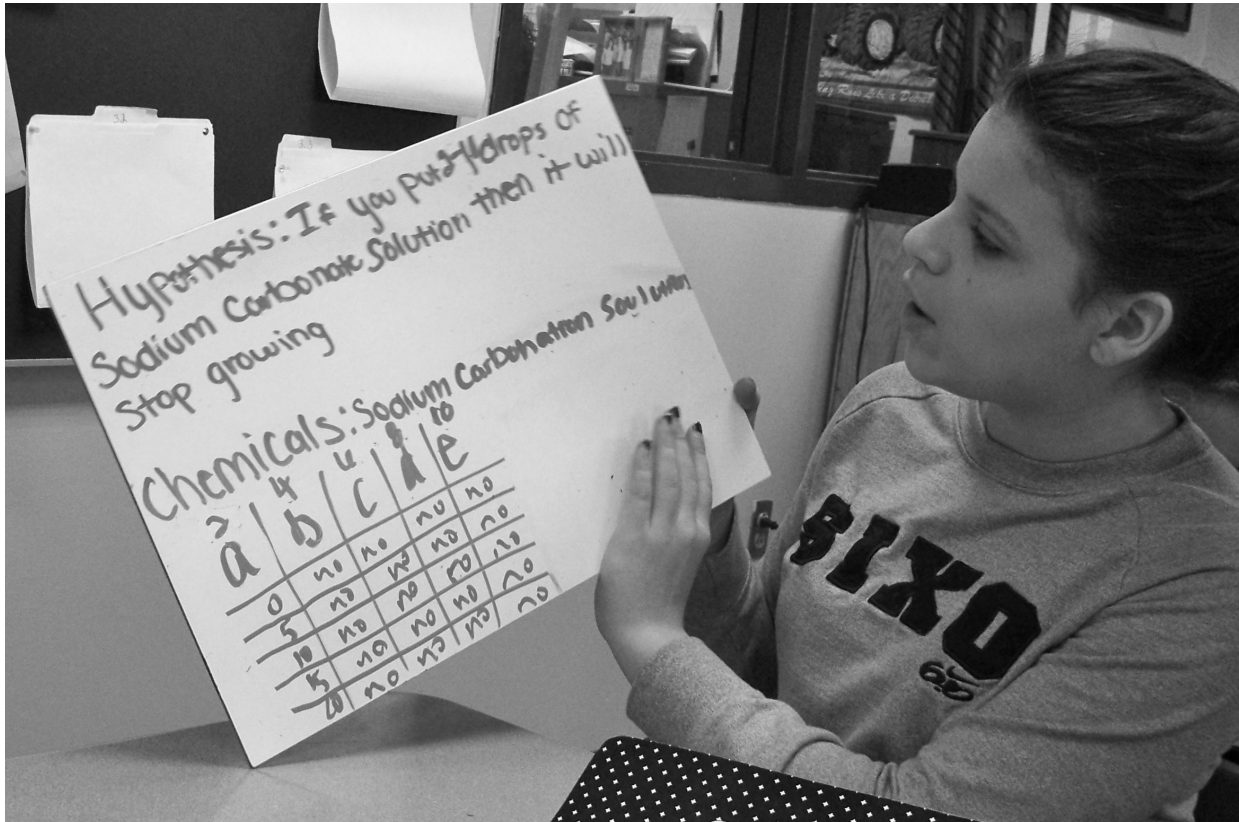


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Facilitating Effective Inquiry-Based Instruction

The Importance of Cultivating Inquiring Minds

by Gaea Hock

Inquiry-based learning is not a new concept in agricultural education, but one that still seems to challenge teachers as they work to implement the strategy in their classroom and the total agricultural education program. There are many benefits for students when teachers use inquiry-based learning. Ten highlighted in a TeachThought.com article include:

1. Nurture student passions and talents
2. Empower student voice and honor student choice
3. Increase motivation and engagement
4. Foster curiosity and a love of learning
5. Teach grit, perseverance, growth mindset, and self-regulation
6. Make research meaningful and develop research skills
7. Deepen understanding to go beyond facts and content
8. Fortify the importance of asking good questions
9. Enable students to take ownership of their learning and to reach their goals
10. Solve the problems of tomorrow in the classrooms of today

While all of these are important, the last one, “solve the problems of tomorrow in the classrooms of today” is especially crucial. There are many grand challenges facing the agriculture industry including, but not limited to water scarcity, feeding a growing population, sustainability concerns, and the need for agricultur-

al scientists. Agriculture teachers should be working to prepare their students with the skills needed to address and work toward solving these and future problems.

I spend most of the spring semester traveling the state visiting student teacher interns. I enjoy seeing the progress of my students while staying connected to the high school classroom. Recently, I spent the day with Christina Hoffman, who is completing her internship with Mr. Daniel Knapp at Inman High School, in Inman, KS. She showed me a project two students have been working on over the last year. They decided to design a hydroponics system in the greenhouse and designed it themselves. The amount of inquiry required to think through each step and make progress toward their goal was impressive to me. As agricultural educators, we should be encouraging and supporting this type of inquiry in our classrooms,



SAE programs, and FFA activities.

How are you cultivating inquiring minds in your classroom? In your total agricultural education program? The authors included in this issue of the magazine offer excellent tips, strategies, and advice to effectively and purposefully implement more inquiry-based instruction in your own classroom. I hope you will learn valuable strategies to help prepare your students to solve the problems of the future.

Reference:

10 Benefits Of Inquiry-Based Learning; 10 Reasons To Use Inquiry-Based Learning (August 28, 2017). (<https://www.teachthought.com/critical-thinking/10-benefits-of-inquiry-based-learning/>)



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Inquiring Minds and Agricultural Education

by Kasee L. Smith

Humans are naturally curious. When we observe the world around us, we are evolutionarily programmed to pose questions in our minds and seek out potential solutions. You likely employ curiosity on a regular basis as an educator. For example, if a typically outgoing student comes into class quietly and puts their head down when they get to their desk, you probably wonder what the root cause could be. In a lab setting, you might wonder why some of the tools are out of place, and seek out the student or students who were responsible for cleanup to find an answer. When a CDE team doesn't place as well as you expected, you are probably curious then also, and chances are, you seek out a potential explanation. Curiosity is the core concept behind inquiry-based learning.

Inquiry-based learning is a common term in modern education. In my time as an educator, I have heard the term from high school teachers and administrators, from state staff, colleagues in teacher education, industry professionals, and even legislators who are working to create policies which will affect everyone else on the list. The problem is, while the term *inquiry-based learning* is often used, it is not often understood. Ask an educator to describe inquiry-based learning, and they will likely talk about students examining a subject, utilizing case studies, or forming hypotheses, but a clear definition can be elusive. As we begin this issue of the Agricultural Education Magazine, let us begin with an inquiry into

just what inquiry-based learning looks like in an agricultural classroom. The remaining articles in this edition are designed to help you implement inquiry-based strategies in your classroom, you'll hear where to start in both traditional and lab-based settings and what industry needs from students as they enter the workforce. It is my sincere desire that this issue helps you in your efforts to create more *Inquiring Minds in Agricultural Education*.

Defining Inquiry-Based Learning

According to the National Council for Science Education (2000), education is inquiry-based if students are following the same process as scientists in their examination of the topic. The process includes the following:

- Make observations
- Exhibit curiosity and define questions from existing knowledge
- Propose a preliminary explanation
- Plan and conduct a scientific examination
- Draw conclusions from evidence collected
- Consider alternate explanations
- Communicate conclusions

From this definition, it seems as though inquiry-based learning would be limited only to teaching through the scientific method, but like most things in education, there is much more to the implementation of inquiry-based learning than a simple science

experiment. In fact, the thought that inquiry-based learning is a single science experiment is likely the cause for most of the confusion surrounding this instructional method. So, how can we define inquiry-based learning in a way that is both consistent and clear? We have to break the term down into the core concepts. First, inquiry-based learning allows students to examine a topic without providing explicit direct instruction. Second, all inquiry-based lessons deal with posing and answering questions. When we combine the two fundamental parts of inquiry-based learning, we arrive at the following definition: *inquiry-based learning is a collection of student-centered instructional methods, which prioritize ideas, questions, and analysis of a topic.*

The Phases of Inquiry-Based Learning

How do humans form an inquiry? We know that the beginning of the inquiry process is a curiosity surrounding an observation, but where does the mind go from there? There are many researchers who have spent decades examining how students and educators employ the process of inquiry to learn. According to Pedaste (2015), there are four phases of inquiry: orientation, conceptualization, investigation, and conclusions.

In the **orientation** phase, students become aware of the key concept or idea. They may become aware through an immersive experience to stimulate their natural curiosity, the teacher may pose a question or provide a case

An Entry to Inquiry-Based Learning

Now that we have discussed what inquiry-based learning is, how it works, and how you engage at different levels as an agricultural educator, we can move on to the more pressing question: how can you enhance inquiry in your classroom? If you aren't used to consciously implementing inquiry-

“You can implement components of inquiry-based learning with just a few modifications to your current curriculum.”

based learning in your classes, the learning curve might seem pretty steep. Here's the good news, you can implement components of inquiry-based learning with just a few modifications to your current curriculum. To increase the amount of inquiry-based learning in your class, consider utilizing the following concepts:

Ask why. The best way to stimulate curiosity in your students is to get them thinking about potential explanations for the way the world works. Ask your students to consider “why” for one concept per day in your class. For example, why does a ruminant need all four compartments in their stomach? Why does a 6013 electrode need different amperage than a 7018?

Stimulate questions. Prompt discussion about questions in your classes, and more importantly, allow the students to develop the questions that are asked in the room. Have students write questions based on a topic, scenario, or even the regular class content.

Start at the beginning. An open/true inquiry lesson might be too much as an introduction to inquiry-based learning. Don't be afraid to use confirmation or teacher-guided inquiry as you begin to help students understand what inquiry might look like in your class.

Whether you are new to inquiry-based learning or a seasoned pro, utilizing this concept in your classes increases the cognitive level of instruction, helps students apply knowledge in other

settings, and can be a great way for students to start inquiring into other topics. The world needs more curiosity, and you have the ability to shape your class in a way that will guide the next generation of inquiring minds to solve the grand challenges of agriculture, society, and the future.



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Ready, Set, Inquire! The Practical Guide for Teachers

by Joanne Pfeiffer

So you've seen some cool inquiry lessons, you like the idea of incorporating inquiry into your classroom, but just how do you go about getting started?

Pick a subject you know well

Often the subjects that we know the most about are the ones we are most passionate about. As you start on this journey to change how you are teaching your students, select a topic that you are already familiar with and hopefully a lesson you are currently using. It will help you with thinking of different ways to make this happen. As you develop and implement more lessons, then you can tackle subjects that you might not be as familiar with.

Keep in mind that not all inquiry lessons look like a science lab set up, just like not all science labs will meet the definition of inquiry. Inquiry could be a card sort, an agriscience fair project, a well crafted question that students dig into and discuss, or a shop project of students creating the best designed welding tables or log splitter.

Find your inquiry chart

Inquiry is more than a fun, hands-on activity. It involves questions, evidence, explanations, making connections and communication skills. If you overlook these essential features of inquiry you have shortchanged your students as they will not walk away from the lesson with all of the skills that the activity could have helped develop. This inquiry chart will help keep you focused on the important things that must

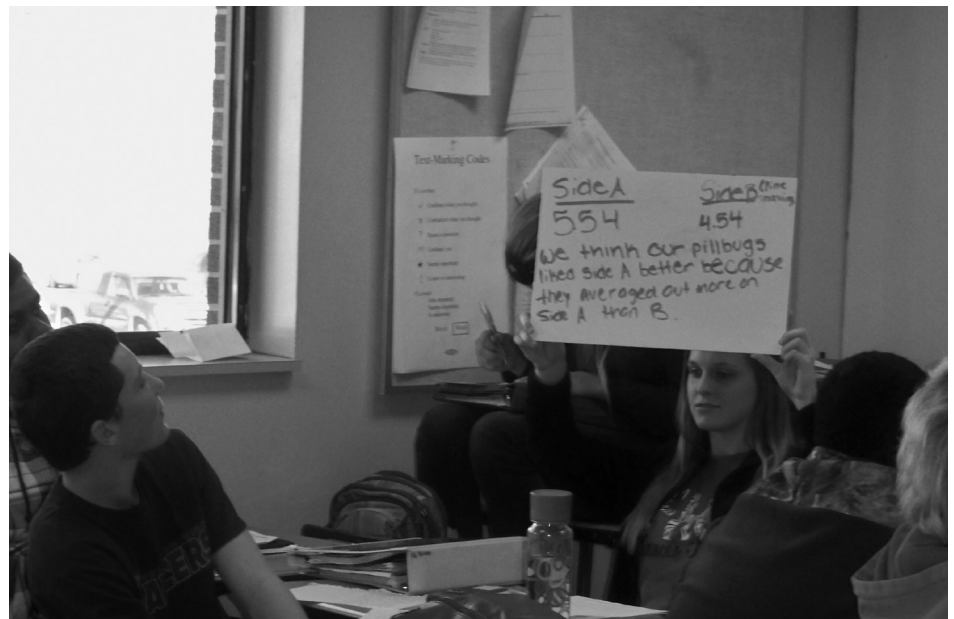
happen during an inquiry lesson.

Define your question

Now that you have your subject matter selected and your chart at hand, start by formulating what types of questions you want students to grapple with. It may be an incredibly open-ended structure like an agriscience fair project where students decide to determine if milk can increase plant growth. You may have more of a "cookbook" lab where you give students the question "What types of seasonings can be added to ground beef to produce the best tasting burger?" It's always great when the students create their own question, but we all recognize that is not always possible due to time constraints, materials needed and topics we have to teach!

We all love teaching so much that sometimes we just want to smother our students with information – information that is either

unnecessary at the time or will be more valuable later in the lesson. For example, if students are going to be challenged with designing the best packaging to ship a single peanut butter and jelly sandwich in, telling students about marketing information that is on some packages and how air is used to fill plastic wrap to prevent crushing may dim the excitement to get started or it just has no relevance to what the first part of this activity will include. Why couldn't you craft some questions at the end of the activity about what other things packaging does; besides protect the product? Or why does it seem like potato chip bags are never really full? Students need to be the workers; you need to be the coach. Your work was in the creation of the lesson and the monitoring that everyone is working, their job is in searching and thinking about how to create a package that meets the criteria that you have set up.



Communicating results allows students to reflect on if they have solid data and allows them to reflect about where mistakes may have been made.

Do not give in to the temptation of giving them the answers

Students are really good about asking for help and waiting the teacher out. They have been taught that if they wait long enough, someone will give them the answer. This is one of the hardest habits to break. Part of the beauty of inquiry is that students search for information independently. Our help needs to be in the form of questions, to help those students who need modification or those who are truly stuck and need to think about it from another angle.

Another way you can help students with the organization of an inquiry lab is by requiring them to document the process. They need to record the question that they are researching, a prediction or hypothesis of what will happen, the materials they will be using, the steps they will be following, the creation of a data table to write what data they gather and a place for them to record their conclusion. They may do this on a piece of paper in their notebooks, on a poster to display later, or on a worksheet you have provided. Chunking this out into small pieces will help them not feel overwhelmed. It will help you monitor that each student is on the right path. And it will provide them with notes in their own language that will help them understand what is going on.

Where's the evidence?

Our hamburger seasoning lab is one of students' favorites, but without making them brainstorm what types of data you would collect and what that looks like, this part of the inquiry would be easy to overlook and we would miss out on a discussion about how our taste test panels need to have a



Building directions (and holding students accountable for following them) into the activity forces students along the path of learning. If there were no procedures for following the dichotomous key activity, students would tear the flower apart and then look for the answers at the end of the key, defeating everything you set out to do. Finding the right answers is not the goal of inquiry. It's in the discovery of knowledge, making connections to the real world and communicating with others.

pal walks into your classroom to watch a cool, engaging lesson unfold. But I think the most important part of the lesson is if the students can come up with the explanation portion (the why did this happen) because of the data they have collected (fewer radishes were harvested in the pots that had the highest plant population due to over-crowding and competition for light, nutrients and water.) Students have to be directed back to their data to use it to justify what they think happened. You need to be on hand to help prod and poke the students along who are struggling. Sometimes I sound like I have a one word vocabulary - "Why?"- as I continuously push students to explain their thinking. I have found students are great at taking notes, they do well with studying for tests, but

your lesson. Many of our average students who are very involved in hands on hobbies and work are the ones who have enough knowledge of how things work to make the connections between the classroom and the real world. This is amazing to watch unfold. I think we (as agriculture teachers) have always prided ourselves in the fact that the things we teach have a real world application. Our inquiry lessons should be no different.

Communicating

The activity is finished; your classroom is cleaned up, what's next? Students need to be able to communicate what they have learned whether it is a "turn to your partner and talk," a gallery walk of student created posters, or a group summary shared out to the class of what they discov-

ered- either verbally or on a small whiteboard. Do not end your lesson with students answering some questions and being on an island by themselves. Scientists and researchers work together at communicating their results and discoveries and so should our students. It is so much more powerful for students to discover they are right or wrong on their own by comparing their data to the class data than it is for the teacher to grade their data table. As soon as students realize their data is way off of the class average, they start searching for the reason of why their data looks different. And isn't that what we need them to be able to do? Problem solve on their own? Anything we can do to hoan our students' communication

skills, we need to be doing because communication skills are the most cross-curricular overarching career skill we can help provide them with.

So now what?

Take a lesson that you currently teach and use the chart to turn it into an inquiry lesson. Think about the "so what?" part of the lesson that you want your students to walk away with having learnt. If what you are doing doesn't help students learn the concept that you are focusing on or doesn't help them develop deeper meaning to your objectives, you need to step back and tune your activity a little more. After you are done teaching your lesson, spend 5 minutes reflecting and making some written

comments on how the lesson went, what needs changed and how it can be improved. If you can do it while it is fresh in your mind, your lesson will be ready to go next time.

Creating good solid inquiry lessons is challenging and will test your creativity and organization. However, it also will stretch your students, engage them in challenging topics and create true meaning of what is going on in the lesson. I think it's easy to see that the benefits outweigh the work required to pull off an inquiry lesson. And the more inquiry you use, the better you will get.



Students may need coached in what is important to write down. Some activities may only have color changes that occur, some have number of drops that you count, some shop activities are simple answers, like "did the engine start?"



Joanne Pfeiffer is an agricultural educator at Federal Hocking High School in Ohio.

Inquiry-Based Learning: How Do I Start?

by Kalynn Baldock

Many conversations I have with other agriculture instructors about inquiry-based learning lead to the question: “how do I start?” Often, inquiry-based learning is underutilized in the classroom because instructors are intimidated by how to implement such lessons.

What is Inquiry:

The first step in implementing inquiry-based lessons is often just having a discussion with students about the style of inquiry-based learning and the expectations of this type of lessons. Often when students learn they will be able to make some of their own decisions with inquiry-based learning, they get excited. Unfortunately, excitement is not enough to create a successful inquiry-learning environment. Students and instructors need to understand the basic components of inquiry-based lessons and the reasoning behind why this type of lesson is beneficial. By knowing that inquiry-based learning will consist of engaging in scientifically oriented questions, giving priority to evidence, formulating explanations based on evidence, connecting the information to prior knowledge, and communicating the justification of their explanations, students will better understand the process.

Model Inquiry:

When beginning inquiry-based lessons in an agricultural classroom, it is not necessary to immediately have students participate in self-directed inquiry lessons. Self-directed inquiry, or free inquiry, are lessons where

students choose everything about the topic. Introducing students to inquiry-based learning with this approach might lead to major headaches and confusion for both students and teachers. Actually, in many agricultural classrooms inquiry-based lessons are already being utilized. They are just highly structured and not defined as inquiry-based lessons. With structured inquiry lessons, the entire class works together to answer a question using the same procedures. According to the National Research Council (2000) “Essential Features of Classroom Inquiry and Their Variations,” working as a class to answer a common question is still an inquiry-based lesson, just more teacher-driven rather than student-driven.

Slow but Steady:

Once students have been introduced to inquiry-based learning and have had the opportunity to work through some teacher-driven, inquiry-based lessons, it is time to start moving the inquiry towards a more student-driven lesson. This does not have to happen all at once. By utilizing the chart “Essential Features of Classroom Inquiry and Their Variations” from the National Research Council (2000), instructors easily can begin to take structured lessons already in place and move just one component towards student-driven lessons. This could mean simply changing a lesson in which the teacher instructs the student exactly how to present their data, to allowing students to decide the most appropriate method to present their data. Taking it one step at a time gradually allows stu-

dents to begin to understand the process and what they need to be looking for once they start completing student-driven inquiry.

Be Prepared to be Patient:

It is inevitable for students to think student-driven inquiry is too hard. Students have grown used to classes where they are given all of the information and told exactly what the expectations are for every assignment. It takes time for students to become comfortable with the ability to complete an assignment as they see fit and not as they are told. While students are adapting to being responsible for their own learning, teachers can implement some strategies to ease them into the process. Question cards used to limit the number of questions students may ask during a lesson is one tool I have found to be very useful. At the beginning of the lesson, I hand out question cards to each student; every time they ask a question they have to turn in a card. Knowing they have a limited number of questions encourages students to think through the process prior to asking the question, often discovering they knew all along how to proceed. As students get more comfortable with inquiry, begin to lower the number of question cards, until they are at one or possibly none.

Ask Questions:

Many teachers worry that once their students are utilizing student-driven inquiry the concepts the lesson is supposed to teach may be lost. This is where the instructor can guide students through the use of questions. Often, throughout an inquiry lesson I will



wander around the classroom asking thought-provoking questions, which in turn helps lead students in the right direction to make them come to conclusions on their own.

Allow Failure:

With inquiry-based learning sometimes students learn more by having a failed experiment. When an experiment or inquiry does not turn out as planned, students can then further investigate to determine where things went wrong.

Have Fun:

The most important step with using inquiry-based learning in the agricultural classroom is to remember to have fun with it. Inquiry is supposed to allow students to be creative, while learning about things that interest them. If you make inquiry fun, students

will become excited to participate in the next inquiry lesson.

Regardless if you are a first year teacher or veteran teacher it is not too late to start inquiry-based learning in your classroom. Giving your students the opportunity to take ownership of their learning through inquiry-based learning will assist them in becoming productive members of society who are able to solve problems and find answers.

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Using Inquiry-Based Instruction to Enhance the Local Agricultural Education Program

by William Doss and Dr. John Rayfield

Today teachers use a variety of instructional teaching methods in agricultural education. For new teachers entering the field, the most frequently used instructional techniques include cooperative learning, demonstration, and lecture (Voges & Rayfield, 2018). However, an underutilized teaching method with great potential is inquiry-based instruction. The definition of inquiry-based instruction varies from source to source, but most explanations of the process involve causing students to scientifically inquire to solve a problem of interest (Anderson, 2002). The scientific content of agricultural education courses lends itself well to using this teaching method and is viewed as an effective instructional technique, however it is one of the least frequently used methods among agriculture educators (Smith, Rayfield, & McKim, 2015).

Inquiry-based learning has several benefits for students including having higher content knowledge achievement and higher scientific reasoning skills (Thoron & Myers, 2011, Thoron & Myers, 2012). According to Thoron and Burleson (2014), students had favorable views of inquiry-based instruction and even preferred this learning technique. With the positive benefits and favorable student attitudes toward inquiry-based instruction, maybe this teaching method should be employed more often.

The structure of the agricultural education program is ripe

for inquiry-based learning. Students can easily have the opportunity to use inquiry learning in all three sectors of agricultural education: classroom/laboratory instruction, FFA, and supervised agricultural experiences (SAE). With an early introduction to using the scientific method in students' agricultural education careers, inquiry-based learning can more easily be utilized by all students as they progress through the program. Students can be taught the following steps of the scientific method in an introductory agricultural education course:

- Through observation, determine a problem to be solved or question to be answered.
- Gain more knowledge on the subject of interest through a review of literature.
- Form a hypothesis or set research objectives.
- Design an experiment to test the hypothesis or address the research objectives.
- Collect data and analyze to record results of the experiment.
- Draw conclusions from experiment results.
- Communicate new knowledge gained from the experiment with others.

A simple lesson with a hands-on activity allowing the students to use the steps of the scientific method can help increase understanding of the process and highlight practical application within agricultural education.

Requiring students to complete an **inquiry-based project** several times a year would in-

crease the use of inquiry-based learning in the agricultural education classroom and laboratory. Complexity of the project does not have to be high, especially in the lower level classes, to give students practice using the scientific method. These projects could be completed individually or in groups. The use of inquiry-based learning can give students the freedom to explore a problem they are interested in and create buy-in. Taking advantage of genuine curiosity will create student interest in the course content and can help increase their participation in other areas of agricultural education.

A good way to involve the whole class in inquiry-based learning is by having an **agri-science fair competition** between all students in a class. The class agri-science competition can be course subject specific, while at the same time giving students freedom to pick a topic of interest. Students can use existing school facilities such as the greenhouse, agricultural mechanics laboratory, or school livestock facilities to conduct the experiment. Upon completion of the experiment, a written report and a visual display such as a tri-fold or poster should be developed by the students to showcase their results. The instructor can then assess student performance using the scientific method with a letter grade or even judge the competition. A good way to increase program visibility to the community is to have outside stakeholders or even school administrators serve as judges.

This type of activity lends itself well to the more advanced agricultural science courses, especially if higher complexity is expected.

The National FFA Organization also provides several opportunities for students to showcase inquiry-based learning. The **FFA Agriscience Fair** competition gives students a competitive environment to exhibit their skills in scientific inquiry and knowledge gained through experimentation. With the use of in-class agriscience fair competitions, the instructor can easily encourage the top students to participate in the FFA competition with the bulk of the work already complete, again increasing student involvement.

Research SAEs have historically had the lowest participation of all SAE categories. Teaching students with inquiry-based instruction can help increase student research SAE participation because they will be able to see the practical application. Another way of looking at requiring students to conduct inquiry-based projects is through the lens of SAE. Students could easily conduct the project outside of class, under instructor supervision and consider it to be their SAE. This helps increase student SAE participation within your chapter as well as provides complimentary content practice related to classroom and laboratory instruction.

Other opportunities from the National FFA Organization showcasing inquiry-based learning are through the research **proficiency awards** and **Star in Agriscience** award for outstanding research SAEs. Encouraging students to keep records on agriscience research projects conducted outside of class, as suggested earlier, can

help students become eligible for these FFA awards, which also helps improve your program image.

Using inquiry-based instruction is a worthwhile endeavor for agricultural education instructors. It can help increase student involvement in the classroom, SAEs, and FFA participation. For agricultural education to remain relevant in the eyes of many, it must contribute to STEM education and career and technical education (CTE). Inquiry-based learning is used frequently in STEM education and could easily be learned in agricultural science courses in addition to the required science courses.

There are limitations to inquiry-based instruction. It is a more difficult teaching method due to planning, resources, and the time which must be devoted to experimentation. If our teacher education programs will continue to focus on this method as a viable means of instruction in secondary agricultural education courses, students, teachers, and stakeholders will reap the benefits of this underutilized teaching method.

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Implementing Inquiry-Based Learning in the Classroom

by Valerie Bayes

Children are naturally curious, and that curiosity doesn't dissipate with age. It just gets buried – to be found again later when something piques their interest. In an employment setting, agricultural companies, like Bayer, are looking for students with the ability to use their curiosity to make critical workplace decisions. As educators, you can help facilitate that curiosity through lesson plans and activities.

One successful approach to engaging students is to use inquiry-based learning and step away from direct instruction in the classroom. These lessons frame real-world problems in such a way that students can clearly see the value in solving them. Additionally, inquiry-based lessons give students a purpose for the problem-solving skills they've gained throughout their education, allowing them to have complete ownership of their solutions. This provides students a different kind of reward upon successful completion than the traditional grading scale.

To assist educators as well as connect youth with agriculture, Bayer took a large challenge facing the industry and created an inquiry-based lesson around it.

You can find the Food Solutions Challenge on the Education & Outreach page of the Bayer website. <https://monsanto.com/company/outreach/education-outreach/>

The Food Solutions Challenge revolves around food loss and its effect on the environment, specifically focusing on food production and supply chain. The lesson plan has three primary goals:

Raise awareness and support students to think more deeply about compelling issues that shape society and agriculture (e.g. climate change, food security, the economic viability of food production, and feeding a growing planet).

Prepare students with a broader understanding of the issues, an understanding of the complexity of the many factors and inputs that affect these subjects, and the ability to draw their own conclusions.

Identify how our food systems contribute to carbon emissions and how inventions can mitigate agriculture's effect on the environment.

Essentially, the challenge asks students, "How might we move toward a more carbon neutral or carbon positive food supply chain?"

While many of your students might not be directly involved with food production and supply chain, it is a topic that affects everyone. We only have this one planet which is tasked with feeding a quickly growing population. Scientists foresee our world needing to sustain 10 billion people by 2050. Even today, we struggle to feed, clothe, and fuel the world's population while using resources, both natural and synthetic, in the most efficient and sustainable way.

To help students understand the importance of this problem, or any for that matter, it is vital to provide them with a base of information from which they can begin to explore possible solutions. This does not have to be an overwhelming onslaught of data.

For example, in presenting students with the Food Solutions Challenge, spending a mere 35 minutes presenting the facts of food loss, food production, and supply chain's effects on the environment will go a long way in guiding students toward solutions. The lesson plan will walk you through a structure for sharing all the information compiled in this presentation. Your students will then need to conceptualize and ideate a plan of action.

Discussing topics such as impacts of food loss, the difference between food loss and waste, greenhouse gas emissions, and natural resource use in food production and supply chain will set the stage for the importance of solving the problem. Explaining the causes of food loss will give students an understanding of how and why the problem exists.

While you will give students the information you think they need, don't be afraid to empower them to search out information on their own. Remind them what you have provided is not necessarily all the information available, but that additional research may be required to solve the problem.

Finally, provide your students a specific problem related to the topic you've presented to them, something currently hap-

pening in the real-world. This will help them relate to all the information you've just given, as well as spark their creativity.

In terms of the Food Solutions Challenge, we've provided case studies regarding cassava production and storage problems resulting in food loss, asking students, "How might we reduce food loss before it reaches the consumer in order to increase the amount of available food and lessen the impact on the climate?" While your students might not have a connection with cassava or even food storage prior to hitting the grocery shelves, they understand the importance of putting milk in the refrigerator to keep it from spoiling.

Though not necessary for an inquiry-based lesson plan, it is always beneficial to expose your students to different challenges of the world than those they live and breathe daily. As long as you can help them relate to the topic at hand, which will be supported by your emphasis on the overall problem – in this case food loss and insecurity, they'll learn something new about another region while gaining a better understanding of how they can make a difference in their own environments.

Before setting your students free to explore potential solutions, introduce them to this new type of project with non-traditional requirements and grading system. Inquiry-based lessons are not traditional class assignment and should not be presented or graded as such.

For the Food Solutions Challenge, we ask for a business model canvas. Similar to what many of your students will eventually need to create in their careers later in life, this business canvas requires

students to fully think through their projects. Starting with an executive summary to briefly explain their solution, students will also need to provide their anticipated outcomes, short-term and medium-term goals, and additional information on the type of solution they are proposing.

Remember to keep an open mind when grading these proposals. If a plan hits a road bump, encourage your students to find a work-around, exploring each piece of their plan for areas that could be improved or tweaked to find the desired solution. Just like with life, there isn't a singular solution to any problem. Instead of searching for an exact answer, focus on how the students arrived at their solution and what questions they might not have considered along the way.

Lastly, don't be afraid to teach outside the box. While this article focuses on a single lesson plan, a certain curriculum and a ton of resources aren't required to provide students with an inquiry-based lesson. All you really need is a problem worth solving, maybe some markers and a flip chart, and your own curiosity for finding solutions. Often, you'll be able to find others in the community passionate about real-world problems who can be used as subject matter experts for your lesson. Your students will feed off your passions and often provide innovative solutions you might not have expected.

In summary, a successful inquiry-based lesson plan can be implemented by:

Piquing their interest with a problem that matters to them – even if they don't know it yet.

Providing a solid base

of background information—they're looking for a solution, not doing a research project.

Presenting a specific real-world problem to spark their creativity and get the ball rolling.

Throwing out the traditional project requirements and grading rubric—there are no wrong answers.

Experimenting, looking outside of the classroom, and continuing to engage your own curiosity to inspire your students to do the same.



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Inquiry-Based Learning (IBL) in the Agricultural Mechanics Laboratory: A Look at Using IBL in Electrical Circuit Wiring Exercises

by Trent Wells

Background

Agricultural education teachers use a variety of instructional approaches to engage students in the different learning experiences offered through their programs (Phipps, Osborne, Dyer, & Ball, 2008). These instructional approaches are typically intended to be used to effectively convey information, allow for skill and knowledge development, develop students' abilities to think critically, grant opportunities for the application of relevant information that addresses practical issues, and maintain students' interests in the topic being studied (Phipps et al., 2008). As one of numerous instructional strategies used by agricultural education teachers, inquiry-based learning (IBL) can be beneficial for student learning, particularly when addressing scientific or technical content (Skelton, Blackburn, Stair, Levy, & Dormody, 2018). Moreover, using IBL as an instructional approach can result in greater student content knowledge understanding versus using a subject matter approach (Thoron & Myers, 2011). Even more interesting, students have tended to respond positively to using IBL in agricultural education coursework (Thoron & Burleson, 2014). IBL has historically been operationalized by agricultural education teachers as problem-based learning (PBL) (Parr & Edwards, 2004).

When considering the entire agricultural education program, laboratories are an important component that can serve as excellent

venues for teaching and learning (Wells, Smalley, & Rank, 2018). Laboratory facilities allow for hands-on applications of content and include several types, including school farms, greenhouses, and agricultural mechanics (Shoulders & Myers, 2012). Moreover, laboratories have long occupied a prominent role in helping students to better connect theoretical content to practical settings, thereby helping to invigorate and reinforce learning and application (Twenter & Edwards, 2017). As a content area, agricultural mechanics can be a pragmatic context for academic content (e.g., scientific reasoning facilitated by IBL-focused instructional practices, etc.) (Parr, Edwards, & Leising, 2006). It was my experience, during my early years as an agricultural education teacher, that using my agricultural mechanics content and laboratory was a useful and interesting method to engage students with IBL-oriented teaching practices. In the scope of this article, I will focus on my experience teaching electrical wiring within the confines of my

agricultural mechanics laboratory.

My Experiences Integrating IBL into Electricity Content

As a former agricultural education teacher, I always enjoyed teaching agricultural mechanics content. My students enjoyed it as well, and we spent much of each academic year engaging in numerous lessons and projects that included content such as electricity, welding, woodworking, small gas engines, concrete, plumbing, and more. The hands-on skill application appeared to engage students and build excitement for participating in the learning experience; in my Intermediate Agriscience course, I recall that students





were quite eager to practice their electrical wiring skills and heartily competed with their peers to determine who was the quickest, yet most accurate, at performing the task at hand. However, during each lesson my mind inevitably wandered into the realm of questioning my instructional approach. I always wondered if my students would be able to think through future problems and successfully apply what I was teaching them. In other words, I was questioning if I was really making an impact on my students' transferability of content knowledge over the long term. When considering this, I began to hypothesize that perhaps I needed to consider a different approach to how I was implementing the different projects and tasks that my students were completing during the different lessons (e.g., tearing down and re-building small gas engines, wiring electrical circuits, etc.). Thus, I began to turn toward a more IBL-focused approach that emphasized experimentation, questioning, and based

on my experiences, a greater depth of understanding and future application of the content knowledge and skills. In retrospect, the process was quite straightforward and natural and much of this transformation occurred as I transitioned from my first year to my second year in the classroom.

During my electricity unit, I covered many of the topics that I had seen in other teachers' curricula (safety, tool identification and use, basic electrical theory, circuit wiring, etc.). After discussing electrical theory and safety and proceeding to tool identification and use, my students were placed into groups of three and we began various exercises in circuit wiring, which included duplex outlets, single-pole switches, three-way switches, and wiring up service entrance panels (SEPs). I gave my students wiring diagram notebooks that depicted each wiring diagram individually along with a simple grading rubric. These diagrams were taken from the Iowa FFA Association website's Agri-

cultural Mechanics Career Development Event (CDE) page. While working through each diagram, I engaged my students in an informal IBL instructional approach by allowing them to work through each circuit wiring exercise as small independent groups with very little interference from me. Each group's circuit was live-tested with lightbulb(s) and/or an outlet tester when students felt they were ready to do so. As they encountered different issues related to their electrical circuits during the live-testing phase, the students were mandated to consult the wiring diagrams, hypothesize what the issue(s) could be, and discuss the possible causes and outcomes of their troubleshooting ideas and actions within their small groups. Additionally, experimentation with different wiring techniques and configurations to address the issue(s) was one of my expectations, which were announced verbally before each circuit wiring lab took place. As a final method for solving the problem(s) with their electrical circuit, the students were permitted to consult with me on their circuit's issue(s) in exchange for a minor points deduction (2%) on that particular wiring exercise (I called it my "finder's fee"). For every three circuit wiring exercises completed, I had the students go through a blind circuit wiring test, within which each small group got the opportunity to study a wiring diagram for 10 seconds and then wire the circuit from memory and through troubleshooting. A successful test on the first attempt resulted in the awarding of full credit, while each subsequent test resulted in a reduction of 10% of the total available points (e.g., one re-test resulted in a grade of 90%, two re-tests



resulted in a grade of 80%, etc.).

My intent with this approach was to allow for my students to be creative in their approach to both questioning and problem-solving through the hands-on, minds-on context of electrical circuit wiring. Moreover, I sought for them to be able to practice developing knowledge and skills related to critical thinking and electrical wiring that would be transferable beyond my agricultural education program. After completing numerous circuit wiring exercises over the course of 20 days, I felt confident that I had been successful in helping my students to grow intellectually and to better develop their abilities to work with their peers to thoroughly analyze a situation and think through issues before attempting

to fix them. Interestingly, I had several students report that they enjoyed the fact that I was hands-off and let them work independently to try to solve both simple and complex problems. A couple of juniors said they felt like they were being treated as young adults who were capable of thinking for themselves while doing something they enjoyed; these two students also

said working with electricity was their favorite part of the Intermediate Agriscience course and they thought about studying electrical technology at the local community college as a result. As their agricultural education teacher, hearing that made me feel that taking some degree of risk and trying a different approach to teaching traditional agricultural mechanics content paid off well. Learning to effectively integrate an instructional approach that makes a teacher give up some control of the teaching and learning process and hand it to the students (i.e., using IBL in an agricultural mechanics laboratory) can be a strange feeling, but it is worth it in the end. After all, our purpose is to help facilitate the teaching and

learning process, and what better way to do so than to use a meaningful subject matter and context to help that process along. I imagine that many agricultural education teachers follow an approach similar to the one I described, so while I expect that it may be nothing new or earth-shattering I hope that sharing my experiences with the profession will facilitate some ideation for those who have a daily hand in positively shaping and impacting students' lives.

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How Real is Real Enough? Projects, Problems, and Inquiry

by Jason McKibben

The first of three tardy bells rings. A few moments later, hoodies with ear bud cords and hair shuffle through the ag mech shop into my classroom. Somehow in the next 15 minutes I am going to have to move, cajole, horse trade, or shoehorn those groggy students from reality of a fifteen year-old at 7:25 AM to an eager learner. There aren't enough dogs or ponies in PT Barnum's big top to get that done. Looking at the board, students notice my posted objective "AFNR 130.2 Students will be able to define the basic principles of electricity." The voice they find says with no hesitation that they are in ag class, not IPC (integrated physics and chemistry). In short, they do not believe science has a place here. Without skipping a visible beat or letting them know that today's lesson is going to push me beyond my normal here-is-the-most-practical-way-you-could-ever-do-this-activity teaching style, I launch into my plan. What they don't know is that I am absolutely terrified that I am embracing the "touchy feely" side of teaching. They don't know that I have literally lost sleep thinking about whether or not I should push things outside of the very practical.

My norm for teaching electricity in the seven years that preceded this story was to give students wires, switches, solderless connections, multi-meters, lights, and a wiring diagram for a 1949 Ford 8N. I normally included the 8N too. They had to trace wires, find bugs, and help rewire. In a sense, my entire teaching philoso-

phy boiled down to making sure my students could see how what they were learning applied to the "real-world." Somewhere around this time my wife moved from teaching elementary to 8th grade science. She began bringing home lessons and ideas from workshops that took me aback. My common comments to her new teaching approach included, "how is that practical" or "that's neat and all but it's not in any way real". She was doing things like pushing bb's down surgical tube, making mats out of straws, and using doughs that conducted electricity. It was the conductive dough that became what I needed to push me out of my practical nature and into this "weird" world of the abstract and unusual. She laughed at me (like usual) and said that I should come down and watch her kids (my kids next year) learn in her classroom.

Let's set some things straight about inquiry. Inquiry is part of what I call the continuum of *BL, alongside things like problem-based and project-based learning. They are all part of a long line starting on the left with project-based learning and ending in inquiry-based learning on the right. They have a few things in common. The biggest thing is that the put the student in control of the learning. These methods let the student "discover" the answers rather than have them told to them. They are part of the larger group of learning modes known as experiential learning and as such, they rightfully require students to have some reflective

time to process what happened.

To differentiate between the three major portions of the *BL world it is best to look at the driving forces behind the methods. The far left of the continuum is project-based learning (PBL). In project-based learning the project is the driver of the students' experience. The student production of a "thing" is paramount. That "thing" could be something tangible, like a building a feeder in ag mechanics or something less tangible like a food web in a wildlife class. The key is that students are having to create something. According to most of the models a project in project-based learning needs to have a challenging question, be able to sustain interest, give the student a voice or choice, be a publicly viewable product, involve critique and revision, have an opportunity to reflect, and be an authentic project.

Sliding towards the right on the *BL continuum is problem-based learning (PBL). The key element to problem-based learning is solving a guiding problem. That problem is given to the students and they must find the appropriate solution. That solution can come in almost any form or mode. The problem should motivate students to dive deep into the content, make students make and defend solutions, and provide time to reflect on the process.

Moving farther to the left of problem based learning is inquiry-based learning (IBL). In inquiry-based, like problem-based, there

is a guiding question. However, the question leads to the discovery of overarching problems. So the answer to the problem is not the paramount outcome for students, it's the discovery. Students must identify the solutions to those problems to ultimately answer the initial question. There are steps to inquiry; immersion, research questions, predictions, experimental design, observations, analysis, conclusions and explanations. Inquiry very much feels and should feel like the scientific process.

| Type of Learning | Outcomes |
|------------------------|--|
| Project Based Learning | Public Project |
| Problem Based Learning | Answer to the problem |
| Inquiry Based Learning | Solutions, those could be answers or further questions |

One of the more common methods of the three we have discussed in ag teaching, is the project-based learning method. This goes back to the 1930s as a hands on portion of school where “boys” could learn the skills needed to run a farm. Project-based learning in agricultural education is most often understood to begin with the Stimson Home Project Method (Moore, 1988). Stimson’s method is predominately concerned with application projects taking place outside of the traditional day of learning, at home (Roberts & Harlin, 2007; Stimson, 1915, 1919). We would most likely recognize this type of project based learning as Supervised Agricultural Experience or SAE. However, we don’t often think about how this method is being used in the classroom.

In all *BL type lessons, in the classroom, the problem/scenario or question is the driving or organizing concept behind the lesson.

According to the developers of the gold standard model, the problem/question is the reason students have to learn the information (Larmer & Mergendoller, 2015). A driving or focusing problem/question should be a challenging yet non-intimidating question that helps to point the student in the direction that they are going to be expected to go (Larmer & Mergendoller, 2015). The requirements I laid out for projects earlier in the article include seven basic criteria; a challenging question, sustaining interest, a student a voice or choice, a publicly viewable product, involve critique and revision, have an opportunity to reflect, and be an authentic project.

Sustained Inquiry: When engaged in this version of project-based learning students are expected to identify their points of confusion and feel compelled to find the answer to that new question. This freedom to use the inquiry model to sense the problem, formulate the problem, search for the answer, and resolve the problem encourages students to achieve a deeper understanding (Shulman & Keisler, 1966; as cited in Ethridge & Rudnitsky, 2003).

Student Voice and Choice: A student’s voice in the project is the perceived or actual ability of the student to develop a sense of ownership in the project (Larmer & Mergendoller, 2015). Ownership allows the student to use their own judgment to make decisions about the questions asked, how the driving question/problem will be answered, what resources or tools will be used to answer

ancillary inquiries, the jobs or roles they will play within their team, and ultimately the product that they will create to answer the driving question or problem (Larmer & Mergendoller, 2015).

Reflection: A universally-required element housed within the overarching theme of student-centered learning, reflection is inherent in the system. Reflection should be done continuously in an informal self-directed way, and more formally as a part of journaling, formative assessments, discussions, or presentations (Larmer & Mergendoller, 2015). Reflection is thought to help the student internalize the information and create concrete connections out of abstractions (Larmer & Mergendoller, 2015). It is said that reflection helps students be able to continue to apply that information beyond the context of the project or situation (Larmer & Mergendoller, 2015).

Critique and Revision: Students are encouraged to engage in reflection to help deepen their understanding. Critique and revision is another form of reflection, albeit a more pointed and critical look at processes and understanding (Larmer & Mergendoller, 2015). Through thoughtful criticism and revision, students are able to increase their quality of work, identify the unknowns, and address erroneous assumptions (Larmer & Mergendoller, 2015). Utilizing thoughtful critique in a social setting allows students to increase authenticity of the project, and more closely creates a safe creative and inquisitive space that mimics the “real-world” point of view. This step emphasizes having evidence to back up the suppositions made by students, and highlights the im-

portance of “formative evaluation” (Larmer & Mergendoller, 2015).

Public Product: the linchpin, to what has been labeled gold level project-based learning, is the creation of a tangible product of some kind. This production can take almost any form. Public presentation of that product increases the student’s cultural pressure to perform, not wanting to be perceived as unintelligent or lacking in ability. Public displays play on cultural norms, and have been suggested to help increase the underlying understanding of the activity (Bandura, 1977). This motivation provides a “healthy motivator” through managed anxiety to the student (Larmer & Mergendoller, 2015).

Authenticity: The researchers who advocated for and developed this model said that project should have “high levels of authenticity,” and define authenticity in terms of several things. A project can be authentic if it: involves a real-world process, has actual impact on others, is based in real performance standards, uses industry appropriate tasks or tools, involves the building or creation of something that will be used or experienced by others, is deemed personally important (based on culture, personal interest, identity or issues surrounding that student’s life), or involves an authentic context (Larmer & Mergendoller, 2015). The use of this OR that makes me pause when I think of designing projects for those kids stumbling into my shop at 725 in the morning. According to the folks who built the models for how to use project-based learning best, a project can be any of the stated criteria and it is considered authentic. Which of these matters the most?

Of these qualifiers, what makes the project the most “authentic”?

One would think that as projects become “more authentic” they should make students learn more. It would be logical that if a project A had four criteria for authenticity it should do twice as good as project B with two criteria for authenticity. However, I have found that the most authentic projects and the least authentic projects often result in the same outcomes.

A research article in a 1997 issue of the *Journal of Agricultural Education* (Johnson, Wardlow, & Franklin) included one experiment that led researchers to conclude that, for the test scenario, a “traditional paper and pencil” instruction was equally effective as hands-on learning. When I read this I was thrown back. As an ag teacher I can tell you that students in my classes “learned more” when we did things with our hands. I was confused that researchers would contradict what I understood my experiences to be. So what was going on?

Since that time, I have found (and what I think Johnson et al. was seeing back in 1997) is that the results had to do with more authentic projects not necessarily leading to more learning. What we have found today is that students who participated in “mid-level” authenticity project actually learned more than those who participated in “high-level” or “low-level” authenticity projects. It is not so much about how closely the activity parallels the authentic version of the project, but more about how students can connect the concepts to their authentic application in an engaging manner.

Let me take you back to that

original story. The kids in my Texas ag mech class were about to participate in a project based learning scenario. They were given a scenario where the only outcome was to build several direct current circuits using some unusual materials. The biggest change was that rather than use wire, they used homemade doughs that could conduct electricity. This dough is the same toy that most of us played with when we were kids. One of my wife’s teaching partners found a recipe that said if you put enough salt and lemon juice into it, the dough will conduct electricity. We found another one that used sugar instead of salt and it served as a great insulator. Students were given these two doughs, a pile of LED lights, a battery pack, and access to a digital multi-meter, and told to make a couple representations of circuits based on a scenario I had written. When it was all said and done, these kids learned more about the concepts of electricity in the two or three days they “played” with dough than most of the kids I had taught to build wiring harnesses on that old 8N.

So, what was happening? The dough circuits were engaging to the students. They wanted to “play” with electricity and when they did, they had to make more connections to what was actually going on than if I had given them a spool of 18-gauge wire and some solderless connections. Before we started the assignment, if I would have asked my students about conductors, even my 8th graders could have told me that wires conducted electricity. However, if you asked them what conductors do, they would have looked at you like you had a horn growing from your ear. They “knew” wires con-

ducted electricity but didn't honestly know what that really meant. What they learned through the lesson with dough is that conductors transfer electricity in the shortest path possible. They learned that if you touch two conductors together the electricity will literally make a short(er) circuit, and that if you put an insulator between two conductors it has to be thick enough to block the electricity from overcoming the insulation. They "played" with voltage, amperage, and resistance in ways that simple wires never would have inspired them to do. They had to make more leaps of understanding from what they thought they believed to be true to what was actually true. By using these less authentic projects students had to understand what was at the core of what I was trying to teach them.

Now, why does it matter? If you are trying to teach concepts to students, like voltage, amperage, resistance, or perhaps heritability, carbon-nitrogen balance, or mixing a solution, sometimes it's ok to not be "the most authentic." If the goal is to teach a concept, we don't have to be beholden to the most practical way of doing it. We can see the concepts and the application of those concepts as two different things. They don't have to always be done together or a specific one before the other. As long as we are doing both, teaching the concept and the skills we don't have to worry if both are done in the most "authentic" or "real world" way possible. We can be freer to use projects, problems, and inquiry that make students question what they think they know and are left wanting to know more.

So how real is real enough when it comes to project/problem/

inquiry based learning? What I have found in both experience and research, it needs to be as real as your kids need it to be to have to learn something new the things they see have to challenge what they think they know and stay interested in learning it. It most importantly it must keep them pushing those hoodies back at 7:25 to find out what objective is on the board today.

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“Is Our Food Safe?” That is the Question Students are Asking

by Randy Webb

In 2017, the Carroll County Public Schools received a grant for educational enrichment. The teachers in the school system were asked to develop programs that students could engage in during a three-day educational activity-based experiential learning enrichment. These engagements were to dig deeper into content that were covered in class, but due to time constraints would be hard to experience during the normal class time. The intersession also allowed students to choose from a catalog of optional activities and workshops. These activities were advertised in half-day, full-day or three-day options where the students sign up for just as they would in selecting a class during the school year. For the second year in a row, I have offered a three-day experiential learning workshop focused on food safety.

In 2011, President Obama signed into law The Food Safety and Modernization Act (FSMA). FSMA is transforming the nation’s food safety system by shifting the focus from responding to foodborne illness to preventing it. According to the FDA, this is in direct response to dramatic changes in the global food system and in our understanding of foodborne illness and its consequences, including the realization that preventable foodborne illness is both a significant public health problem and a threat to the economic well-being of the food system.

This year’s food safety workshop once again teamed up with the community and industry to give students the opportunity to follow their food from seed to



table. The focus was to teach the students how food safety was managed each step of the way. The students were able to identify and examine concepts of the food chain which makes our food supply the safest in the world. During the three-day intersession, the students traveled to the sites where the food products were produced, packaged, transported, prepared and served. Time was also spent in the classroom to discuss background information concerning food safety. Students were given background information at the beginning of each day correlating to the places and activities they are visiting that day.

Day 1

The first day of the intersession was sponsored by the Carroll County Farm Bureau’s Young Farmers. President, Ashley L. Edwards, planned and coordinated the day’s activities. Ashley also serves as the county’s horticultural extension agent. The first stop on the tour was a visit to Light Farms. The group met with Justin Light, a recent graduate of the Agricultural Technology Program at Virginia Tech. Justin, a member of the Young Farmers is managing the family operation.

The operation is producing 70 acres of broccoli, cabbage, green beans, squash, and pumpkins. The operation also produces about 50 acres of hay and has a 60 head commercial cow/calf operation. Justin began the tour at the farms’ site of production, explaining the operations stewardship plan of protecting the land through good management practices. Justin explains that crop rotations and cover crops help prevent disease and ensure sustainability of the land. The group was also informed of the GAP certification program that applies to on-farm production and post-production processes, resulting in safe and healthy food products. The group then traveled to Justin’s packaging facility where they learned about safe handling practices and programs that producers must participate in. Justin explains that next year in order to market his products he will have to participate in the GAP Harmonization Initiative. The second stop was at Snake Creek Farms, a family owned and operated vegetable production operation. The family has a long history of farming in Carroll County. The present operation includes property that has been farmed by the family for six generations. Their focus

today is primarily vegetable production, but they have a history in dairy and beef production. The group was introduced to John C. Banks, Jr., who explained the details of their operation. The farm currently produces greens, cabbage, sweet corn, and pumpkins. He explains that they are currently farming around 900 acres of vegetables and maintains a modern packing and cooling facility. During the tour Mr. Banks showed areas of the operations post-harvest facility. He explained precautions are taken to reduce the risk of microbial contamination during production, harvesting, and post-harvest. This information supports the theme of GAP and food safety echoed at Light Farms.

The third stop on the tour was a visit to the Southwest Virginia Farmers Market. Ashley Edwards introduced Skyler Lawson, a member of the Young Farmers and Market Technician. Skyler began the tour with a brief history of the farmers market and how the role of the market had changed since its inception. He explained that today the market serves as a transportation and cooling hub for local farmers to bring their products to hydro-cool and package prior to shipping. He explains that the market serves the farmers by allowing them to use the market as a shipping point. It also provides limited services at a charge. Skyler explains some of the food safety concerns related to hydro-cooling products for all the different farms. He explains that the system there uses chlorine or ozone to disinfect the water, this can reduce the potential risk of spreading and contamination.

The concluding stops on the first day was at the Carroll County

office of Virginia Cooperative Extension. Where lunch was provided by the Carroll County Young Farmers. Following lunch Ashley Edwards presented a short program on food safety. During her presentation she explained the different food safety programs and what it means to our food supply in the United States. The topics covered included: FSMA, GAP, and preventative measures to take toward food safety. Health and Hygiene was introduced where students participated in an activity that revealed how easily germs can be spread. A student was given a lotion to spread on his hands, he then shook hands with several students in the room. Ashley then used a blacklight to show the students how easily the germ spread to the students that were touched. Ashley then told the students to wash their hands to remove the lotion, she then examined the students again to reveal that they had not done such a great job washing. This got the students attention as she asked how many washes their produce before they eat. "Have you ever just grabbed an apple and started eating, just think of all the hands that has touched that apple before you bought it". Ashley then went on to discuss how wildlife and domesticated farm animals can affect commercial crops, water quality in both pre-harvest and post-harvest, handling and sanitation, and why it is so important for farmers to have a food safety plan.

Steve Pottorff the County Ag Agent, Unit Coordinator, presented a short presentation about the extension service and the programs available to the community and to the farmers in Carroll County. The students then returned to the high school to

discuss the first day. Before they left that day, the students were asked to look at some prepared petri dishes. The dishes were used to culture bacteria, and he asked each student to touch inside the dishes. The dishes were taken up and removed from the classroom.

Day 2

The second day of the food safety intersession began with a visit to Virginia Produce Company. There the group was introduced to Kristina Banks the Food Safety Coordinator. Kristina began the tour in the conference room, where she explained her role at the company. The group was then given a tour of the facility, beginning with the waste products area. She explained about how the waste was made available to local farmers for livestock feed and that once it was considered waste it could not be used for human consumption. The students were challenged to come up with a solution to save the products based on the global need for food. The tour then moved to the production floor where workers were preparing valued added packaging for retail sales. Food safety protocols were explained to the group as they toured the processing floor. The tour continued with an explanation of the coolers and inventory controls. The tour concluded in the shipping department. The students were explained inventory control methods used to identify product origins and destinations.

The second stop on day two was at the Crossroads Institute in Galax, Virginia. The group was met by Mark Davis, owner of Squealer's Barbeque. Mark met with the group in the teaching kitchen, designed as an incuba-



tor for entrepreneurs to develop a business plan and startup new businesses in the food service industry. It was here that Mark started his business. He explained that one of the keys to success was delivering a safe wholesome meal in a timely and presentable fashion. He explains that this all starts in the kitchen where the food is prepared. Mark questioned the students if they had ever noticed a restaurant's rating posted near the entrance. He explained that these ratings say a lot about the business and the food safety. Mark explained several management practices that help ensure the safety of the food. After the presentation the students moved to the teaching kitchen where the food safety measures discussed in the presentation were considered as the students prepared a meal of salad, barbeque chicken, mashed potatoes, and cookies.

The third stop led the students to Independence, Virginia in Grayson County. For the second year Grayson Natural Farms have welcomed the food safety inter-session tour. The students were

welcomed by owners Gary Mitchell and Brantley Ivey. They told the students about building a sustainable business that provides the opportunity to offer local, natural food to the public through Grayson Natural Farms (www.graysonnatural.com). They explained that Grayson Natural Farms cattle never receive any antibiotics or hormones. Furthermore, they take pride in providing their customers with a 100% traceable product that is never irradiated or fed any animal by-products. This allows them to produce an all-natural, grass-fed beef that is lower in cholesterol and saturated fats and higher in beneficial Omega-3 fatty acids, conjugated linoleic

acids, and healthy antioxidant vitamins such as Vitamin E when compared to grain fed beef. The group was then introduced to Joe Maloskey an USDA inspector, and Chris Sayers, Director of Meat operations. Chris and Joe led the students on a tour of the production facility. On the tour students learned about food safety as it relates to meat products. Although the safe handling of meat is extremely different than that of fresh fruits and vegetables the students saw a lot of similarities. The idea that prevention was the key to food safety was a theme the students heard at each stop on the tours. At Grayson Natural the students learned about the prevention of cross-contamination between the processing room, the smoke-house, and the packaging rooms. Joe explained microbial concerns in the meat industry and how blood-borne pathogens could lead to health risk in the final products. He explained the critical control points of the operation, and how the company ensured they are delivering a safe healthy product to their customers. At the end of the tour Chris gave the students a sample of the Landcrafted Foods (www.landcraftedfood.com) beef sticks. The group also received packaged ribeye steaks for the



final day of the intersession.

Day 3

The last day of the food safety intersession began with preparing baked potatoes and corn for lunch later that day. The potatoes and corn were donated by Virginia Produce Company at the end of the tour on Day 2 of the intersession. Students washed the corn and potatoes, removed the husk from the corn and wrapped the potatoes in foil. The corn and potatoes were then taken to the culinary arts kitchen where the potatoes were baked, and the corn was boiled for lunch later that day.

Once the students had returned to the classroom, I was waiting with the petri dishes from the first day of the intersession. The students were asked to observe the dishes and explain the difference in the dishes from the first day. The dishes had been parafilm and placed in an incubator in the STEM Lab for Agriculture and left to grow for two days. The observations were apparent that from where the students had touched the

dishes bacteria had grown several colonies. The students couldn't believe that their hands and fingers carried so much bacteria. It was explained to the students in order to begin to understand food safety risks, everyone should start with an understanding of what types of microorganisms can contaminate the food supply. The biggest food safety risks are pathogens. There are three types of pathogenic microorganisms that are a concern in our food supply: bacteria, viruses, and parasites. Bacteria needs food, moisture, and the right temperature to survive and multiply. If handlers of food products can control these factors, they can limit bacterial growth. Viruses are small particles that require a host to reproduce themselves. Basic handwashing, proper restroom use, and illness reporting can help prevent the spread of viruses. Parasites are protozoa or intestinal worms that can only multiply in a host animal or human. Parasites are difficult to control because you never know when, where, or how exposure to the food supply

is introduced. Proper sanitation is the only means of ensuring that they don't enter the food chain.

At the end of the presentation, students were asked to check on the potatoes and corn. They were once again asked to prepare a meal using the food safety techniques learned during the past three days. Students were each given a ribeye steak provided by Grayson Natural Farms, to cook on the grill to a minimum internal temperature of 150 to 165 degrees F. Students then concluded their food safety experience with a meal they prepared using safe handling practices. Once again this intersession workshop proved to be an excellent opportunity for the students to learn about food safety.

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