of science research.

DISCIPLINARY CORE IDEAS

ETS1.B: Developing Possible Solutions

Students are exposed to possible solutions to improve models of Earth's climate such as using improved data, imagery, and color.

PS3.B: Conservation of Energy and Energy Transfer

Students will explore how energy is transferred between places and different forms. Phenomena such as precipitation, wind, and temperature are all reliant upon energy. Students will explore these topics as they intersect both chemistry and Earth's systems.

Jyll's Position

Recap: Jyll believes that we should allow Organization A to access the data because a more accurate model is critical to our planet's response to global warming. Jyll believes that Organization A will be able to generate the most accurate climate model first, so she wants to give Organization A the data even though they didn't pay for it.

Considerations: Jyll's side is a more altruistic, pure scientific knowledge motivated argument. In the capitalistic society we function within, Jyll is less worried about the financial aspects of pursuing science as we are dependent on our planet to survive.

Conceptual Understanding: Jyll is siding more with the pursuit of scientific knowledge without considering the financial implications of those pursuits. Jyll also values that global benefit that Organization A could offer, and feels the financial costs should be a secondary priority. However, Jyll doesn't seem to address the money other organizations spent to fund the satellite that may wonder why they needed to spend the money when Organization A didn't which could lead to future funding issues within the Meteorology community.

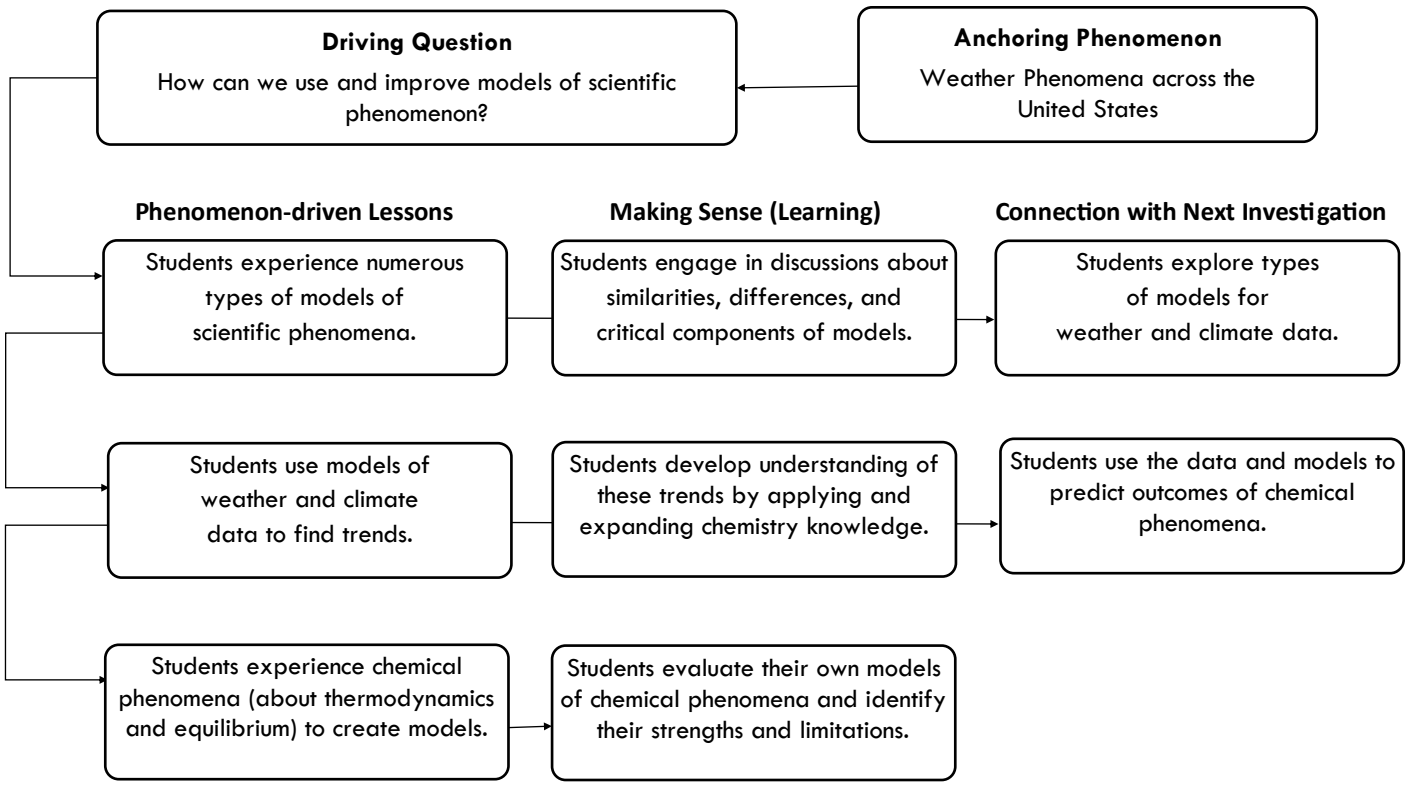
Jakk's Position

Recap: Jakk believes that we should not allow Organization A access to data from the new satellite because they didn't help to pay for the satellite. Jakk would rather wait longer for a more accurate climate model from a different organization than allow an organization who didn't pay for the satellite to generate a new model the fastest.

Considerations: Jakk's side is a more reality-confined argument where one must consider the current and future funding of scientific research. Jakk's stance places that financial contributions should be a consideration when pursuing scientific knowledge because of the system of science research and funding.

Conceptual Understanding: Jakk is siding more with the financial funding of scientific research. Jakk recognizes that since Organization A didn't value funding the new satellite to collect the data that they should not have access to the data. Jakk proposes that even though Organization A is a leader in the community, Organization B, who did help fund the satellite, should now be given a chance to become the leader with this new, improved data set.

Unit Storyline



Program Reflection...ish!

Equitable Moments

As part of our RET experience, we discussed identities through a "Geography of Identity" activity. It was a great tool to allow individuals to describe not only the identities they feel represent themselves but also to identify to what extent – positively or negatively – that identity impacts their life. There was significant power in hearing from others how identities influence their lives – personally, professionally, parentally, and in partnerships. It revealed many spaces of life where we each felt inequity in our lives. It also provided situations where equity work could be used to support one another to achieve success.

In classroom applications, there are many uses of the strategies found in "Geography of Identity". One, suggested by a peer is to transform the activity into an "Understanding of Learning" for different topics of a unit or unit in a course. Students can self-reflect on what topics they best understand and where they still need support. Further, this could be used to reflect on their identity as a learner – how well do they use to study, learn, practice, and reflect. Developing systems for students to grow and reflect on their own learning processes can certainly help them succeed as learners.

Enjoyment as Motivation

In more recent education research, an emphasis on intrinsic motivation for students has become more valued. While our education system at the high school level has many extrinsic motivators – grades, credit, and diplomas, developing a sense of "being a learner" who desires knowledge is a noble goal of our modernizing educational system. The enjoyment of learning as a motivator is a consideration that should be part of all instructional decisions.

This summer, the RET program exposed us to ways to engage students in finding enjoyment and experiences that appeal to students. We used a method of colored plastic cups to gauge student's opinions that could reveal topics of interest to students. Additionally, we also engaged with frontiers in the science disciplines that can offer engaging and real-world science applications that will appeal to our students and draw upon their intrinsic motivation.

Goals of Doing

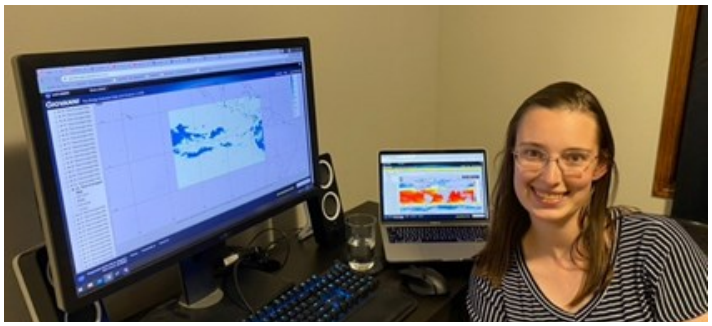
The epitome of the RET experience is the research work. This summer I had the opportunity to engage in meteorological research focusing on the intertropical convergence zone (ITCZ) in the eastern Pacific ocean. It is a region that is crucial to the weather and climate in the both continents of the Americas. Current climate models are not accurate to the observational data of the current weather and climate. By looking for trends in the data, researchers hope to improve the models.

Models are an essential tool to science researchers but also to teaching science. Integrating the research work from the RET into the classroom will require students to explore the development, use, and improvement of models. Students understanding how models can help us to understand complex ideas, make sense of abstract data, and share thinking with others is essential to their development as scientists and critical thinkers.

Perfection and improvement

This summer we read the text, "Ish" by Peter H. Reynolds. The text focused on the idea that being perfect at something is not as much an accomplishment as the perseverance and progress made throughout an experience – it's okay for something to be slightly "-ish". Further, the value of someone's work and ideas are different from person to another. In the text, a younger sister sees the value in her brother's artwork when no one else did.

Within my classroom, I hope to incorporate this text by privileging progress and growth of a student's goals over achievement or accomplishment of a societal standard. Further, I want to ensure my students know and feel that their passions, even when in "ish" states are valued and incorporated into our classroom learning experience. I don't expect all my students to become scientists, but I hope they can see how science and their passions relate to one another.



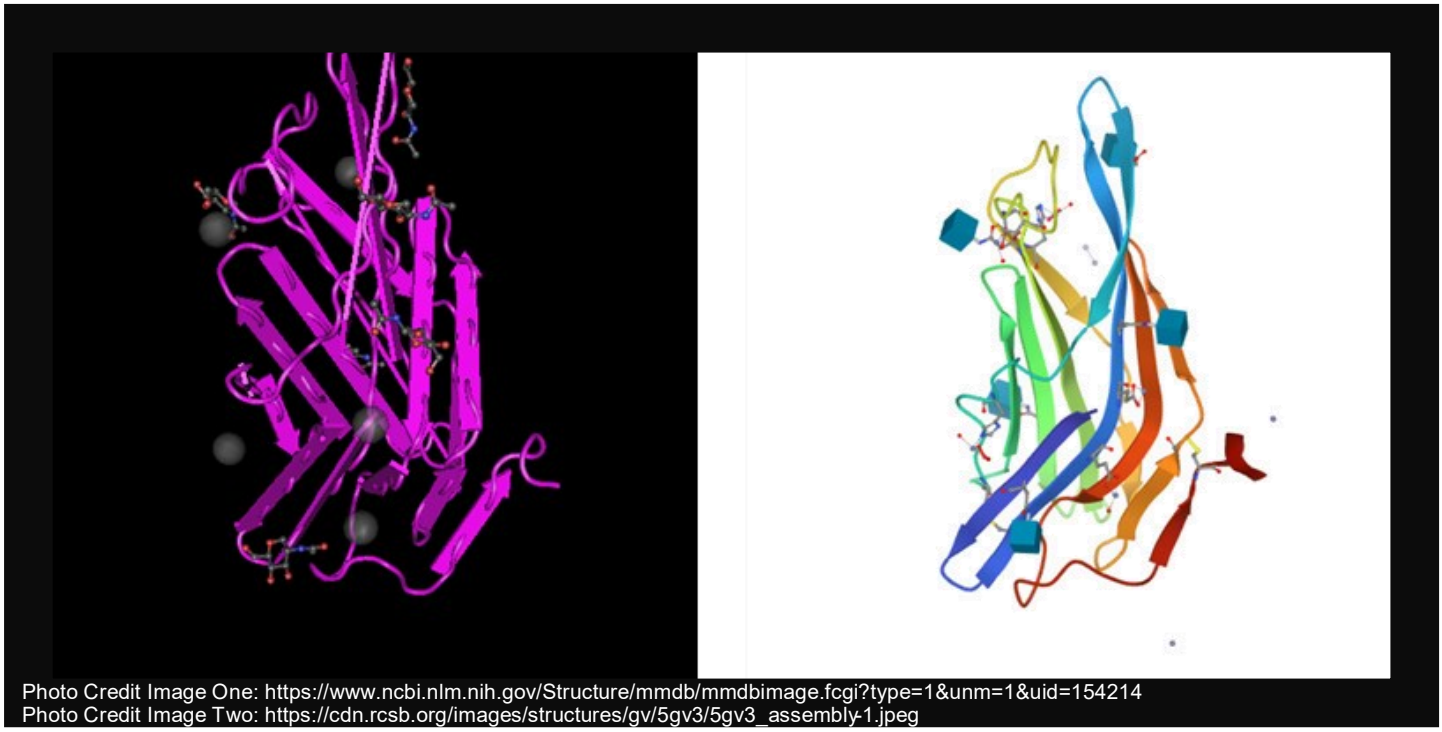


Photo Credit Image One: https://www.ncbi.nlm.nih.gov/Structure/mmdb/mmdbimage.fcgi?type=1&unm=1&uid=154214
Photo Credit Image Two: https://cdn.rcsb.org/images/structures/gv/5gv3/5gv3_assembly-1.jpeg

by Lindsay Jackson

Jyll & Jakk

Think about:

Biogenesis of Acidic Organelles

Jakk thinks:

The initial increase in Lysotracker stained organelles would suggest that biogenesis is occurring, but Lysotracker stains all acidic organelles, so the name of the stain has no bearing on the hypothesis. Since autophagosomes and endosomes are also acidic, it is possible that the increase in red-stained organelles is due to something other than lysosomes.

Jyll thinks:

The initial images showed an increase in the amount of items stained red. Based on the initial research provided on Danon Disease and information about degradative organelles; the experimentation of the wild type and the mutants will support the hypothesis that the increase in red stained items is due to the biogenesis of lysosomes in the cell. Afterall, the stain is called Lysotracker for a reason.

Overview:

Students will be building their knowledge and understanding of the scientific process as it pertains to current and ongoing research. Students will be analyzing data to determine whose hypothesis is best supported by the by the current research. Students will also be determining possible next steps for experimentation and research.

Student Handout

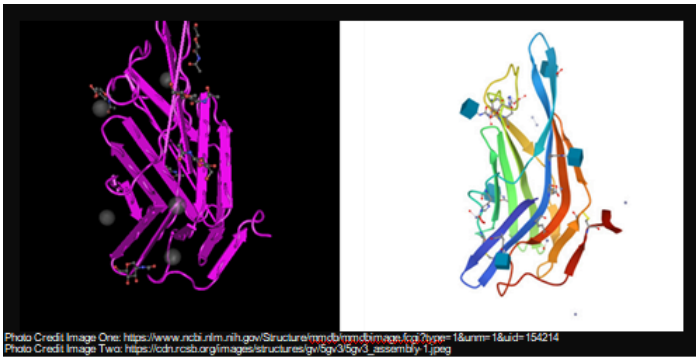
Purpose: The purpose of this assignment is to help students build knowledge and understanding of the scientific process as it pertains to current and on-going research. This assignment will also be used to help students learn and practice their research and communication skills, as well as, their ability to think critically about opposing viewpoints. Overall, a number of science literacy skills will be addressed as students work through the ideas presented in this Jakk and Jyll thought dilemma.

What: Students will be analyzing data and research to determine whose hypothesis is supported by the data and present additional next steps for the research.

How: Students will repeat the following process as data and research becomes available and as guest speakers' schedules allow.

1. In groups, brainstorm what is being shown in the images. On the JamBoard record your ideas and reasoning for those ideas. Have at least one group member ready to present your ideas to the class.
2. Read through the provided article using the three-color method.
   a. 1st color = circle new vocabulary
   b. 2nd color = underline main point(s) of each paragraph
   c. 3rd color = identify questions you have
   d. In groups, discuss what you read. Add to your notes as needed.
   e. Engage with guest speakers to gain knowledge and understanding of the article and content.
   f. Repeat the process as new data is available to analyze.
   g. Depending on the unit, students will be asked to connect the information they are learning about through this thought dilemma to the content. Examples include:
      h. Cells function not only as part of a system, but as a system themselves.
      i. Cell components cause the cell to function.
      i. Proteins are the result of RNA being read.
      ii. Proteins respond to the physical and chemical environment.

Abnormal functioning of component parts can cause mutations, some of which have a negative effect (disease and disorder).



Jyll & Jakk

Think about:

Biogenesis of Acidic Organelles

Assessment Summary

Thought experiments, aka thought dilemmas, provide students and teachers both with a way to assess the students' learning. The thought experiment is a new take on an old technique. Students are posed with two similar, yet different, perspectives to a question and asked to pick a perspective and explain why they agree with it. As students reflect on their own knowledge, understanding, and experiences to answer the question they are required to make connections to their new learning and experiences to create a response to the question that is meaningful and grounded in evidence.

Thought experiments can be used as pre-assessments, formative assessments mid-unit, and as summative assessments. This thought dilemma is going to be used over the course of two units in hopes that students will be able to make connections to the content and to the research and experimental processes. This Jakk and Jyll is linked to current, on-going, research and experimentation and therefore provides the perfect opportunity for students to see how all aspects of the scientific model work together.

In this dilemma Jakk and Jyll are posing two different hypotheses to the same question - why is there an increase in the amount of red-stained organelles? This question allows the teach and students to evaluate learning related to the following questions:

What are diseases and disorders?
What are cells and how do they function?
What is the genome and why are there genotypes and phenotypes?
What are mutations?
What are proteins and how do they function?

As students work together to analyze microscopy images, research and analyze articles, and analyze data they will build and support their argument for their chosen position (Jakk or Jyll). Students may find that as they do their research and analysis that they modify their chosen position or create their own hypothesis to the question.

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). If time and access to supplies allow, students may also be able to test a hypothesis.

Recommended Use

Teacher Notes

When developing this Jakk and Jyll, I was looking for a way to incorporate the experimental design process into the respective perspectives presented by Jakk and Jyll, thus they are both proposing a valid hypothesis to the question. Due to the nature of this Jakk and Jyll, I can see it being used multiple different ways by the teacher.

The first recommendation for use that I suggest is to use it as a tool to talk through the experimental design process. There is one question that has resulted from the same data and research but two valid ideas for investigation. This could lead to students then learning about and discussing how to determine which hypothesis to test first. This could also lead to discussions about how best to analyze and communicate data, and what models would yield the best results.

The second recommendation for use that I suggest is to present students with the dilemma to determine their current level of knowledge and understanding and then re-present the dilemma at the end of a given unit or series of lessons to allow students an opportunity to show their growth.

The third recommendation for use that I suggest would be to present the students with the phenomenon and a starting question - how can we study organelles - or something similar. Allow the students to do some background research and

investigating. Then present them with the dilemma without Jakk and Jyll's hypotheses and ask the students to come up with a hypothesis. They are then creating their own dilemma to argue.

Mental Model Manipulation

The original presentation of this Jakk and Jyll, along with the three outlined in the Teacher Notes, provide students time to reflect on their current level of understanding, their current mental model of the material. Providing time for students to identify where they are before they "dive deeper" into the material allows them the opportunity to make connections with the new material.

Many students struggle with the idea of a question not having a right/wrong answer or not having an answer at all. Thought dilemmas like this one provide students a structured and brave space to manipulate their thinking and arrive at an outcome that resonates with them. Thought dilemmas provide students with the opportunity to become critical consumers of the information around them and in science that means being able to use evidence-based research to support or refute a claim. It means being able to engage in critical thinking and discussions to arrive at outcomes that are authentic and meaningful and incorporate Social-Emotional Learning, Cross-Cutting Concepts, and Disciplinary Core Ideas.

Structured Discussion

Classroom discussions have the potential to be inclusive or exclusive, therefore providing structured discussions for students should allow for all voices and perspectives to be heard without fear of judgement.

In order for that to occur, teachers and students need to know: the type of discussion that will be taking place, the purpose of the discussion, the intended outcome(s) of the discussion, and the limitations of the discussion before the discussion takes place.

This Jakk and Jyll engages students in multiple aspects of discussion as they work individually, in small groups, and as a class to arrive at an understanding of the data and research. The different types and levels of discussion will allow students the opportunity 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)

The process that students take as they learn about, investigate, and arrive at an outcome for this Jakk and Jyll will provide them the opportunity to:

- reflect, and potentially revise, their reasoning resulting in a stronger evidence-based argument through discussion.
- explain their thinking
- collaboration and debate
- presentation

Visible Thinking

Visual thinking is an aspect to learning that can take many forms and provide students and teachers with additional ways to assess progression to content proficiency. When I limit students to a single assessment, I may be limiting their ability to to show their full understanding toward a desired outcome. My question then is how can students express to me their understanding? The answer, visual thinking. Visual thinking incorporates any communication strategy that will allow the teacher, or peer, to make unbiased observations of a student's progress.

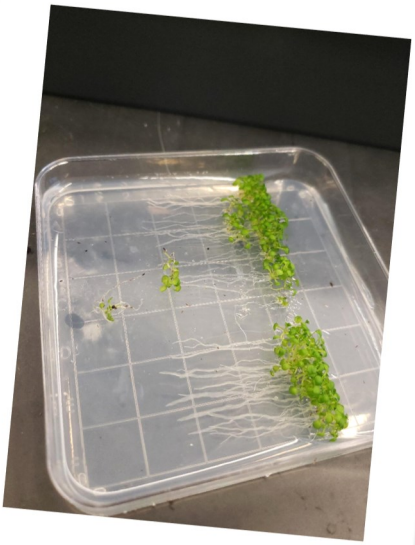
Allowing students to use the process of visual thinking during their discussions and research provides them, and me, with a way to see where they started and where they finished in their own words and their own chosen format. When it comes to the Jakk and Jyll though dilemma, visual thinking could take the form of:

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

The previous list is in no way comprehensive, but provides a sampling of ideas.

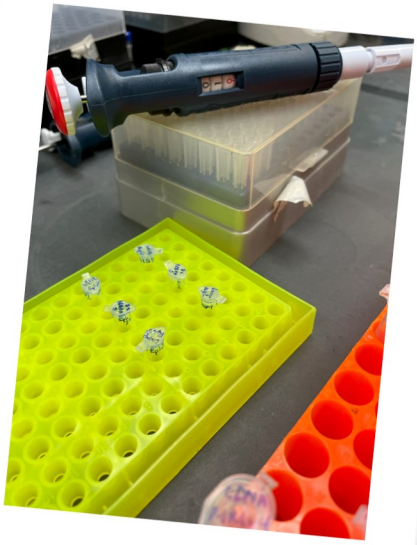

BOOM CHICKA POP
SWEET & SALTY KETTLE CORN

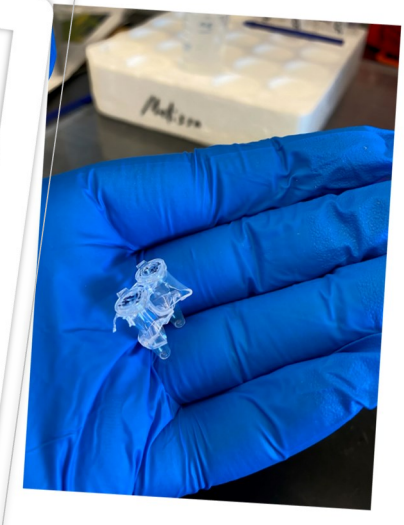

R.I.P. air fryer. You were the real mvp.




BOOM CHICKA POP
SWEET & SALTY KETTLE CORN

Background photos by spemone from Pexels





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

Asking Questions and Defining Problems:

Asking questions is an integral part of science and engineering. As students read articles, analyze images, and engage with guest speakers they will practice developing and asking questions that help them think critically about the world.
Students may use their questions to do additional research, plan investigations, analyze models, and/or analyze and interpret data.

Engaging in Argument from Evidence:

Through the progression of the Jakk and Jyll Thought Dilemma and content students will engage in research and discussion to critique and evaluate different perspectives on the same subject.
As students use the claims, evidence, and reasoning technique to analyze the perspectives and data they will be fostering their ability to become conscientious consumers of science.

Obtaining, Evaluating, and Communicating Information:

This experience will allow students to develop their communication skills by using words, tables, diagrams, graphs, mathematical expressions, and more to engage in critical thinking, reading, and discussion. Practicing these skills provides students an opportunity to deepen their understanding and become more effective communicators.

CROSSCUTTING CONCEPTS

Cause and Effect: Mechanism and Prediction:

Through this Jakk and Jyll students will be able to relate the mutation of a protein in an organelle to the phenotypic response of human disease and make predictions as to what caused the mutation and how to design an experiment to test that prediction.

Systems and System Models:

This Jakk and Jyll presents students with content regarding the human system. Most students will have to reflect on the ethical/moral implications of human genetic testing. This reflection will provide students the opportunity to learn why and how model systems are used in science.

Structure and Function:

Students will be able to use this Jakk and Jyll to reflect on and learn about how each part of a scientific system contains structures with specific functions. If one aspect of one structure is not working properly, it may or maynot, affect the functioning of the whole system.

Stability and Change:

The stability of a system is based on all the structures of the system working together. When parts of a system are stable and other parts of the same system are changed, there is an effect on the whole system. This Jakk and Jyll allows students to see how stability and change within the human body can lead to illness and disease.

DISCIPLINARY CORE IDEAS

LS1: Structure and Function

LS1.A: Structure and Function
LS1.C: Organization for Matter and Energy Flow in Organisms

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 Common Ancestry and Diversity
LS4.B: Natural Selection

Jyll's Position

Recap: Jyll believes that the increase in red-stained organelles is due to the biogenesis of new lysosomes in the cells. She also believes that since the stain is called Lysotracker that lysosomes are the only thing that can be stained.

Considerations: Students that align with Jyll's way of thinking may conclude from the available data and research that Danon Disease, and disease like Danon, are due to a deficiency in or absence of a lysosomal protein.

The students that think like Jyll may then also conclude that a greater appearance of stained organelles means the cell is creating more of the organelle to compensate for the deficiency.

Students who align their thinking with Jyll may also have little understanding of how chemicals are named and branded. This would lead to the assumption that Lysotracker will only stain lysosomes.

Students who choose Jyll's hypothesis may also have little knowledge of other organelles in the cell that could be stained by the Lysotracker.

Conceptual Understanding: Jyll and students that think like Jyll will be following the current trend of research and the current hypothesis being tested at Iowa State University.

Jakk's Position

Recap: Jakk believes that the increase in red-stained organelles is due to an increase in acidic organelles in the cell, not just an increase in lysosomes because the stain dyes any acidic organelle.

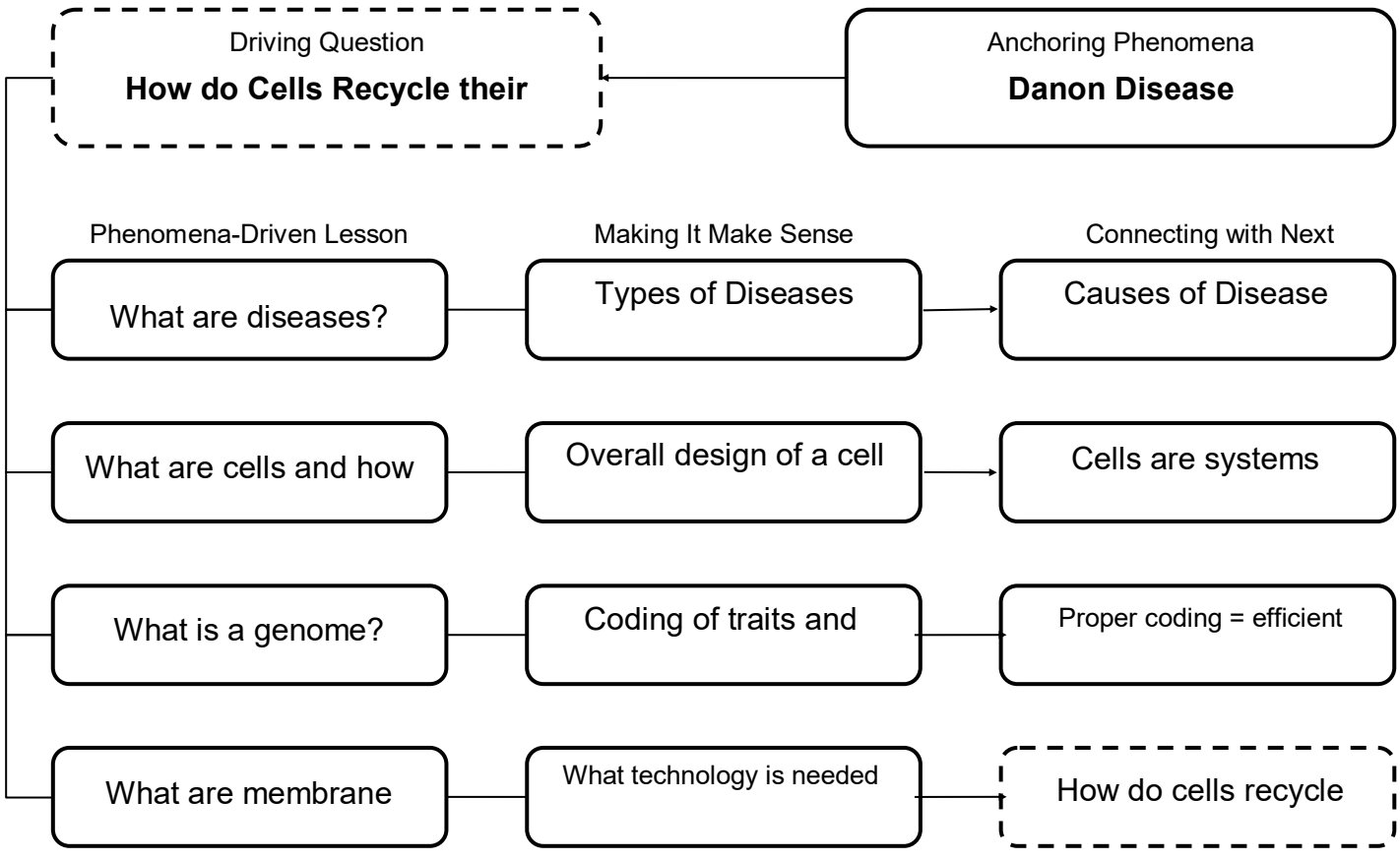
Considerations: Students that align their thinking with Jakk may conclude from the data and research that more than one organelle and protein may be involved in disease and disorders like Danon Disease.

Students that think like Jakk may also conclude that in some systems, different structures can compensate for the lack or inefficiency of another part. In this case that would mean that there could be an increase of other acidic organelles or that other organelles are increasing their acidity level.

Students that align with Jakk's thinking may recognize that chemical dyes can have misleading names and may do more than the name suggests.

Conceptual Understanding:

Jakk and students that think like Jakk are suggesting an alternative hypothesis to the one currently being tested at Iowa State; but is based on the current evidence and research.



Program Reflection

Equitable Moments

The progression toward more equitable experiences in education, science, and society is near to my heart. As a white woman in science and education I have had both privileged and discriminatory experiences in my life. My experiences though are only a starting point for conversation when it comes to the experiences of some of my friends, family, and students.

I had the privilege this summer to work with a professor and lab team who are passionate about creating equitable experiences for students and people as a whole in science. The American Society of Plant Biologists Position Statement on Diversity reads, "...words are not enough. We must all work diligently and tirelessly toward dismantling the structures and practices on which systemic biases are built...silence and inaction are not options when our colleagues, friends, and community members are marginalized, targeted, or harmed." (ASPB, 2021)

As I reflect on conversations from this summer with RET member and others, the realization that equitable-ish has become acceptable because it is where education has lived for so long. Equitable-ish is no longer acceptable and conversations now have to turn into action.

What are some of the actions that this summer has allowed me to think about and explore:

- creating more personalized learning experiences for students
- allowing students to showcase their learning in a manner that is comfortable for them
- having students periodically reflect on their identity and their feelings about certain aspects of said identity
- creating brave spaces for students to engage in structured discussions
- allowing students to "see themselves" in our curriculum through research and guest speakers

Let's stop living in the world of equitable-ish and living in the world of equality.

Enjoyment as Motivation

Teaching and learning, learning and teaching. The story of my life. I grew up with two teachers for parents and was constantly reminded that if "I'm not learning, I'm not living, everyone should strive to learn something new or relearn something they've forgotten every day, for they say we stop learning is the day we die." These words are part of what drive my passion for being a part of the ISU RET program. I get to use lab skills that I wouldn't normally practice, I get to learn all kinds of new content and research, and I get to see how some things never change.

So I ask you, is a teacher ever not a student and a student ever not a teacher? Think about it.

How often do we as teachers look at and watch our students, listen to our students, talk with our students, and learn from them? We might learn something new about technology, about their culture, better yet - about them. We might be reminded of what it was like to learn a concept we didn't like and change things up. We watch our students help each other work together to solve problems and produce outcomes that they would only feel comfortable doing with others their age. We see them interact with others they may not interact with and intervene when we don't. Whatever the case may be, we learn from them just as much as they learn from us.

The progression of teaching and learning for me is far more than what content I teach and how I am going to assess my students. The progression of teaching and learning starts with how my students feel, what experiences and expertise they bring to the class. It starts with meaningful discussion and thought-provoking questions.

Teaching and learning, learning and teaching, is it the story of your life? Is it the story of your student's life? Are you progressing in only one direction? If you are, I challenge you to change your one-way progression to a pendulum - always moving from one end to the other, never stopping but always progressing.

Goals of Doing

The words research and lab experience solicit different thoughts and emotions for people. For me, they are -ishish. I love the process of learning, but am anxious when it comes to lab work for fear of doing

something incorrectly. So when I move the -ish to the end of the action and get research-ish and lab-ish my feelings change and am instantly less anxious. I wonder if my students would feel the same?

Research-ish. This summer we engaged in conversations with Page Keeley, Ted Willard, Roxanne Pals, and others to learn about and engage in research-ish things.

Learning about what went into creating the *NSTA Atlas of the Three Dimensions of NGSS* and *The NSTA Quick Reference Guide to the NGSS* provided an academic look and application for research. Learning from Page Keeley how she developed her famous Keely Probes provided an academic application to science-based research. Participating the Actionable Research with Roxanne provided the opportunity to be part of research being done on Nudge Theory.

Research-ish can also be applied to the lab experience because progress not perfection seemed to be the moto. As scientists we perform experiments and do research to learn more about something. We make hypotheses, consider different models to use for testing, and make conclusions based on the analysis of evidence.

Sometimes the data we collect refutes our hypothesis or the protocol doesn't yield the result that it is supposed to yield. The outcome is research-ish. Some of us (as adults) and our students want to stop at the -ish; but what progress would be made if we did?

Perfection and Improvement

What can I say, everything that we have done this summer can be used to Progress toward an Improved Classroom. -ISH, Progress not Perfection, and research...all things that I can improve the classroom experience for my students.

The Possible Arc for Learning reminded me how a lesson planning template I used to use to balance Research-ish experiences in a balanced format. I'm excited to see how I can mesh the two together to progress toward a more equitable and improved classroom experience.

Progress not Perfection when paired with virtual classroom visits from professors and lab team members, the experience my students have with science can be engaging, challenging, and relevant to their life. It can provide them the opportunity to see how failure isn't bad, it is just a way to progress forward by changing our mental model.

Incorporating Nudge Theory into my classroom is an intriguing way to think about improving the classroom experience for my students. Perhaps it can even become research-ish for the students.

Helping students be in the moment so that they can engage with the content and become critical consumers of science is another way I can progress toward an improved classroom.

The final, and for me one of the most important, pieces of progressing toward an improved classroom is me. My modeling of -ishness, my acceptance of progress not perfection, my incorporation of research, and most importantly my creating an equitable experience for all of my students.

Thoughts from Lindsay's Lab

Why do you believe it is important to partner with the Office of Biotechnology and offer research experiences for K-12 science teachers?

The RET program allows us to train teachers that will be better prepared to spark interest in STEM among their students, amplifying our outreach efforts. Experiencing how scientific research works provides teachers with additional perspectives to increase science literacy, even among those students that will not follow a path in STEM.

In what ways has your RET teacher grown most over the summer?

She has increased her ability to develop testable hypotheses that can be used in the classroom.

How do you plan to continue the partnership with your RET teacher and their students during the upcoming school year?

My graduate student and I will visit her classroom (in person or virtually), to provide real-life context to the questions/research used in the classroom.

by Nick Jackson

Jyll thinks:

Cotton is the 9th highest produced commodity in the United States and is a billion-dollar industry. Corn, soy beans, wheat, and other top commodities have been heavily researched, and improvements have led to higher production, greater resistance to pests, and larger profit margins. Similarly, there are plenty of opportunities to improve cotton fiber development through scientific research, and we should invest our time and resources into understanding the important biological processes that impact development. When we understand these processes, we can modify cotton plants to thrive in a variety of different climates and improve the overall production value of this billion-dollar commodity.

Jakk thinks:

For decades cotton has been one of the top commodities in the United States. Instead of investing our time and resources into scientific research, we should invest our profits into cotton farmers and workers to increase our production. With scientific research, we have seen improvements to other top commodities, but they were at the expense of many years of research and large amounts of money. The best way to increase cotton production is to invest the profits into local farmers and cotton workers. Tax incentives and increased funding will show an immediate boost in jobs and quality of production. By investing the profits of a billion-dollar industry into the working people, we will see a larger benefit in production than from research that may or may not provide any economic or agronomic value.

Student instructions:

Create a report that justifies an increase in funding for either Jakk or Jyll. Provide evidence for how an increase in funding would boost production of cotton.

Assessment Summary

Students will be formatively assessed with the rubric below:

Identifying: Identifies that an increase in funding to either scientific research or cotton farmers and workers will increase production but does not use specific examples and evidence for how this increase will occur.

Explaining: Explains how an increase in funding to either scientific research or cotton farmers and workers will increase production using specific examples and evidence.

Evaluating: Evaluates how an increase in funding would be more beneficial to scientific research or to cotton farmers and workers using specific examples and evidence.

Defending: Defends an increase in funding for either scientific research or cotton farmers and workers by using evidence to critique counterarguments and to support claims that argue for an increase in funds to either side of the dilemma.

Recommended Use

This could be used in Unit 10 (Aqueous Solutions) in Chemistry I, Chemistry II, or Honors Chemistry.

Connecting with Indiana Standards

SCIENCE & ENGINEERING PRACTICES

1. Asking Questions and Defining Problems

Students must ask questions and define problems regarding cotton production and how it can be improved. They will use evidence and argumentation to develop a position on how they should approach the problem.

2. Engaging in Argument from Evidence

As students gather evidence, arguments will be constructed to support Jakk or Jyll positions. Students need to address counterevidence and be able to defend arguments with evidence that supports their position.

CROSSCUTTING CONCEPTS

1. Influence of Engineering, Technology, and Science on Society and the Natural World

Students will explore the impact of research and scientific discoveries on top commodities in the United States. By funding scientific research, there are impacts on society and the natural world.

2. Systems and System Models

Students will implement models that help explain chemical interactions between materials that play a role in our understanding of important processes for cotton development.

DISCIPLINARY CORE IDEAS

PS1A: Structure and Properties of Matter

PS1B: Chemical Reactions

Jyll's Position

Recap: There are plenty of opportunities to improve the agronomic value of cotton through scientific research. We should invest in research that aims to improve cotton production.

Considerations: Jyll's statement uses examples of research with other top commodities (corn, soy beans, wheat, etc.) to imply that advancements can be made to cotton in the same way. Jyll may need to expand this idea and explain specifically what kinds of improvements could be made to cotton and how those would increase production.

Conceptual Understanding: Investing in scientific research can lead to greater understanding in processes that lead to development. These processes can be modified to increase the agronomic value of cotton.

Jakk's Position

Recap: The best way to increase production of cotton is to invest in the farmers and workers. Tax incentives and increased funding will show an instant boost in jobs and production quality. Conversely, research may or may not improve the agronomic value of cotton and will use a lot of time, energy and resources.

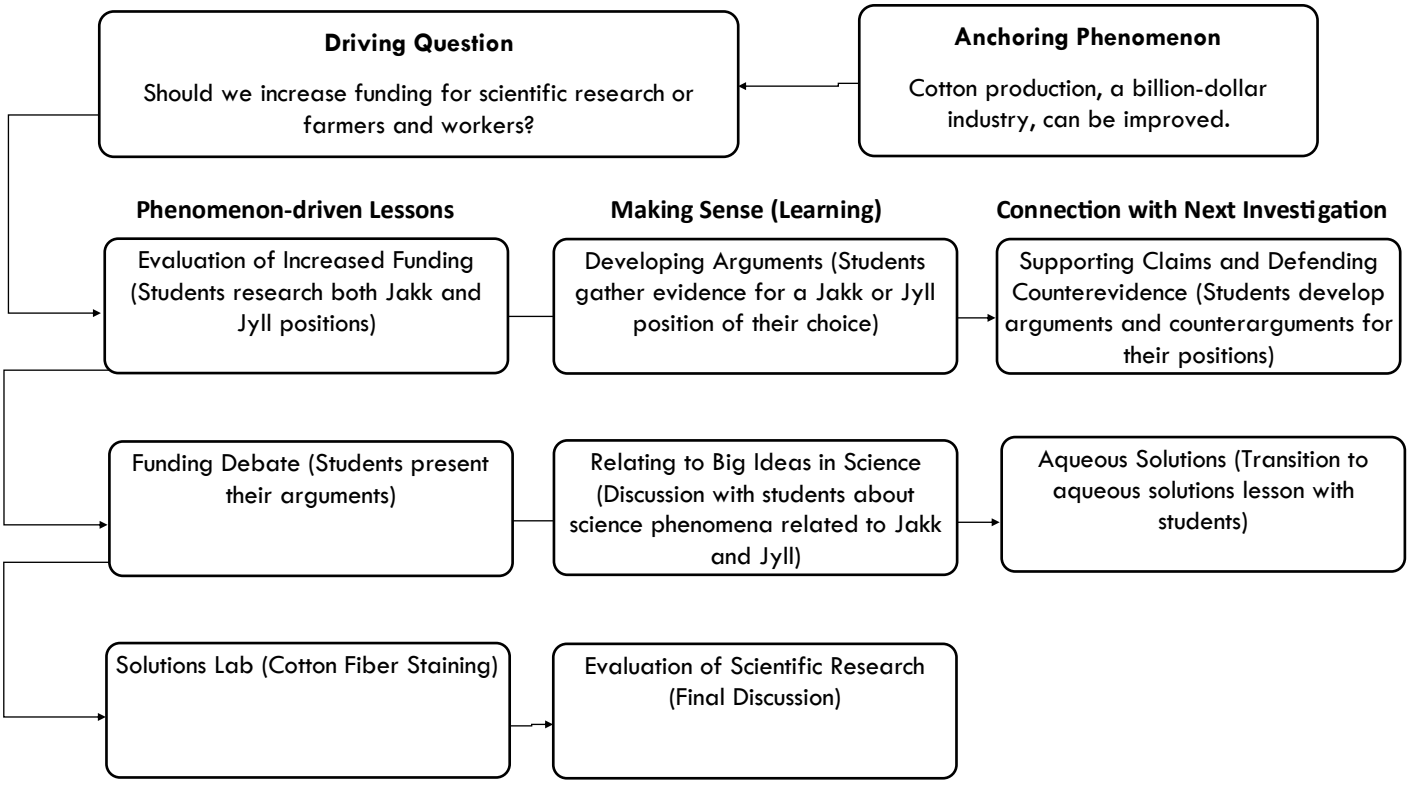
Considerations: Jakk implies that increasing the amount of money going to cotton farmers and workers will increase production more than

advancements in research. Jakk needs to expand on specifically which tax incentives would benefit farmers and workers the most and how an increase in funding would be used to boost production.

Conceptual Understanding: Increasing the amount of capital for cotton farmers and workers will lead to more jobs, higher quality, and larger production.

Photo by Magda Ehlers from Pexels

Unit Storyline



Program Reflection...ish!

Equitable Moments

With the curriculum that I have developed from the RET program, I hope to give each student in my classroom a voice. Too often, students participate in classroom activities without the ability to discuss their ideas. With the Jakk & Jyll activity, the very design of a dilemma provides opportunities for research, argumentation, and debate of an important science topic.

Interestingly, I live in an area with a lot of scientific researchers (Purdue University), farmers, and workers. Although students may be divided, the activity aims to develop classic reasoning, research, and debate skills. By the end, each student will be heard, and discussion of a common ground will attempt to unite the group and connect to science standards in the classroom.

Enjoyment as Motivation

Designing curriculum that engages every student and provides opportunities for scientific inquiry is something that I strive to do throughout the school year. Unfortunately, teachers have so many obligations, deadlines, and requirements that it is difficult to keep the primary focus on student learning and engaging content.

For this reason, the RET program has made an impact by allowing me to set aside six weeks to focus on my teaching, student learning, and how science is used beyond the classroom. By setting aside this time to focus on the students, I hope to bring the joys of research and professional development to my classroom next year and make an impact for years to come.

Goals of Doing

Participating in research at Purdue University has allowed me to take my teaching and learning beyond the classroom. Research has benefited my teaching in a number of ways, and I have enjoyed connecting with my lab members to understand how their research impacts the world. I am looking forward to sharing these experiences with my students and showing how the big ideas in science connect to real-world problems and solutions.

Additionally, I hope to transfer some of the new lab techniques and skills that I have developed to my students. Learning from the researchers in my lab has had a tremendous impact on the way that I hope to facilitate lab activities in the future.

Perfection and improvement

The topic of failure is something that I discuss with faculty, parents, and students every year. Failure often isn't a tool that students use to improve. In many cases, it is more closely linked with a feeling of shame that restricts the ability to persevere and pivot to a place where they can find success. Students feel a sense of pressure for perfection that can inhibit their ability to use failure as a tool for growth.

In my classroom, I want to shift the culture from perfectionism to growth. Giving students the opportunity to fail, learn, and adjust is an important skill for resilience and will transfer to all other aspects of their lives. Being successful does not always happen easily and should not be an expectation without the proper struggle. Engineering a useful struggle for my students is something that I look to put at the forefront of my classroom, and I hope to instill a better sense of resiliency and to shift students to a growth mindset.

Thoughts from Nick's Lab

In what ways has your RET teacher grown most over the summer?

Understanding cell wall biochemistry and breaking it down to students.

How do you plan to continue the partnership with your RET teacher and their students during the upcoming school year?

Be a point of contact for any questions that might come up during the lesson plan and it's execution.

Should we continue to use antibacterial products in the fight against disease?

by Malissa Jeffrey with support from Marc Benedict

Jyll thinks:

The evidence shows that plain soaps clean just as effectively as antibacterial products. Plain soap and water are effective in removing chemicals, dirt, and debris while sanitizing products do not. Furthermore, soaps can be made with natural ingredients that do not harm the environment or human health. There is also a possibility that antibacterial products may contribute to the evolution of more antibiotic resistant microbes. Additionally, antibacterial products remove beneficial bacteria as well as the infectious. Even if used effectively, these products pose a risk to human and environmental health. Finally, plain soaps made by small business can help drive economic development at the local level.

Jakk thinks:

We need to use antibacterial products to protect ourselves and others against illness. Studies done on the ingredients have resulted in companies adjusting the products to fit safety standards. Individuals in close contact with those at high risk for infection, elderly, and the immunocompromised need these products to live and work a sterile, safe environment. This alone makes the money invested in these products worth it. Furthermore, there is no definite proof that antibacterial product use leads to the evolution of antibiotic resistant microbes with normal use. Protecting the health of people now is more important than a potential future risk.

Student instructions:

Based on your current understanding of the topic, decide who you agree with more - Jakk or Jyll. Provide evidence from your own experiences, research, and background knowledge to begin building an argument for your decision.

1) Based on your knowledge of evolution and mutations, decide if you agree more with Jakk or Jyll. You may not agree with every aspect of the perspective, but choose the one that is most aligned with your thinking.
2) Using a credible source, such as Google Scholar, find a minimum of two articles that can help you defend your position. Then, find a minimum of two articles that challenge your perspective.
3) Prepare to share your thinking in the form of a visual aid (think: poster, t-chart, mind map, paragraph, etc.) or as a brief oral report.
4) As a class, we will continue to gather evidence to support or counter argue our claims.

Assessment Summary

Students should be asked to produce a visual aid they can use to organize their thinking, evidence, claims, and sources. Several drafts of this visual aid will likely be made as students organize their evidence to support their claim in a logical, effective manner. Summative assessment may include the progression of these drafts from basic claims to detailed and based on empirical evidence.

Assessment should include the ability of students to engage in the following argumentative practices:

- Clear and effective organizational structure
- Acknowledgement or addressing of opposing views
- Comprehensive evidence, facts, and details from credible sources
- Effective and appropriate vocabulary
- Citation and reference to credible articles, scholars, and professionals
- Application of claim to scientific systems, mutations, adaptations, natural selection, or evolution

It is important to note that there may not be one definitive answer to this thought experiment. Students should be assessed holistically on their ability to define their system in terms of application of these products and how they may benefit or harm with long term use.

Recommended Use

The core learning goal is for students to be able to engage in argument based on evidence and reasoning. Due to the various styles of student learning, teacher deliverance of material, and assessment techniques, many options exist to best fit the structures and formats in a specific classroom. Time frames could be a few class periods to a week or more depending on student need.

A reasonable amount of time should be allotted for initial student thinking and research. Guidance may be needed by individual students on what makes a source "credible" and how to access scholarly resources. Students should be given a choice on a method to record their initial thinking in an organized manner. After sufficient time, a whole group discussion can be utilized to further promote thinking and ideas not previously addressed in individual research.

Depending on the need, there are flexibilities inherent in the activity to promote engagement, evaluation, and communication skills and to reject confirmation bias. Examples could include, but are not limited to:

- Students defending their initial choice of Jakk or Jyll based on evidence
- Random assignment of students to take on the role of Jakk or Jyll
- Identifying student selection, then assigning them to the opposing role

It is important to discuss with students the possibility of there being no "right answer." Attention to the system - who is using the products and why they are using them - may sway students towards a middle ground or if/then method of thinking. Students may even change their thinking on what they believe to be the correct answer, and this should be emphasized as perfectly acceptable. Additionally, detailed discussion on how and why they changed their thinking could deepen understanding of the core ideas of the topic.

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

Constructing Explanations and Designing Solutions

Students will apply scientific reasoning and theory to connect evidence to their claims

Engaging in Argument from Evidence

Students will construct an argument based on evidence to support their alignment with either Jakk or Jyll

Obtaining, Evaluating, and Communicating Information

Students will critically read and evaluate scientific literature to make valid claims in support of their position

CROSSCUTTING CONCEPTS

Cause and Effect: Mechanism and Explanation

Understanding how disease, the prevention of disease, mutations, and evolution occur are critical to make predictions about their possible effects on humans

Stability and Change

Students will be able to make predictions about the evolution of populations and whether this will cause irreversible changes

DISCIPLINARY CORE IDEAS

- **Ecosystem Dynamics, Functioning, and Resilience**
  - LS4.D-H1
  - LS4.C-H4
- **Inheritance and Variation of Traits**
  - LS3.B-H1
  - LS3.B-H2
- **Natural Selection and Evolution**
  - LS4.B-H2

LS4.C-H1, H2, H3, H4, H5

Jyll's Position

Recap: Jyll believes that antibacterial products are not necessary to fight infections. Without long term data on the effects of the common ingredients on the environment, the risk for negative consequences is too great. Additionally, the possibility of antibiotic resistance could potentially make these products more harmful than previously thought.

Considerations: Some students may align with Jyll based on the monetary investment of antibacterial products. They may also argue that plain cleaning products have been demonstrated to clean just as effectively as antibacterial cleaning products. Students may also have a desire to protect the environment as much as possible, especially with the current climate crisis. Additionally, some may have an emotional response to supporting small businesses at a local level. For some families, making and selling soaps can be a favored hobby or income generator.

Conceptual Understanding: Students aligning themselves with Jyll may or may not fully understand evolution of micro-scale organisms like microbes. These students may have a basic understanding of adaptation, natural selection, and the mechanisms behind antibiotic resistant microbes. Upon further research and argumentation, students may arrive at a consensus that these products may or may not be needed in some systems or circumstances.

Jakk's Position

Recap: Jakk believes that antibacterial products are necessary to assist in preventing the spread of illness, infection, and transmittable disease. These products have been tested for environmental impacts and adjusted accordingly to fit safety standards. Without definite proof these products lead to antibiotic resistance, we should continue to use them to protect ourselves and those at risk.

Considerations: Students that side with Jakk may focus on the importance of these products in systems where there are higher than usual health risks to others, such as hospitals, childcare centers, nursing homes, and public spaces. These students may have close relationships with others that could be considered immunocompromised that they want to protect, or are immunocompromised themselves. To some, the importance of protecting the immediate health of others may take priority over long-term effects.

Conceptual Understanding: Students will need to conduct research and explorations on the mechanisms behind antibiotic resistance. An understanding of adaptation, natural selection, and evolution will be essential to making connections to the potential risks of using these products. Furthermore, an analysis of the differences in these mechanisms when applied to the micro-scale of bacteria and viruses is critical. It is also important to note the common ingredients used in these products, where they come from, how they are synthesized, and their potential environmental effects

Unit Storyline

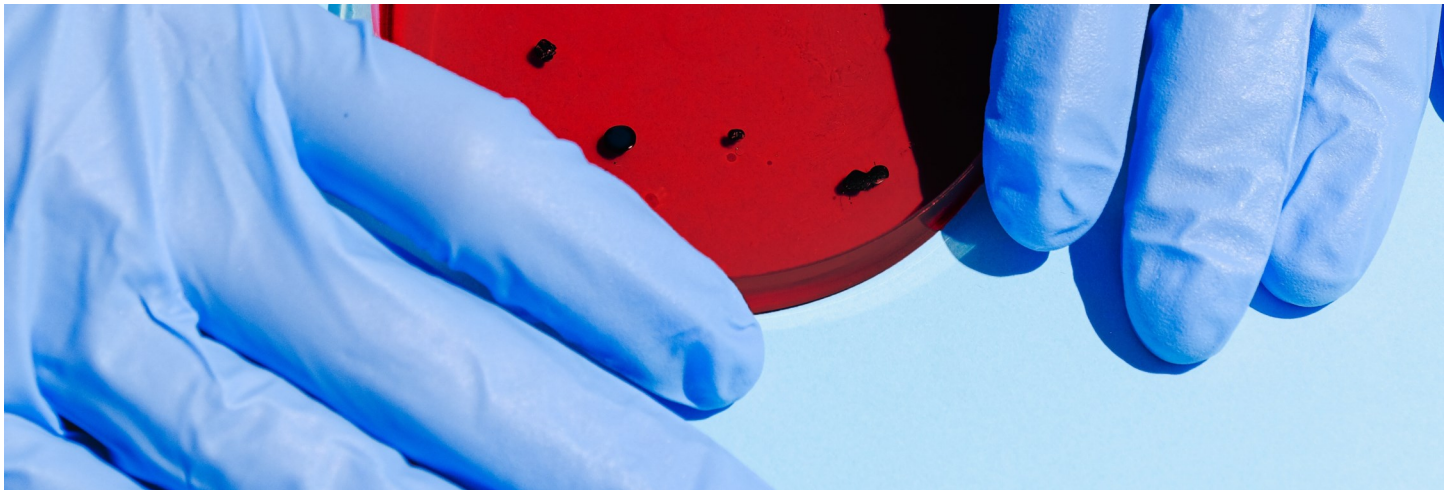
Driving Question

Should we continue to use antibacterial products?

Anchoring Phenomenon

Story of flesh-eating bacteria survival or outbreak

Phenomenon-driven Lessons	Making Sense (Learning)	Connection with Next Investigation
What are microbes? (Keeley Probe)	Microbes are found everywhere and have various types and structures NIH Microbiome Project	Microbes exist in a micro-scale environment with unique ways of living and growing
Lab Investigation of using various cleaning products and microbial growth	Cleaning products may have different effectiveness in removing microbes	Why are some microbes left behind?
What are the mechanisms behind evolution?	Adaptations, mutations, heredity, natural selection	Discussion with Dr. Serb on how microbes evolve
Do antibacterial products drive antibiotic resistance?	Explore current research HHMI Biointeractive: "Origins of Antibiotic Resistance"	Is there a time and a place for antibacterial products?



Program Reflection...ish!

Joint Reflection from Malissa & Marc

Equitable Moments

Our district is unique in that we are a very small, very rural community with a majority white population. This poses the need to expose our students to diversity that they will undoubtedly encounter in the future. These encounters could take place in higher education, the work force, military settings, etc. Without past exposure to individuals with diverse ethnicities, backgrounds, identities, or socioeconomic class, they are at a disadvantage to building relationships with those that are different than them.

By purposefully incorporating images, stories, interviews, and conversations around non-traditional scientists, we hope to resonate to kids that their history does not define their future. Even if they come from a past of trauma, inequity, or diversity, they can choose their own path by combining their effort and our support.

Enjoyment as Motivation

A component we believe has a major impact on students is their engagement and curiosity with the material. As educators, we can purposely create "moments" in our classrooms where students become excited about learning and want to continue building on those experiences. This could be as simple as a conversation that allows us to relate to one another, or a fun activity that we planned geared towards specific student interests.

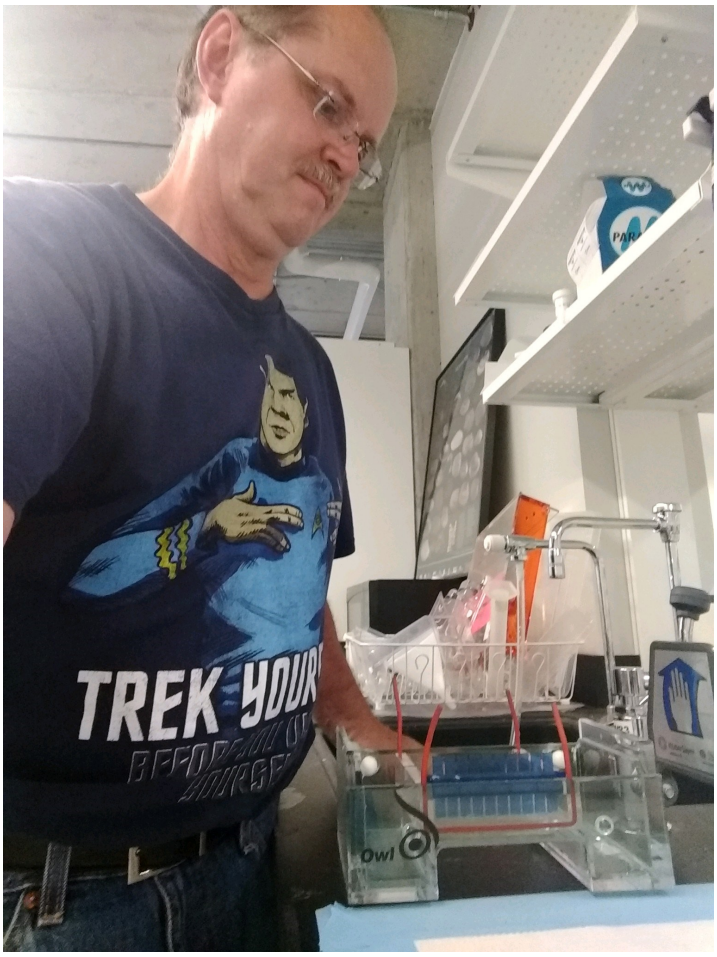
As our roles as mentor and master teachers will deepen this coming school year, we recognize the importance of creating these moments for other staff members. Our goal is to create -ish moments for other teachers where we become the "Marisol" in acknowledging their work and supporting their needs and growth.

Goals of Doing

The Jakk and Jyll will allow us to engage with Dr. Jeanne Serb about her research in the evolution of organisms. This will also be an opportunity for our students to see diversity presented as a woman in STEM. Through our exploration of mutagenesis done by students in our classroom, we can provide them with an opportunity to further knowledge in the scientific community. This ownership over authentic learning will prove to them that they have a place in the world of STEM.

Perfection and improvement

Our thinking is that we need to create a support system for students and teachers where we can let go of our perfectionism and begin taking risks. This can be very difficult for some people, and we recognize the need to empathize with the feelings that come along with breaking down our own personal barriers. By breaking down these barriers, we can create our own experiences of learning where we have ownership and pride. Our biggest challenge in creating this culture will be to teach students about responsible failure. If a student truly gives effort and makes choices reasonable to their capacity, we will be there to guide them towards failing forward. Reflection will play an imperative role in assisting these students and teachers in fully embracing all aspects of a growth mindset.



Thoughts from Malissa & Marc's Lab

Why do you believe it is important to partner with the Office of Biotechnology and offer research experiences for K-12 science teachers?

The RET is an awesome opportunity for teachers to engage with the topics that they loved prior to becoming a teacher. The energy is contagious!

In what ways has your RET teacher grown most over the summer?

It has been great to watch Malissa get comfortable with being a student again and appreciating (and enjoying!) the opportunity to learn. Each week, she became more relaxed with the not-knowing, while growing an openness to ask questions and direct her learning. I am looking forward to continuing the process with her in the classroom.

Marc has been a multi-summer participant, but all of his previous work was with another investigator. It was a real honor to be Marc's "second lab." In my lab, Marc was able to demonstrate that he conceptually learned lab techniques by applying knowledge from one experience to a different one. Additionally, Marc was both a learner as well as a mentor with his team-teacher, Malissa. I am excited to continue working with both of them in the upcoming year.

How do you plan to continue the partnership with your RET teacher and their students during the upcoming school year?

Malissa had developed a compelling Jyll and Jak. I plan on virtually visiting her classroom to discuss how organisms evolve through genetic mutation.

Marc and Kyle are developing a video tutorial to annotate genes on a genome, which can be used in the classroom for "gene discovery" just like the Human Genome Project. This is a true partnership, as the lab will use the tutorial to train new students. We also are discussing a lab-based project for HS students to create mutant genes.

Photo by cottonbro from Pexels

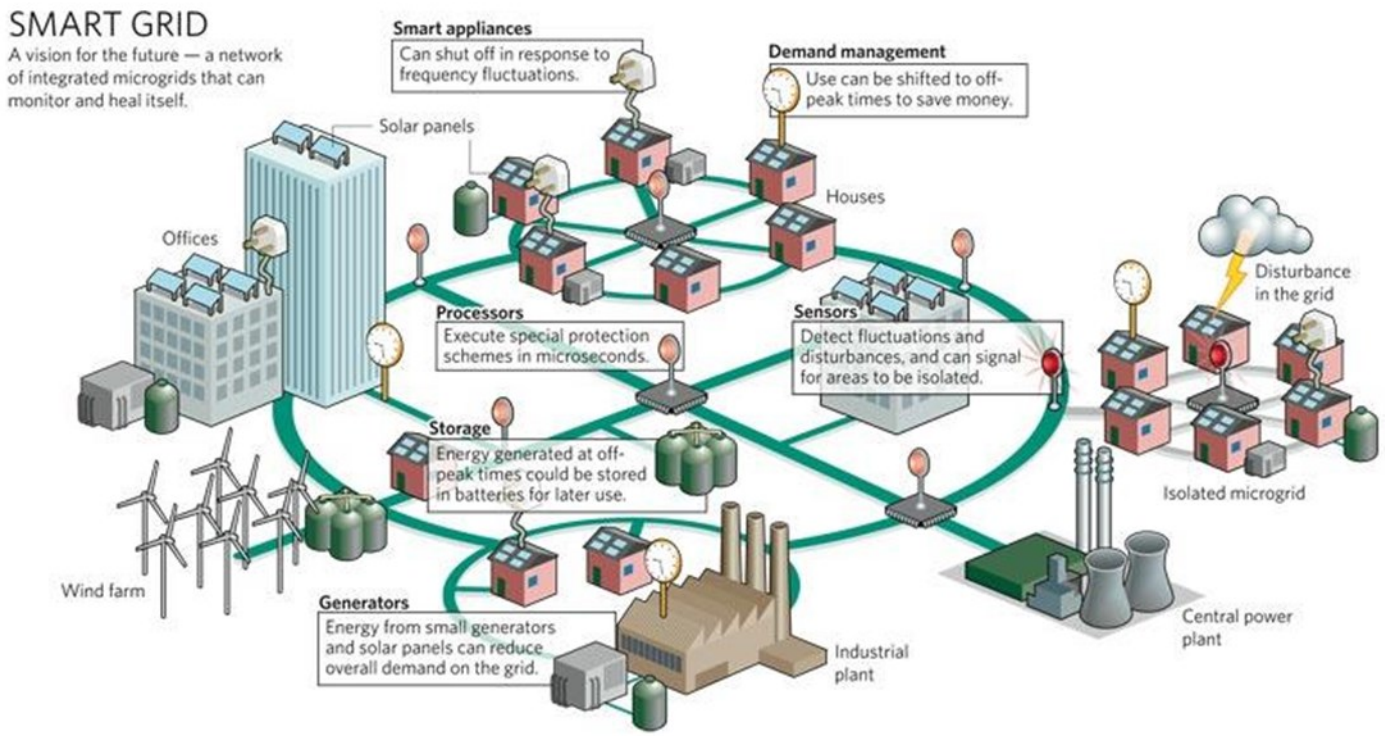


Photo credit: blog.phoenixcontact.com/marketing-sea/2017/04/smart-grids-how-automation-empowers-the-future-of-electricity

by Brandon Kleve

Jyll thinks:

Preventing thermal heat loss is a huge environmental concern, it results in burning more fossil fuels, increasing greenhouse gases in our air. Utilizing new aerogels can revolutionize thermal protection, these aerogels can be lighter than air and be made into either foam or fibers. These new aerogel blankets can be utilized by satellites and spacecraft to prevent thermal loss as well as protect the aircraft from radiation. These gels have been found to work on the microscopic scale and also have potential for commercial use in housing and electronics on a larger scale saving energy.

Jakk thinks:

Today's electric grid is aging and is being pushed to do more than it was originally designed to do. A 21st century grid must be flexible and smarter as our energy mix continues to change. Carbon nanotube spray coating can change the way electronics work. This coating can possibly increase processing speed, decrease the size of electronics, and protect electronics in the depths of space. This technology also could revolutionize the way electricity can travel from within the smallest electronics, to wind turbines, and electrical stations across the world.

Student instructions:

Read and decide which viewpoint you feel you agree with the most. Make a claim on why you feel the change is necessary for improving energy conservation. Next find evidence that supports your claim by locating a scholarly article on google scholar, validate that evidence with 2-3 sentences of reasoning. Make your CER on a whiteboard, include your citation from your scholarly article. Your group will then present your whiteboard and the argument in a gallery walk in the back of the classroom. We will then create a class argument for both sides and discuss the benefits and disadvantages from both sides.

Assessment Summary

This dilemma would be used to get students to argue which insulating/conducting material or energy source grid would be best to improve. Students will need to make a claim in which they feel which change is most necessary now. Students will need to provide reasoning for why they chose their position and provide 2-3 sentences or pieces of evidence they feel support their argument. Finally, I want to students to think about what information isn't present that would help clarify or support their position better.

Recommended Use

Student Discussion and Debate:

Students will be completing the dilemma on a whiteboard and present their whiteboard to fellow classmates either in small group sharing or potentially in a larger group depending on class size and comfortability. Another option would to do a gallery walk around the room with the whiteboards present around the room with students reading and analyzing each other's work. Finding similarities between Jakk's and Jyll's arguments and comparing them together as a class.

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

Energy and Matter

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

DISCIPLINARY CORE IDEAS

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 that thermal energy conservation can be improved by using aerogels that provide better insulation and heat protection than current materials. These aerogels can benefit society and the environment by being utilized in housing and electronics.

Considerations: Students who choose Jyll's viewpoint may feel that her material is easier to individual change, as they have a choice to make that change, rather than a large infrastructure change. This change can be done individually, it may be small but easier to achieve.

Conceptual Understanding: Understanding where thermal energy comes from and how energy conversion plays a role in their daily lives. Understanding how energy moves from one source of energy to another and that impact on the environment as a consequence of energy consumption.

Jakk's Position

Recap: Jakk feels the current electrical grid needs to be overhauled as the current system is outdated and needs to be changed. New technology and spray coating can provide the opportunity to change the system now to fulfill energy needs entering the 21st century.

Considerations: Jakk's infrastructure change requires a lot of moving parts. This change will be expensive and time consuming compared to Jyll's. This may dissuade some students as they change maybe too large and made from a congressional decision rather than an individual decision.

Conceptual Understanding: Students will need to understanding where and how electrical energy is produced, and that this energy is produced from a variety of sources. Once this energy is produced it needs to be transferred from one source to another.

Unit Storyline

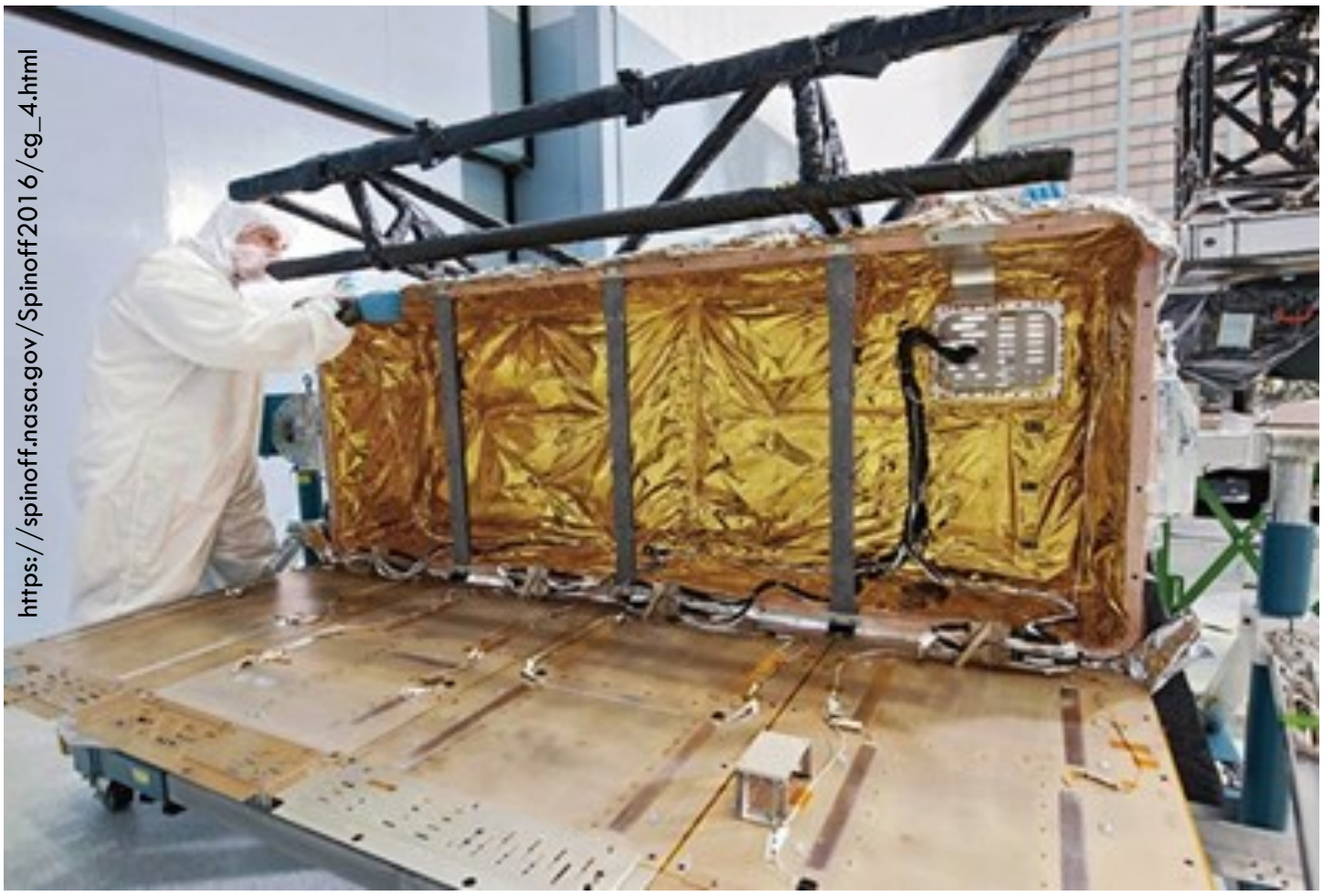
Driving Question

How does conservation of energy play a role in all energy transfers within all systems. How can I minimize energy loss in and out of that system.

Anchoring Phenomenon

Changing Electrical Grid

Phenomenon-driven Lessons	Making Sense (Learning)	Connection with Next Investigation
Mitten problem Probe	How are heat and temperature different?	In what ways an heat be transferred?
Melting ice lab on different materials.	Thermal conductivity is related to a materials specific heat	Using conservation of energy and specific heat to solve for all variables in equation.
Thermal Equilibrium lab practical	Solving an authentic lab-based problem, within a specific percent error.	



https://spinoff.nasa.gov/Spinoff2016/cg_4.html

Program Reflection...ish!

Equitable Moments
Every student has self interest in energy, their cell phones, cars and houses all require some level of energy. Energy plays a role for all living organisms, meeting these energy needs more efficiently will have less impact on the environment and provide better access to meeting these energy needs and provide a sustainable cleaner environment for future generations.

Enjoyment as Motivation
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.

Goals of Doing
My research is looking at thermal diffusivity at the microscopic level using innovative lab techniques to find these values at the nanoscopic level. This thermal transport is looking at only one dimension of heat transfer rather than all three dimensions that take place on the macroscopic level. In these calculations it is important to understand the concept of specific heat and how each material has a unique value depending on its molecular structure. This is similar to what is happening in the research but not on the microscopic level.

In my other research we were looking at graphene aerogels and how reducing graphene aerogel with localized laser heating can reduce the oxygen atoms in the lattice structure reducing electrical resistance.

Perfection and improvement
In my classroom I want to make sure all opinions are respected and valued even though they may be different than another student's opinion. Establishing a classroom culture that values one another's opinion is important in society. In this argument both sides can be right and wrong, there is no "correct" answer. Modeling the pro's and con's for each argument on the board allows students to see each argument's viewpoints.

Thoughts from Brandon's Lab

Why do you believe it is important to partner with the Office of Biotechnology and offer research experiences for K-12 science teachers?

It could save a lot of time on looking for good participants. Also it makes the program interesting. It is definitely of great importance for people in academia and K-12 science teachers to be partnered because these are the teachers who prepare/train the next generation of researchers. The more a science teacher has research experience, the more they can motivate and help their students to pursue these majors.

In what ways has your RET teacher grown most over the summer?

Applying his own knowledge to help with our research. Also works out future plans of collaboration.
During this period, I and Brandon worked on the TET technique, which is a very unique technique to characterize the thermal properties of fibers, and he learned all of the physical and technical concepts very fast.

How do you plan to continue the partnership with your RET teacher and their students during the upcoming school year?

We are planning to be in contact during the coming year, and hopefully, Brandon can join us again the next summer to work on the other techniques that are available in our lab.

Think about: Ecosystem Disruption

by Julia Little

Jakk thinks:

More research funding should go to developing products from petroleum. Consumers appreciate the benefits of petroleum-based, synthetic clothing fibers, such as polyester, rayon, modal, spandex, and nylon. Some of these benefits include quick drying, elasticity, durability, low cost, ready availability, and wrinkle resistance. Polyester fiber recycling continues to increase. The contribution to global warming from the use of petroleum to make high performing fabrics is inconsequential to the use of petroleum for transportation.

Jyll thinks:

More research funding should go to developing renewable, agricultural biomaterials. To reduce the mining of petroleum and, thereby, decrease anthropogenic causes of climate change, we should focus on renewable biomaterials for clothing fibers, such as cotton, flax (linen), silk, wool, cashmere, and hemp. Synthetic fibers absorb very little moisture and become sticky with sweating. Synthetic fibers require 20 to 200 years to decompose. Cotton is the preferred fiber for clothing in the world, with a 25% market share in 2019. Consumers prefer renewable products.

Student instructions:

Using what you have learned thus far in AP Environmental Science, decide who you agree with more—Jakk or Jyll. Providing evidence for your choice is important and will help you build an argument for your decision.

1) Decide who you agree with more—Jakk or Jyll. "It depends" will not work here. You must choose a stance.
2) Make a list of vocabulary words from Jakk and Jyll's thinking that you perhaps need to review, such as: petroleum, polyester, rayon, modal, spandex, nylon, elasticity, durability, renewable, biomaterial, cotton, flax, wool, cashmere, hemp, renewable, decompose, synthetic.
3) Think about the course content and inquiry labs we've experienced in class to make a list of potential evidence for Jakk, evidence against Jakk, evidence for Jyll, and evidence against Jyll.
4) Individually, if necessary, or with a partner who chose the same perspective, Jakk or Jyll, use Google Scholar to find articles to help develop your evidence for and against Jakk and for and against Jyll.
5) After discussing your findings with your partner, write a coherent page that supports your stance (Jakk or Jyll) and refutes the other stance.
6) Each individual or team will share with the whole class, will field questions, and will lead a discussion about their evidence.

Assessment Summary

A written argument will be produced by each individual or collaborative team that includes the Jakk or Jyll preference as well as evidence for the stance and evidence against the other stance.

It is important to emphasize that there is not a correct point of view here. What is important is the review of concepts already learned, the collection of evidence to support the chosen stance and refute the opposing stance, the collaboration with a classmate, the coherent presentation of the stance and evidence to the class, and the respectful whole class discussion. During the evaluation process, the purpose is to critically review the content, the validity of the non-opinionated evidence, and the delivery—not the person's or team's position itself.

This argumentation method presents two similar, yet different, perspectives to the procurement of textile fibers. As students process new information, they may even create 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 pros and cons of using limited research funds for developing textile fibers from oil or from renewable plants. This assessment should be used to evaluate and support student learning related to the question:
*How do we live sustainably on Earth?

Recommended Use

Mental Model Manipulation: Thought experiments help students move beyond factoids and algorithmic solutions by requiring study of peer-reviewed findings and development of evidence-based reasoning to construct an argument.

Structured Discussion: Students collaborate with peers, present their stance evidence as well as evidence against the alternative stance. Respectful, whole-class discussions reinforce the "no correct answer" and reinforce the value of thorough review of the evidence.

Visible Thinking: In addition to the written assessment summary, the Jakk and Jyll thought experiment could also take one of the following forms:

*pros/cons t-chart
*agree/disagree t-chart
*concept map
*poster
*outline
*collage
*slide presentation
*modified Public Forum debate format

Connecting with College Board AP Environmental Science Standards

Science Practice 7—Environmental Solutions
Propose and justify solutions to environmental problems.
7.A. Describe environmental problems.
7.C. Describe disadvantages, advantages, or unintended consequences for potential solutions.
7.F. Justify a proposed solution, by explaining potential advantages.
Big Idea 4: Sustainability (STB)
Unit 5 Land and Water Use, 5.12 Introduction to Sustainability
Unit 6 Energy Resources and Consumption, 6.1 Renewable and Nonrenewable Resources
Unit 9 Global Change, 9.5 Global Climate Change

Connecting with Next Generation Science Standards (NGSS)

SCIENCE & ENGINEERING PRACTICES (SEP)
1.7 Engaging in argument from evidence
*Learners respectfully provide and/or receive critiques on scientific arguments by probing reasoning and evidence and challenging ideas and conclusions, responding thoughtfully to diverse

perspectives, and determining what additional information is required to resolve contradictions. (ARG-H3)
*Learners compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g. trade-offs), constraints, and ethical issues. (ARG-H1)

CROSSCUTTING CONCEPTS
2.2 Cause and Effect: Mechanism and Explanation between cause and correlation and make claims about specific causes and effects (CE-H1)

DISCIPLINARY CORE IDEAS
ESS3.A. Natural Resources
ESS3.D Global Climate Change

Jakk's Position

Recap: Jakk's position is based on the thinking that the market economy is the preferred way to allow limited research funds be allocated. He pushes for the continued development of fibers through the chemistry of oil.

Considerations: Students who think similarly to Jakk most likely subscribe to the benefits of improvement in synthetic fibers, and their multiple uses in clothing, structural materials, coatings, and storage. He may also focus on the need to carefully manage soil, water, and nutrients for expanded biomaterial agriculture, as well as the competition between biomaterials for feeding an expanding world population and biomaterials for fiber, building materials, and energy. He may stress the negative effects of monocultures. Students may also point out the many valuable products obtained from oil and safe new methods of extracting raw hydrocarbon resources, such as fracking.

Conceptual Understanding: Jakk's thinking will demonstrate understanding of the differences between renewable and nonrenewable resources; chemical processes required to produce products from petroleum, such as distillation; and world resources distribution.

Jyll's Position

Recap: Jyll's position is based on the thinking that we should return to renewable sources of fiber, that are plant-based instead of petroleum-based. She realizes that synthetic fibers are only one product from oil, but that most oil is used to produce diesel fuel, gasoline, and jet fuel, which contribute to rising carbon dioxide levels in the atmosphere and continued global warming pressure. She understands the ongoing conflicts that arise between oil-rich and oil-poor nations, as well as the benefits of energy independence.

Considerations: Students who think similarly to Jyll most likely will argue for the positive effects of sustainable agriculture. They will argue that continued fossil fuel mining and use will contribute to more intense storm events, loss of biodiversity, drought, heat waves, sea level rise, ocean acidification, and suffering of the world's most vulnerable people.

Conceptual Understanding: Jyll's position will demonstrate her understanding of sustainability, renewable and nonrenewable resources, land use, the greenhouse effect, global climate change, ocean warming, ocean acidification, and human impacts on biodiversity

Thoughts from Julia's Lab

Why do you believe it is important to partner with the Office of Biotechnology and offer research experiences for K-12 science teachers?

It is important to offer research experiences for K-12 science teachers to promote the use of inquiry-based teaching methods and allow teachers to bring research experiences into the classroom.

The RET program enriches teachers and their students for years to come, while simultaneously helping mentors and their labs become better at their jobs. It is a win-win in the best way!

We as professional scientist have to contribute to people's education on all levels. The teachers are the best way to share our knowledge with young generation and hopefully future scientists.

In what ways has your RET teacher grown most over the summer?

Julia has built a great deal of confidence in her research and benchwork skills, and has done an incredible job of integrating our research into inquiry-

based lessons for high school students.

In understanding the actual science we perform, its broader intellectual context and connections to other disciplines, and the rhythms of daily science life and function.

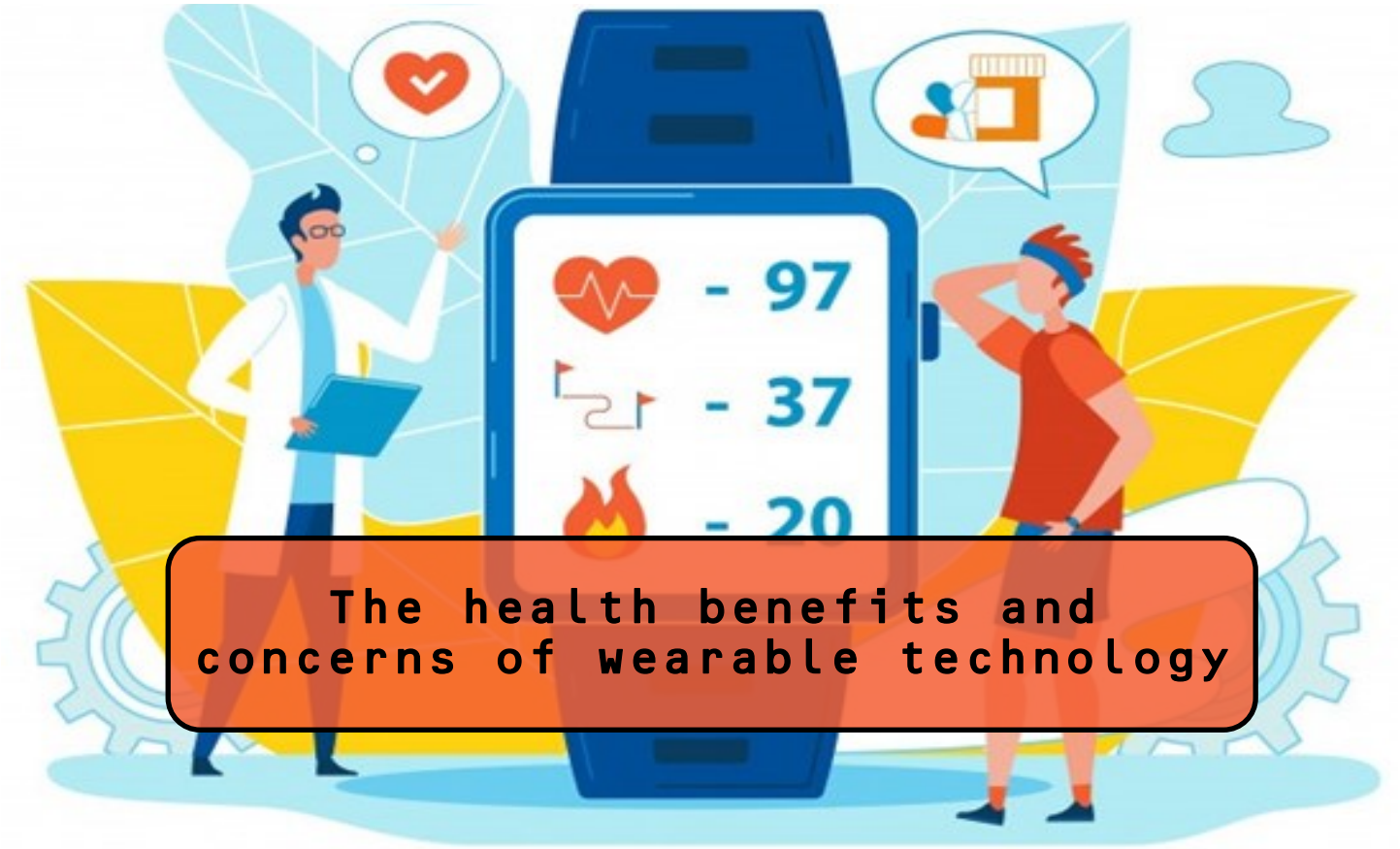
Julia is a “Knowledge Seeker”, “Highly Enthusiastic” to learn new techniques and “Highly Attentive” to follow complex experimental directions in a thorough manner. She is eager to teach her students the high-quality science. I hope her experience in my lab opened new options for her in what and how she can bring science to her students.

How do you plan to continue the partnership with your RET teacher and their students during the upcoming school year?

I plan on continuing to be in contact with Julia to discuss research and the work being done in our lab, and I also plan to communicate with her students about my work in the lab and what research is like in general.

We hope to develop virtual classroom experiences for mentors and their teacher's students. I will be very happy to stay in touch and assist Julia in any way possible to share her new experience at ISU with her students.

Photo by cottonbro from Pexels



The health benefits and concerns of wearable technology

by Josh Vanderwiel

JYLL THINKS:

Smart watches that provide the user with health information could lead to a less healthy life. By having access to this data 24/7 the user will try to micromanage their lifestyle and jump to incorrect conclusions whenever the data is inconsistent. She believes that everyone should listen to their body as they have evolved to notify us of any irregularities. Jyll is also concerned with where the information is going without her consent.

JAKK THINKS:

Smart watches that provide the user with health information will help them live a healthier life. Continuous data that is sent to doctors will help them more accurately treat problems before they become serious. Additionally, he believes that by having constant access to the data the user can adjust their lifestyle and treat problems before they need to see a doctor. Jakk believes this information should be automatically sent to numerous doctors for evaluation.

STUDENT INSTRUCTIONS:

Science is intentionally unbiased; however, it can be difficult to keep our biases from impacting our decision making as researchers. As consumers we are also biased, but should this bias impact how we do research about buying a product such as a smart watch?

Read and decide if you agree with Jakk or Jyll's viewpoint on having constant access to medical information through a wearable smart device. Write down 3-5 main reasons why you believe the viewpoint you chose AND why you disagree with the opposing viewpoint. Make sure to do research to support your claim with evidence!

Be prepared for a short debate in small groups and to share with the class!

Assessment Summary

This thought experiment is designed to show students how their biases and prior experiences can cause conflicts in the decision-making process of a group of researchers. The assignment introduces a dilemma that may be at the forefront of society in the near future.

Research dilemmas are not uncommon in current day science, and some would claim they are slowing down the advancement of society. Everyday dilemmas like how to solve climate change or the purpose of space exploration are often at the forefront of the news because of their great impact on the future of humanity.

Students should be able to recognize that neither side of this thought experiment is "right" or "wrong". Instead, they are two opposing viewpoints, both of which could be supported with additional research.

The goal of this activity is to allow students to practice good research and argumentation strategies that could be transferred to other controversial dilemmas and everyday conversations.

Recommended Use

This thought experiment/activity should be used to extend students learning outside of the standards and into a real-world setting. Due to the nature of this dilemma, each student will have their own biases about technology and its role in health monitoring. Supported, with research as evidence, students will be able to put an argument together in favor of either side of the dilemma. It is possible that students have discussed similar dilemma's before, so it is important for them to have research evidence to support their claims. This will help students avoid using opinions in their arguments.

I have this assignment set up as a Think-Pair-Share embedded into a debate. First, students will be given time to research and formulate an argument. This allows students to organize and support their initial thoughts on the dilemma. Next, students will participate in a small group debate. This ensures that every student has the opportunity to share their thoughts and findings from the initial stage of the assignment. Finally, it is important to allow students to share with the class. I recommend using some form of a classroom consensus model to compile students' ideas in a visual manner.

I also recommend tying the idea of argumentation into students' everyday arguments as well as the real-world societal dilemmas. Encourage students to use some of the research and argumentations strategies when at home or when talking about highly controversial topics. Remember the goal is to show students how to properly conduct themselves in an educational argument.

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 Argumentation from Evidence

Students will need to listen, compare, and evaluate competing viewpoints. Students will need to analyze an opposing claim to find its weaknesses.

Obtaining, Evaluating, and Communicating Info.

Students will need to communicate clearly and persuasively the ideas and methods they generate through research and personal experiences.

CROSSCUTTING CONCEPTS

Cause and Effect

Students need to analyze how this decision may affect the future of online privacy and how we protect medical information.

DISCIPLINARY CORE IDEAS

AP Chemistry College Board Standards:

ENE-6.A Explain the relationship between the physical components of an electrochemical cell and the overall operational principles of the cell.

NGSS Matter and its Interactions:

HS-PS1-2 Construct and revise an explanation for the outcome of a simple chemical reaction.

Jyll's Position

Recap: Students who agree with Jyll believe that constant access to health data will cause the user to be rasher and more confident about incorrect health decisions. They believe in the biological signals of the human body. They are also concerned about the security of the device. Th
ey want to know who has access to this data and how they can keep it out of the hands of big corporations.

Considerations: These students may struggle with data. Some of these students may be cautious of doctors or technology. These students are very concerned with privacy when it comes to technology. They will want to know who has access to the data. Is the data going to doctors, tech companies, or health insurance companies? They may want to steer the discussion towards targeted advertisements and "always listening" smart devices. These students will put their morals and ethics ahead of societal advancements.

Conceptual Understanding: Students who align with Jyll's thinking may benefit in seeing how much more effective continuous data is in drawing conclusions. These students will spend time researching how the body sends signals to notify the individual of any problems.

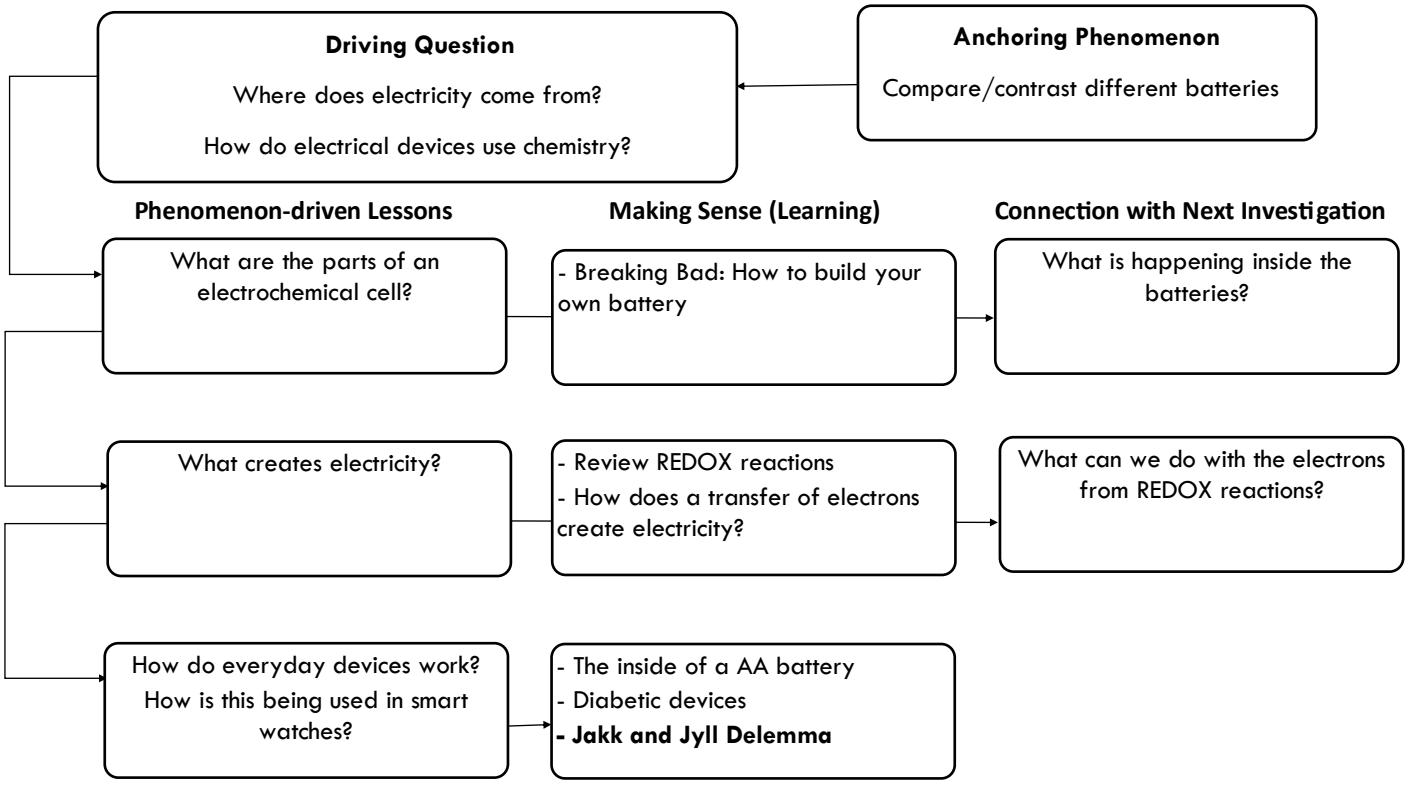
Jakk's Position

Recap: Students who agree with Jakk believe that all data is good data. That the user will be able to analyze, interpret, and act on the data from the watch. The data will also help doctors have a better understanding of their patients. Constant monitoring of an individual health will help diagnose problems and stop them before they become severe. Therefore, they believe that the data should be available to as many doctors as possible.

Considerations: Students who agree with Jakk are likely people who trust data and can interpret it easily. They might believe that all technological advancements are good for society. These students may prioritize societal advancement over morals and ethics.

Conceptual Understanding: Students who align with Jakk's thinking may not be informed on the buying and selling of personal data that goes on between large corporations. They may need help understanding how vulnerable their data is and how it is already being used against them.

Unit Storyline



Program Reflection...ish!

Equitable Moments

The most eye-opening part of the RET program, and my first year of teaching was a comparison we heard between our students and plants. The metaphor goes on to talk about how when a plant is not growing, we ask questions about the environment. Do I need to water it more? Do I need to move the plant? We need to approach a struggling learner in the same manner. There needs to be a mental shift from thinking that the student cannot learn or that it is their fault. Instead, we need to approach the situation as if the student were a growing plan and ask ourselves what is this student's environment? Is there anything we can do to help improve their environment?

As someone who flew through the American education system with ease, it can be easy to assume my students have very similar experiences. However, it is immediately clear to me that this is far from the case. The purpose of the plant metaphor is to remind teachers to think proactively. This has taught me the importance of finding a way to make sure each our students is in an environment that they can learn in. However, we have far less control of this when students leave our classroom. This has taught me to reevaluate the value I put on work outside of my classroom such as homework, study guides, or after school review sessions.

Enjoyment as Motivation

Another eye-opening moment of the RET program was learning about the power of moments. The power of moments teaches us, as teachers, to create memorable moments for students. In each lesson, students will usually remember the beginning and the end, but forget much of the middle of the lesson. In addition to this, student also remember highly engaging "moments". A "moment" is when a student is highly engaged and motivated which leads to more genuine learning.

This has shown me a new approach to lesson and unit planning. When planning new curriculum, I will put extra time into the beginning and the end. In addition, I will ask myself what are the "moments" of this year? This unit? This lesson? In doing so I hope to build the long-term retention of my students by increasing the number of "moments" they hang onto once they leave my classroom.

Goals of Doing

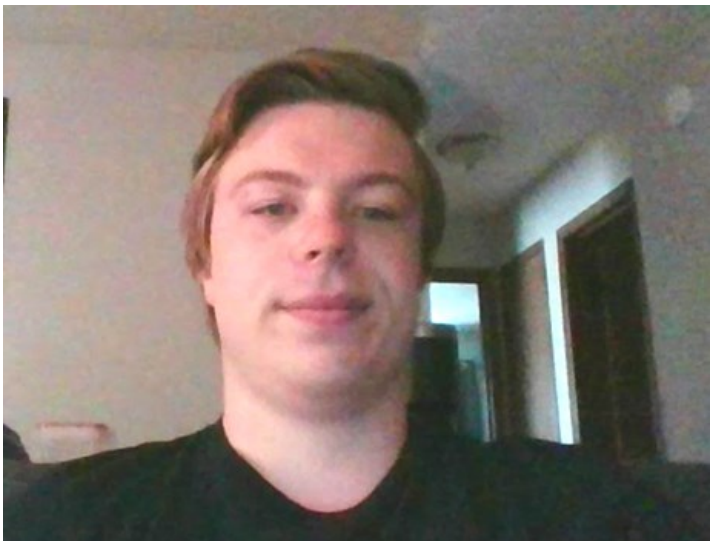
The RET program has taught me two key ways to make sure students are learning in the classroom. First, it is important to make sure students are engaged and actively learning. Second, is to make the learning meaningful to them. Students retain and enjoy learning far more when they are directly interacting with content that is of interest to them.

Any teacher will tell you that one of the most frustrating questions we get is "When I am ever going to use this?" Most students cannot see the bigger picture of a lesson like a teacher can. They struggle to realize the lifelong skills they are gaining from being in a classroom. This means, as teachers, we need to make clear connections between research and our content. This begins by reaching out to people who work in the field such as we did this summer through the RET program.

Perfection and improvement

Creating this shift in curriculum so that students are actively learning about applicable topics will require students to be more independent learners. This would require students to work cooperatively and think critically. However, it is clear to me that today's society promotes perfection without allowing for failure or any of these other behaviors. Students in the classroom are hesitant to take risks, speak out, and try new things.

As science teachers, we need to create a class culture that celebrates new ideas, failures, and revisions. The best way to do that is to show students that teachers are not perfect. We must model how we handle and grow from mistakes. I believe that creating this classroom culture is the best way to help our students be better learners.



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