Building Middle School SAE's & AFNR Research

Impact Project
Agriculture, Food and Natural Resources Education (AFNRE) Masters of Arts
Michigan State University

By
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Abstract

The purpose of this project is to provide middle school agriculture, food, and natural resource (AFNR) educators with a curriculum resource that assists students in developing and implementing an approved Supervised Agricultural Experience (SAE) in agriscience research. The need for this project was identified after observing middle school students struggle to develop and conduct an approved SAE program during their short enrollment period. The end result of this project is a six lesson series and student workbook that guides students in the development and implementation of an agriscience research SAE on a topic of their choosing. The curriculum includes an introduction to agriscience; introduction to SAEs and agriscience research; conducting background research; guidance through the scientific process; data analysis and drawing conclusions; and guidance in sharing research findings. This project contributes to the development of successful middle school SAE programs while building student proficiency in the Next Generation Science Standards Science and Engineering Practices.

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Chapter 1 – Introduction

Middle school agriculture, food, and natural resource courses present a very unique and practical addition to existing agriculture, food, and natural resource (AFNR) programs. Middle school AFNR programs have been shown to increase agriculture literacy among enrollees as well as the likelihood of students enrolling in secondary AFNR programs. As the number of middle school agriculture, food, and natural resource programs continue to grow, the demand for high quality curriculum and program resources aimed at middle school aged learners is also growing.

As enrollees in an approved AFNR course, middle school students gain experiences in the classroom, FFA and are subject to the requirement of having a supervised agriculture experience (SAE). Due to the varying lengths of middle school offered courses, a reduced number of students living on farms, and other factors that make resources needed for conducting an SAE program otherwise unavailable, middle school enrollees may either not have an SAE or struggle to develop a quality SAE program.

Agriscience research SAEs are an ideal fit for middle school students because they can be conducted with few or limited resources, at home or in the classroom, and students can choose a topic that best fits their interests and intended career path. Assisting students in developing agriscience research SAEs supports student knowledge and experience in SAE programs which can be applied toward a deeper development of high school SAEs. Students also build knowledge and skills in relation to the Next Generation Science Standards (NGSS) Science and Engineering Practices which are a critical framework that supports NGSS disciplinary content standards. Lastly, students participating in agriscience research SAEs build confidence and self-efficacy in career and life skills which have the ability to have long lasting effects on students.

Purpose

The purpose of this project is to provide AFNR educators with a flexible curriculum resource that will not only teach middle school students about the scientific process needed to conduct an agriscience research SAE but also about the general structure of SAEs. In response, I am creating a curriculum that focuses on the following learning objectives:

1. Define agriscience and explain why agriscience research is important to AFNR systems.
2. Describe characteristics and skills used by scientists.
3. Create a scientific question and describe its purpose.
4. Explain the purpose of an SAE.
5. Describe the differences between experimental, analytical and invention agriscience research SAEs.
6. Explain the importance of background research for an experiment.
7. Create appropriate background research questions for a research project.
8. Determine credibility of potential resources.
9. Identify testable questions and write hypotheses.
10. Determine variables and controls in an experiment.
11. Formulate specific and replicable procedures/methods.
12. Assemble a comprehensive materials list.
13. Identify best practices for journaling, data collection and reporting in record keeping systems (such as AET).
14. Summarize, represent and interpret data with one or more variables.
15. Use evidence collected during research and thorough reasoning to support or refute a hypothesis.
16. Communicate findings within community and appropriate audiences.

Objective

The objective of this project is to provide AFNR educators with a curriculum resource that assists students in developing and implementing a quality Supervised Agricultural Experience.

Definition of Terms

AFNR- Agriculture, food and natural resources.

Agriscience- Application of science to agriculture.

Middle School- School of three to five years between the elementary and high school focused on the emotional needs of students in the in-between years. For the purpose of this project, middle and junior high school students are defined as those enrolled in 6th, 7th and 8th grade (Jackson and Bosma, 1990).

Supervised Agricultural Experience (SAE)- one of three components of the total Agricultural Education program consisting of planned activities conducted outside of class time in which students develop and apply agricultural knowledge and skills and learn by doing with help from their agricultural education teachers (National FFA Organization, 2019).

Chapter 2 – Literature Review

Middle School AFNR Programs

Since 1988, when the National FFA Organization amended its constitution to allow middle school FFA membership, there has been a substantial development of Middle School AFNR Programs across the United States. In 1992 it was stated there were 1,547 schools with

middle school agricultural education programs in the United States with 58% of states offering middle school agricultural science classes with a total enrollment of 52,968 students (Rossetti et al., 1992). In 2020, it was reported that 74% of states offered middle school agricultural science classes with a total number of enrolled students being 107,856 (Jones et al., 2020). As middle school enrollments have more than doubled in the last 28 years, course structure and student engagement elements have adapted to meet the growth in student membership. Today, middle school AFNR courses are most commonly one semester in length or nine weeks (Jones et al., 2020). However, the length of programs can vary greatly from one full year to a little as six weeks depending on the local school district. A total of 47% of middle school enrollments are 8th grade students, 30% are 7th grade students and 23% are 6th grade students (Jones et al., 2020).

The National FFA Organization (2019) states that agricultural education programs are divided into three parts: classroom/laboratory instruction, supervised agricultural experiences and the FFA student leadership organization. While enrollment numbers have nearly doubled since their inception, middle school AFNR program's classroom and laboratory instruction have remained fairly constant in their coverage of AFNR topics. Rosetti et al. (1992) reported plant science, career exploration, agricultural literacy, animal science, conservation, and mathematics were topics most frequently taught. Jones et al. (2020) later confirmed that career exploration, agriculture literacy, animal science and horticulture are still the foundation of a majority of middle school AFNR programs. Fritz and Moody (1997) provide some rationale for the lack of change in content observed in middle school AFNR programs. "Regardless of career intent, students as future policy and decision makers need to have a working knowledge of the important role of agriculture in our society."(p.64) They cite further that a majority of instructors within their state identified the primary opportunity of agriculture education at the middle school level being agricultural awareness. This wide exploration of agricultural topics allows students to sample

secondary course content. Both Jones et al. (2020) and Rosetti et al. (1992) suggest that Middle School AFNR program enrollees are more likely to participate in high school programs due to the opportunity students have to sample high school course content and participate in FFA activities.

In 2020, 84% of states offered middle school FFA membership with a total of 27% of enrolled AFNR middle school students being official FFA members, while Rossetti et al. (1992) only reported 19 states had FFA members at the middle school level. Jones also found that 69% of states hold state level contests for middle school FFA members (Jones et al., 2020). While FFA opportunities and membership may vary from state to state, Supervised Agricultural Experiences are readily available to students. In 2020, 75% of state FFA leaders reported students in middle school agricultural science courses participating in SAEs.

SAEs & Agriscience Research

As an integral, intra-curricular component of agriculture education, Supervised Agricultural Experience (SAE) can be defined as a student-led, instructor supervised, work-based learning experience that results in measurable outcomes within a predefined, agreed upon set of Agriculture, Food and Natural Resources (AFNR) Technical Standards and Career Ready (National Council for Agricultural Education, 2017). The National Council for Agricultural Education (2015) describes SAEs to be an experiential and work-based learning opportunity that allows local programs to extend beyond the classroom and into the community so individual students may learn how to apply what they are learning in the classroom as they prepare to transition into the world of college and career opportunities. Students conduct SAEs under the supervision of a teacher, parent, employer or other designated individual (Phipps et al., 2008). SAEs should be agricultural in nature but it is also understood that it may not occur on an agricultural enterprise such as a farm or ranch. The experience should correlate with

AFNR classroom instruction and the student's interests and planning within one of the recognized AFNR career pathways. Lastly SAEs should continue experiential learning outside of classroom or laboratory learning. SAEs should tie back to some level of career planning, is student managed and is taking place in a real-world or simulated workplace environment (National Council for Agricultural Education, 2017).

When initially required by the Smith-Hughes Act of 1917, vocational agriculture students were required to participate on a farm for at least six months per year (Phipps et al., 2008). Experiences could include entrepreneurship/ownership where students created their own operation on their farm, or placement where they could be employed by an agricultural farm or business (Phipps et al., 2008). As populations and involvement in production agriculture have changed over the decades, now 73% of students enrolled in agricultural education do not live on farms which greatly reduces opportunities for production agriculture SAEs and placements (Phipps et al., 2008). To address these substantial changes to student demographics and resources, approved SAE areas have been expanded to include: Entrepreneurship/Ownership, Placement/Internship, Agriscience Research, School-Based Enterprise, and Service-Learning (National Council for Agricultural Education, 2017).

Retalick (2010) suggests Agriscience research as a particularly well-suited SAE area for communities and programs where agricultural resources and placements are not readily available. Thiel and Marx (2019) suggest that the flexible nature of agriscience research SAEs, and ability to be conducted with limited inputs and resources make agriscience research SAEs a logical choice for many schools. The National Council for Agricultural Education (2017) recognizes and defines the following three types of agriscience SAEs:

Experimental - An extensive activity where the student plans and conducts a major agricultural experiment using the scientific process. The purpose of the experiment isto

provide students first hand experience in verifying, learning or demonstrating scientific principles in the AFNR career cluster, discovering new knowledge and using the scientific process. In an experimental SAE, there is a hypothesis and a control group and variables are manipulated.

Analytical – The student chooses real-world agriculture, food or natural resource- related problems that are not amenable to experimentation and designs a plan to investigate and analyze the problem. The student will gather and evaluate data from a variety of sources and then produce some type of finished product. The product may include a marketing display or marketing plan for a commodity, product or service; a series of newspaper articles; a land use plan for a farm; a detailed landscape design for a community facility; an advertising campaign for an agribusiness, and so forth. A student-led analytical SAE is flexible enough so that it could be used in any type of agricultural class, provides valuable experience and contributes to the development of critical thinking skills.

Invention – The student identifies a need in agriculture, food or natural resource- related industry and performs research and analysis in order to solve a problem or increase efficiency by developing/adapting a new product or service to the industry. The student plans, documents and develops his/her innovation through the iterative processes of design, prototyping and testing with the goal of creating a marketable product or service. (p. 3)

Furthermore, it has been recognized that agriscience research SAEs can have a profound impact on student learning, career readiness and self-efficacy. In a study by Theil and Marx (2019), it was found that students who participated in agriscience research SAEs

expressed higher levels of perceived self-efficacy of 21st century skills. 21st century skills are defined by the P21 Framework Definitions for 21st Century Learning as “the skills, knowledge, and expertise students must master to succeed in work and life; it is a blend of content knowledge, specific skills, expertise, and literacies” (p.2). Theil and Marx (2019) provide substantial evidence that agriscience research SAEs also allow students to experience all levels of experiential learning. This further reinforces that agriscience research SAEs can meet and exceed the criteria of a high quality SAE as outlined by the National Council for Agricultural Education as well as the mission of agriculture education to prepare students for successful careers and a lifetime of informed choices in the global agriculture, food, fiber and natural resources systems.

Chapter 3 – Methods & Procedures

This project was created to assist middle school students enrolled in a semester-long agriculture explorer course develop and conduct an approved SAE in agriscience research. Six independent lessons were constructed using previously developed materials from my own lesson plans and using materials from the National FFA Organization, the National Council for Agricultural Education’s SAE for ALL campaign and other various sources that support scientific experimentation at the secondary level. Although the lessons were never piloted as a complete product, a large portion of the materials had been successfully used in my own middle school agricultural explorer and middle school life science course previously.

Chapter 4 – Results

The final project consists of a six lesson series which includes six detailed lesson plans, a Google Slide presentation for each lesson and a comprehensive student workbook. The

student workbook is a 40 page document that includes guided notes for each lesson, independent reflection and content application activities, an agriscience research planning form as well as SAE planning and documentation resources. All six lessons, their materials, and the Building Your Agriscience Research SAE student workbook can be found in the appendices of this document.

Chapter 5 – Discussion

The purpose of this project is to provide AFNR educators with a flexible curriculum resource that will not only teach middle school students about the scientific process needed to conduct an agriscience research SAE but also about the general structure of SAEs. After completing the curriculum with students and providing guidance and oversight in the conducting of research, students will have completed an agriscience research SAE that can be submitted as a course assignment, presented to an appropriate audience or entered into a local science fair event. The curriculum was designed so the agriscience research project which students will develop is not content specific. This was intentional so the curriculum could be integrated into a specific unit where the AFNR educator could impose a required topic or field of study pertaining to identified content standards or it can be seen as a blank slate for students to explore an AFNR topic of their choosing.

The series itself is not intended to be taught in six consecutive days but instead as students progress through the scientific process scaffolding them as needed. It is recommended that lesson one and lesson two be taught in close proximity to each other. Students will first develop a sense of what agriscience is, why it is important and how the scientific process gets underway. Once students have identified scientific questions they are interested in pursuing, students are introduced to SAEs, the AFNR educator will introduce specific SAE expectations pertaining to the local program and finally they will identify the scientific question and variation of

agriscience research that will fit their needs. The implementing educator may choose to allow students independent work time to make final decisions on their topic of choice or time to begin developing their SAE plan for approval. Once students have a clearly defined research question, you will complete lesson three to support students in developing a research plan they will use to guide their background research. The AFNR educator will have to consider goals of completion/ timeline in determining how long students will be given to complete their background research. Also note that some students may advance faster in the scientific process than others so you will need to consider student pace when deciding to advance to subsequent lessons. It is important that students complete certain lesson components prior to advancing in the subsequent lessons because materials will build off of one another. Lesson four teaches students the differences in variables and how to formulate a hypothesis; this may require a revisit to lesson three to conduct more research. Next, lesson five supports students in developing their own methods and setting themselves up for successful data collection. This is a highly customizable lesson where specific recording keeping methods can be introduced (for example if your program uses AET.com you may choose to help students set their account, show examples of student journal entries, etc.). The final lesson is intended to be taught after students have collected their data and prior to preparing their results to be shared. Again this lesson in particular can be customized depending on the desired outcomes of student projects. For example, if students will be participating in a local science fair, then they may need to format their report and findings in a specific manner. The National FFA Agriscience Fair Handbook provides an excellent framework for reports, posters and rubrics if the implementing educator does not already have existing criteria. Lastly the Agriscience Research & SAE Planning section of the workbook provides additional resources that you may choose to implement in your classroom depending on student need and the desired outcome of student projects.

Upon the completion of this impact project, there are several identified extensions that could be added to this project in the future. First being the development of two additional

workbooks and amended materials that are tailored to analytical and invention agriscience research SAEs. Although the current workbook can be used to plan an analytical or invention type SAE, it is largely oriented towards the development of experimental research SAEs and may require several adjustments. Secondly, the development of final project criteria and evaluation rubrics could be useful to AFNR educators in the case where there are no local events for students to participate in and the final project is viewed as a class assignment. Lastly, a digital student workbook that is in a fillable format that students can type directly into would be useful to AFNR educators who may be providing learning materials virtually or in a situation where students are one-to-one with electronic devices.

In summary, it is the intent that this impact project be a resource to AFNR educators who are trying to help middle school aged students develop high quality supervised agricultural experiences. Agriscience research SAEs present a very unique and flexible option for students to learn basic skills such as goal setting, planning and recordkeeping. These skills have the potential to greatly advance efforts in SAE development should the student choose to enroll in a high school AFNR program. Additionally, students who develop and implement agriscience research SAEs also have a unique opportunity to further delve into AFNR fields of interest which may or may not align with their own career interests. This self exploration coupled with the building of new skills through the development of an agriscience research SAE have the potential to be impactful on a middle school student's learning as well as the development of critical career and lifelong skills.

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Thiel, B. L., & Marx, A. A. (2019). The Influence of Agriscience Research SAEs on Perceived Self-Efficacy of 21st Century Skill Attainment. Journal of Agricultural Education, 60(1), 80-95. doi:https://doi.org/10.5032/jae.2019.01080

Title of Unit: Building Agriscience Research & SAEs

Title of Lesson: What is Agriscience? (Lesson 1 of 6)

Situation: The purpose of this lesson is to introduce middle school students to the concept of agriscience and demonstrate the importance research plays in the agriculture, food and natural resource systems. This will be the first of six lessons that will outline the scientific process and prepare students so they can plan and implement their own agriscience research project/SAE.

Objective(s): Define agriscience and explain why agriscience research is important to AFNR systems.
Describe characteristics and skills used by scientists.
Create a scientific question and describe its purpose.

Core Standards: NGSS Science and Engineer Practices (6-8th grade):
Practice #1 Asking Questions and Defining Problems

Materials:

Students:
Building Your Agriscience Research SAE Workbook
Digital or printed copy of CK12 Scientific Ways of Thinking

Teacher:
Sticky notes or scrap paper for each student
Lesson 1_What is Agriscience? Google Slide Presentation
Computer with internet access & projector

References: *Specific texts, web sites etc. (so you can find it)*
CK-12 Life Science Flexbook: Scientific Ways of Thinking
https://flexbooks.ck12.org/cbook/ck-12-middle-school-life-science-2.0/section/1.1/primary/lesson/scientific-ways-of-thinking-ms-ls

Interest Approach: Distribute sticky notes and ask students to respond: What is one practice, product or thing that you use everyday that has resulted from research or science? The answer may be specific or general. Ask students to share with the class. Follow up with another question: What is one practice,

product or object that has had a significant impact on agriculture, food or natural resource industries that has also resulted from research or science? Have students share their response with an elbow partner. Ask students to highlight items shared that they feel has had the largest impact with the entire class. Finally ask students: Do you feel research is important to agriculture, food and natural resource systems and why?

Student/Teacher Planning:

What is the Problem?
Students do not understand the role and importance agriscience research plays in AFNR and our daily lives.

Why is it important we solve it?
As pressures such as population growth, increasing pest presences, and demands for reduced dependence on natural resources continue to grow, now more than ever scientists are searching for solutions and technologies that will alleviate these pressures while preparing for challenges that lie ahead.

How should we solve it?
Students will discover first hand how scientists are using the scientific process to create and develop innovative solutions to problems in AFNR systems.

Problem Solution: *How you teach it and what you teach*

Teacher Task	Instructions/Guidance
Interest Approach *(5 minutes)*	Distribute sticky notes and ask students to respond: What is one practice, product or thing that you use everyday that has resulted from research or science? The answer may be specific or general. Ask students to share with the class. Follow up with another question: What is one practice, product or object that has had a significant impact on agriculture, food or natural resource industries that has also resulted from research or science? Have students share their response with an elbow partner. Ask students to highlight items shared that they feel has had the largest impact with the entire class. Finally ask

	students: Do you feel research is important to agriculture, food and natural resource systems and why?
Student/Teacher Planning *Google Slides & Student Workbook* *(5 minutes)*	After completing the interest approach with students, reinforce student learning objectives with students (slide #2). Next question if students know what the term agriscience means? Display the definition of Agriscience (Slide # 3). *The application of science and technology to agriculture is often referred to as Agriscience.* This definition should be recorded in their workbook. Continue to build meaning behind agriscience research by discussing challenges students can currently identify.
Scientific Ways of Thinking *CK12 Flexbook & Student Workbook (10 minutes)*	Before we can understand the science behind the agricultural challenges students share, students must first understand how scientists approach the process of science. Ask students to read the short section on the *Scientific Ways of Thinking*. In their workbooks they should record the skills and characteristics they think they will need in order to conduct their own agriscience research.
Scientific Thinking *Google Slides & Student Workbook* *(20 minutes)*	Complete the remainder of the slide presentation with students. Students will follow along and fill in the guided notes in their workbook.
Asking Scientific Questions *Google Slides & Student Workbook* *(20 minutes)*	After completing the slides, students will come up with three potential scientific questions and their purposes on pg 5 of the workbook. Students should create questions they would be interested in answering and possibly conducting an investigation on.

Applying Solutions: *How students can practice what you taught:*
Students will continue to build upon and apply their knowledge of the scientific method in subsequent lessons.

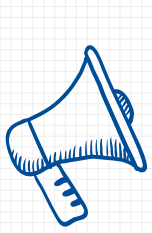
Evaluation: *How you assess what they learn:*
Students can define agriscience, identify skills commonly used by scientists and create their own scientific question with the provided criteria. Students will use this knowledge to build a scientific investigation of their own.

Building Middle School SAEs & AFNR Research

Lesson 1 – What is Agriscience?

Student Learning Objectives:

- ✘ Define agriscience and explain why agriscience research is important to AFNR systems.
- ✘ Describe skills and characteristics used by scientists.
- ✘ Create a scientific question and describe its purpose.



Why is science & research in AFNR Important?

What is Agriscience?

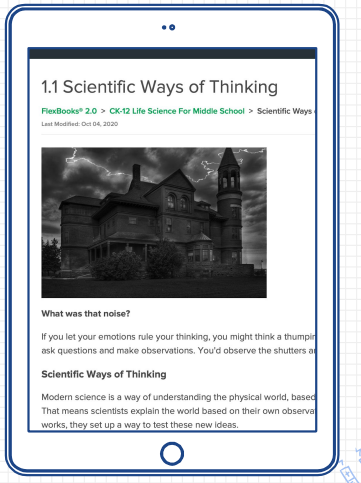
The application of science to agriculture

https://www.lexico.com/en/definition/agriscience

Read: Scientific Ways of Thinking

Read the short section on the scientific ways of thinking. As you read, be thinking about characteristics and skills that scientists use to help them conduct scientific processes.

In your workbook record the skills and characteristics you think you will need in order to conduct your own agriscience research.



How do scientists think scientifically?

Ask Questions!

Scientists ask questions to better understand what is happening around them. They may even make observations to try to ask more specific questions.

Make Detailed Observations!

Scientists observe and record detailed observations. These observations can ultimately help scientists design their experiments and answer questions.

Build Background Knowledge!

Scientists want to better understand the questions they are asking. Scientists use primary sources such as scientific texts and journal articles to build background knowledge on their topic of study.

How do scientists think scientifically?

Find Answers Using Tests!

Scientists conduct experiments to test answers to their questions. Observations taken during experiments then become evidence which can be used to prove questions to be right or wrong.

Are Skeptical!

Scientists never use just one piece of evidence to form a conclusion. Scientists want to know the truth so they question their own conclusions and find other scientists to confirm or disagree with their evidence.

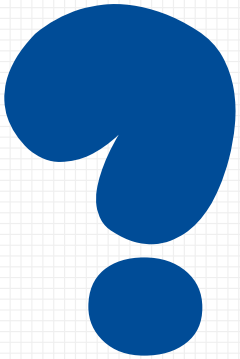
Ok Being Wrong!

Sometimes scientists don't always get it right the first time and that's ok! Through failures scientists still learn about their questions. Although it can be frustrating, failures can have lasting, positive outcomes.

Where do you think the process of science begins?

The scientific process starts with questions

1. Scientists may start with a broad questions such as "What makes a seed grow?"
2. Next, they break the question down into smaller questions: What are the essential factors necessary for seed germination? What factors are necessary for radish seed germination?
3. They state the final question in a way that is can be answered by an investigation or experiment. A good question is: " What effect does the PH of water have on radish seed germination?"



Questions are an essential part of science & often have a significant purpose or objective behind them. For example if I answer _(this question)_ , I can better understand _ (this)_.

Asking Good Scientific Questions

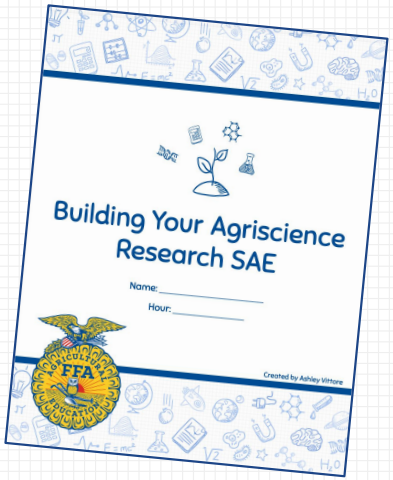
Good Scientific Questions:

- ✓ Can be answered by direct observations or with scientific tools.
- ✓ Easily defined, measurable, and controllable.

Poor Scientific Questions:

- ✘ Based on values or opinions like what people believe is right or wrong, or beautiful or ugly.
- ✘ Too broad, unable to be answered with direct observations or experimentation

Look at the questions on Pg 4 of your workbook and check yes if the question listed is a good scientific question or no if it is a poorly worded question.



It's your turn! Create your own scientific questions on pg 5 of the workbook on a topic of your choice.

Remember: Good scientific questions are defined, measurable, and controlled!

Title of Unit: Building Agriscience Research & SAEs

Title of Lesson: Intro to Agriscience SAEs (Lesson 2 of 6)

Situation: The purpose of this lesson is to introduce middle school students to the three variations of agriscience research SAEs that students have the option to complete through this project. Students will also complete a reflection of their desired SAE outcomes, make career connections with their intended research topic and complete an SAE Research Plan. This will be the second of six lessons that will outline the scientific process and prepare students so they can plan and implement their own agriscience research SAE.

Objective(s): Explain the purpose of an SAE.
Describe the differences between experimental, analytical and invention agriscience research SAEs.

Core Standards: NGSS Science and Engineer Practices (6-8th grade):
Practice #1 Asking Questions and Defining Problems

Materials:

Students:
Building Your Agriscience Research SAE Workbook

Teacher:
Lesson 2_Intro to Agriscience SAEs Google Slide Presentation
Computer with internet access & projector

References: *Specific texts, web sites etc. (so you can find it)*
Ctenophore SAE Video
https://www.ffa.org/ffa-video-center/sae-video-library/?vimeography_gallery=1&vimeography_video=300298552
Foundational SAE Video
https://www.ffa.org/?vimeography_gallery=20&vimeography_video=306197875
Research SAE Video
https://www.ffa.org/?vimeography_gallery=20&vimeography_video=306200096

SAE Research Plan
https://saeforall.org/wp-content/uploads/2021/03/SAE-Research-Plan.pdf

Interest Approach:

Show students the Ctenophore SAE Video (Slide #3). After watching the video. Ask students what the potential impact of the student's research with Ctenophores could be? Students should bring up that they mentioned the bioluminescence produced by the jellyfish is being used to trace neural activity in the brain of individuals who have PTSD. Discuss further how that could change what doctors and scientists know about the brain and disorders such as PTSD. Ask students to think of other research they have heard about recently that they feel could have a significant impact on society. Share with students that simple research projects like the ones they will be conducting in class can go on to have big impacts just like the student's SAE in the video. Today we are going to talk more about SAEs, their impacts, and the variation of agriscience research that can be conducted on the scientific questions students came up with during our first lesson.

Student/Teacher Planning:

What is the Problem?
Students either have no previous knowledge pertaining to SAEs or have little background knowledge of agriscience research SAEs. Students need to be able to identify the variation of agriscience research that will best fit the scientific questions they wish to investigate.

Why is it important we solve it?
SAEs are a critical component of an AFNR student's enrollment in an approved AFNR course. Students who will be completing an Agriscience Research SAE must be able to identify the variation of research they will be completing as well as adapt the scientific process to the structure of the variation they will be conducting.

How should we solve it?
Students will learn about the primary components of a SAE and the three variations of agriscience research SAEs. Students will assess and identify the variation that best fits their proposed scientific question and record desired outcomes of their Research SAE.

Problem Solution: *How you teach it and what you teach*

Teacher Task	Instructions/Guidance
Interest Approach *Google Slide* *(5 minutes)*	Show students the Ctenophore SAE Video (Slide #3). After watching the video. Ask students what the potential impact of the student's research with Ctenophores could be? Students should bring up that they mentioned the bioluminescence produced by the jellyfish is being used to trace neural activity in the brain of individuals who have PTSD. Discuss further how that could change what doctors and scientists know about the brain and disorders such as PTSD. Ask students to think of other research they have heard about recently that they feel could have a significant impact on society. Share with students that simple research projects like the ones they will be conducting in class can go on to have big impacts just like the student's SAE in the video. Today we are going to talk more about SAEs, their impacts, and the variation of agriscience research that can be conducted on the scientific questions students came up with during our first lesson.
What are SAEs? *Google Slides & Student Workbook* *(10 minutes)*	Begin to go over Slides 4-8 with students. Explain the concept of SAEs providing an explanation of how SAEs fit into your program and perhaps sharing examples of previous student's SAEs. Depending on the student's prior knowledge of SAEs, you may need to do a more thorough explanation or a briefer explanation. Students should record a definition of SAEs and differences between foundation and immersion SAEs in their guided notes.
Agriscience Research SAEs *Google Slides & Student Workbook* *(20 minutes)*	Continue to go over slides 9-11. Explain that students need to decide which variation of agriscience research will best fit the question they are trying to answer. After covering slide 11, allow students time to go over pg 7 of the workbook. On this page students will evaluate which variation of agriscience research SAE will best fit their proposed research question.

Next Steps of Agriscience Research *Google Slides & Student Workbook* *(15 Minutes)*	Slides 12-16 will discuss the next steps of an Agriscience Research SAE. Should students want to compete in a science fair they should identify a category that their research would fit into and seek other rules and regulations of the event they wish to participate. You may wish to highlight previous student's research projects, display boards or utilize Star in Agriscience videos or New Horizons articles to showcase student accomplishments around agriscience research SAEs. Finally students will identify intended outcomes of their research SAE in their workbook on pg 8.
Agriscience Research SAE Plan *Agriscience Research SAE Plan -Printed Copy (Remaining time or independently outside of class)*	Introduce students to the Research SAE Plan (pg 31 student workbook). Approved SAE plans are a critical component to any SAE program. Students should begin to develop and continue to add to their plan over the next few lessons as they identify purpose, variables, and methods to be used. Collect SAE plans prior to students beginning their experimentation.

Applying Solutions: *How students can practice what you taught:*
Students will determine the variation of agriscience research which their own SAE will fit into. Students will adapt the planning of their own agriscience research SAE to fit the needs and unique dynamics of the variation of agriscience research SAE they chose.

Evaluation: *How you assess what they learn:*
Students can correctly identify the variation of agriscience research their proposed scientific question will fit into. Students can clearly define the intended outcomes of their agriscience research SAE and students can successfully develop an SAE Research Plan. Students will use this knowledge to continue to build a scientific investigation of their own.

Building Middle School SAEs & AFNR Research

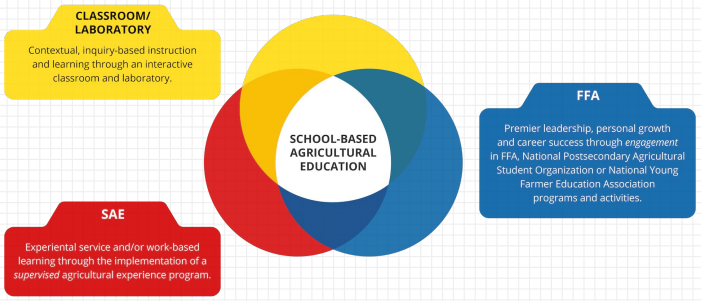
Lesson 2 – Intro to Agriscience SAEs

Student Learning Objectives:

- ✘ Explain the purpose of an SAE.
- ✘ Describe the differences between experimental, analytical and invention agriscience research SAEs.

What is an SAE?

Supervised Agricultural Experience (SAE) is a student-led instructor-supervised, work-based learning experience that results in measurable outcomes within a predefined, agreed upon set of Agriculture, Food and Natural Resources (AFNR) Technical Standards and Career Ready Practices aligned to your Career Plan of study.



https://saeforall.org/

HERE'S WHAT THAT DEFINITION MEANS FOR YOU.

Aligned to Your Career Plan
SAEs are designed to grow and modify as you grow and develop your skills and identify new interests that may affect your Career Plan. The end goal of an SAE is that you are career-ready, no matter what path you take to get there!

Student-Led
You will be the primary decision maker throughout your SAE. Many options may be shared with you by your instructor and other supporting adults, but you ultimately have control.

Connected to Agriculture
No matter what type of SAE you choose, it needs to be agriculturally-related. You can choose to experience any of the AFNR career pathways: Agribusiness Systems, Animal Systems, Biotechnology Systems, Career Ready Practices, Environmental Systems, Food Products and Processing Systems, Natural Resources Systems, Plant Systems, Power, Structural and Technical Systems.

AN SAE IS

Instructor Supervised
Your agricultural education instructor will help guide and foster growth within your SAE as needed. They serve as your SAE mentor.

Measurable
Because SAEs are connected to agriculturally-based knowledge and skills your growth can be measured as a graded component of your agricultural coursework. Your SAE experience may also be considered for high school graduation credits.

Work-Based Learning
Depending on the type of SAE you select, your work-based experience could be in or out of school. Specific definitions of each SAE work-based category can be found on pages 9-20 of this guide.

https://ffa.app.box.com/s/m52qkpzzbdb9ew04hapvy434k33pb9o

Foundational SAE

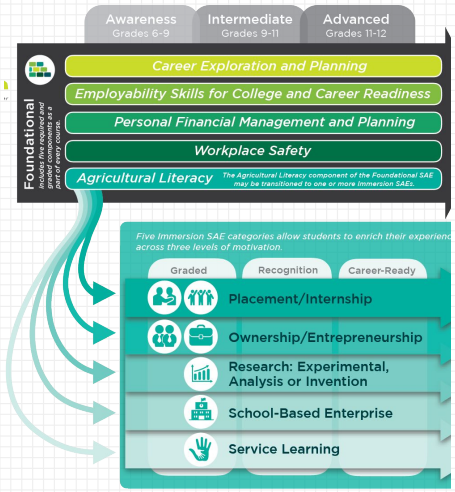
Every student starts with a foundational SAE where they explore career opportunities, learn about employability skills, financial management and planning, workplace safety and build agricultural literacy which may be used to build the next step: Immersion SAE.

https://saeforall.org/sae-for-all-program/?wizard

https://www.ffa.org/?vimeography_gallery=20&vimeography_video=306197875

Immersion SAE

Immersion SAEs allow students to build upon their Foundational SAE activities by gaining real-world, hands-on experience within their chosen career path. Students will enhance their agriculture industry knowledge, gain financial independence and management skills, and determine whether the career choice aligns with their interests and abilities – all while supporting their agricultural education coursework.



https://saeforall.org/immersion-sae/?wizard

Agriscience Research SAEs

When conducting a research SAE, you will identify a problem or question you would like to learn more about, then discover possible solutions through experimentation, data research, or creating prototypes. This will happen through one of three variations of a Research SAE, which are categorized as: Experimental, Analysis or Invention.

https://www.ffa.org/?vimeography_gallery=20&vimeography_video=306200096

Which Research SAE format fits your focus question?

EXPERIMENTAL:

An Experimental Research SAE involves the application to the scientific method to control certain variables while manipulating others to observe the outcome. The student defines the hypothesis the experiment will test, determines the experimental design, conducts the research, collects the data, draws conclusions from the data and recommends further research that can be done.

ANALYTICAL:

An Analytical Research SAE often begins with a question that asks why or how something occurs, followed by a period of data collection using qualitative and/or quantitative methodologies. The student then conducts analysis of data, facts and other information to determine the answer to the posed question.

INVENTION:

An Invention Research SAE applies the engineering design process to create a new product or service. This type of research often begins with the identification of a need and the development of a product followed by an iterative process of prototyping and testing that results in a product that meets the identified need.

FFA Recognized Agriscience Divisions

Animal Systems

The study of animal systems, including life processes, health, nutrition, genetics, management and processing, through the study of small animals, aquaculture, livestock, dairy, horses and/or poultry.

Examples

- Compare nutrient levels on animal growth
- Research new disease control mechanisms
- Effects of estrous synchronization on ovulation
- Compare effects of thawing temperatures on livestock semen
- Effects of growth hormone on meat/milk production

Environmental Service/Natural Resource Systems

Environmental Service Systems: The study of systems, instruments and technology used to monitor and minimize the impact of human activity on environmental systems.

Natural Resource Systems: The study of the management, protection, enhancement and improvement of soil, water, wildlife, forests and air as natural resources.

Examples

- Effect of agricultural chemicals on water quality
- Effects of cropping practices on wildlife populations
- Compare water movements through different soil types

FFA Recognized Agriscience Divisions

Food Products and Processing Systems

The study of product development, quality assurance, food safety, production, regulation and compliance and food service within the food science industry.

Examples

- ✘ Effects of packaging techniques on food spoilage rates
- ✘ Resistance of organic fruits to common diseases
- ✘ Determining if varieties of sweet corn have different chemical energy
- ✘ Control of molds on bakery products
- ✘ Effects of the amount of sucrose used in baked goods
- ✘ Use of a triangle test in sensory science

Plant Systems

The study of plant life cycles, classifications, functions, structures, reproduction, media and nutrients, as well as growth and cultural practices, through the study of crops, turf grass, trees and shrubs and/or ornamental plants.

Examples

- ✘ Compare the rates of transpiration of plants in different locations in a landscape
- ✘ Effects of heavy metals such as cadmium on the growth rate of plants
- ✘ Compare GMO and conventional seed/plant growth under various conditions
- ✘ Compare plant growth of hydroponics and conventional methods

FFA Recognized Agriscience Divisions

Power, Structural and Technical Systems

The study of agricultural equipment, power systems, alternative fuel sources and precision technology, as well as woodworking, metalworking, welding and project planning for agricultural structures.

Examples

- ✘ Compare the energy output of alternative fuel sources to traditional forms
- ✘ Create minimum energy use structures
- ✘ Compare properties of various alternative insulation products
- ✘ Examining the efficiency, the configurations of ventilation systems in a swine facility

Social Science

The study of AFNR areas including agricultural education, agribusiness, agricultural communication, agricultural leadership and sales in AFNR.

Examples

- ✘ Investigate perceptions of community members toward alternative agricultural practices
- ✘ Determine the impact of local/state/national safety programs upon accident rates in AFNR occupations
- ✘ Determine the economic effects of local/state/national legislation impacting AFNR
- ✘ Consumer confidence and understanding of food labels

Research SAE Quality Indicators:

- ✘ Engages in identifying an ongoing program of research following an approved SAE Research Plan
- ✘ Follows scientific process and/or accepted best practices for conducting research to ensure reliability, validity and replicability of research
- ✘ Conducts peer reviews with supervising instructor and other professionals during multiple stages of the research cycle
- ✘ Delivers a summary presentation to a local committee organized by the agricultural education instructor

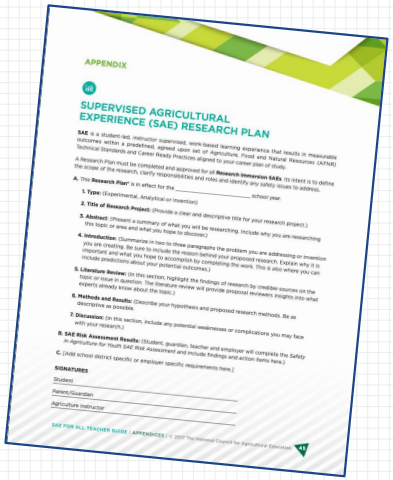
Next steps of Your SAE

As your agriscience research SAE develops, there are many exciting and rewarding opportunities that await!

- ✘ You could participate in a local science fair or share your research with a local committee
- ✘ Apply for FFA Proficiency Awards or FFA Degrees
- ✘ Pursue a career that allows you to continue to explore and research in your field of study

A Research Plan & Student Self-Assessment of SAE (safety) must be completed and approved for all Research Immersion SAEs. Its intent is to define the scope of the research, clarify responsibilities and roles and identify any safety issues to address. You will begin developing this document immediately and will turn in prior to starting your SAE.

*Located on Pg 31 Student Workbook



APPENDIX

SUPERVISED AGRICULTURAL EXPERIENCE (SAE) RESEARCH PLAN

SAE is a student-led, instructor supervised, work-based learning experience that results in measurable outcomes within a predefined, agreed upon set of Agriculture, Food and Nature Resources (AFNR) technical standards and Career Ready Practices aligned to your career plan of study.

A Research Plan must be completed and approved for all **Research Immersion SAEs**. Its intent is to define the scope of the research, clarify responsibilities and roles and identify any safety issues to address.

A. This **Research Plan*** is in effect for the _____ school year.

1. **Type:** (Experimental, Analytical or Invention)
2. **Title of Research Project:** (Provide a clear and descriptive title for your research project.)
3. **Abstract:** (Present a summary of what you will be researching. Include why you are researching this topic or area and what you hope to discover.)
4. **Introduction:** (Summarize in two to three paragraphs the problem you are addressing or invention you are creating. Be sure to include the reason behind your proposed research. Explain why it is important and what you hope to accomplish by completing the work. This is also where you can include predictions about your potential outcomes.)
5. **Literature Review:** (In this section, highlight the findings of research by credible sources on the topic or issue in question. The literature review will provide proposal reviewers insights into what experts already know about the topic.)
6. **Methods and Results:** (Describe your hypothesis and proposed research methods. Be as descriptive as possible.)
7. **Discussion:** (In this section, include any potential weaknesses or complications you may face with your research.)
8. **SAE Risk Assessment Results:** (Student, guardian, teacher and employer will complete the *Safety in Agriculture for Youth SAE Risk Assessment* and include findings and action items here.)

C. (Add school district specific or employer specific requirements here.)

SIGNATURES

Student _____

Parent/Guardian _____

Agriculture Instructor _____

SAE FOR ALL TEACHER GUIDE | APPENDICES | 41

Title of Unit: Building Middle School SAEs & AFNR Research

Title of Lesson: Building Background (Lesson 3 of 6)

Situation: The purpose of this lesson is to introduce students to the process of collecting background research.This is the third of six lessons that will outline the scientific process and prepare students so they can plan and implement their own agriscience research project/SAE.

Objective(s):
Explain the importance of background research for an experiment.
Create appropriate background research questions for a research project.
Determine credibility of potential resources.

Core Standards: NGSS Science and Engineer Practices (6-8th grade)
Practice 1 Asking Questions and Defining Problems
Practice 3 Planning and Carrying Out Investigations
Practice 8 Obtaining, evaluating and communicating information.

Materials:

Students:
Building Your Agriscience Research SAE Workbook

Teacher:
Lesson 3_Building Backgrounds Google Slide Presentation
Computer with internet access & projector

References:

https://openoregon.pressbooks.pub/mhccmajorsbio/chapter/using-credible-sources/
https://www.sciencebuddies.org/science-fair-projects/science-fair/writing-a-science-fair-project-research-plan

Interest Approach: Ask students “What do you think is the purpose of background research?, Why do you think it's important to do background research?” Allow students to share their responses with their elbow partner or survey the entire class.

Student/Teacher Planning:

What is the Problem?

Students don't understand the purpose and impact of doing background research.

Why is it important we solve it?
Background research is a critical part of the scientific process and is necessary to plan out and execute a successful agriscience research project.

How should we solve it?
Students will consider what would happen during an experiment if they did not conduct proper background research on a given topic. Students will then consider the types of questions to research and how to create a research plan.

Problem Solution: *How you teach it and what you teach*

Teacher Task	Instructions/Guidance
Interest Approach *(5 minutes)*	Ask students "What do you think is the purpose of background research?, Why do you think it's important to do background research?" Allow students to share their responses with their elbow partner or survey the entire class.
Teacher/Student Planning *(5 minutes)*	Continue to ask each of the following questions to students: "What would happen if you chose to do an experiment involving mice but did not take the time to research the general care requirements?" "What would happen if you decided to perform an experiment involving water temperature and tadpoles and did not research the maximum temperature at which a tadpole can survive?" "What would happen if you were attempting to test ammonia levels in a chicken coop but you purchased an ammonia test kit that is used to test water rather than air?" Ask students how their experiment would be affected if they failed to do adequate background research. Responses could include harm to test subjects, unethical treatment of animals, skewed results of an experiment, waste of money and time, etc.

Why Background Research? *Google Slides 3-7 & Student Workbook (10 minutes)*	Complete slides 3-7 with students. Students should be following along and filling in their guided notes. Reiterate that a bulk of the research should be done prior to jumping right into their project but also acknowledge that the scientific process is not linear and it is important that they return to research as needed throughout the entire process. Explain that planning out the research they will be doing and predetermining the questions they need to answer ahead of time will help make their time spent researching more thorough and efficient.
Creating a Research Plan *Student Workbook (15 minutes)*	Provide students with in class work time to complete the worksheet on pg 10 of the student workbook. Students will brainstorm potential research questions and create a research plan for background research on their topic.
Evaluating Credible Sources *Google Slides 9-11 & Student Workbook (10 minutes)*	Complete slides 9-11 with students. Students should be following along and filling in their guided notes. Depending on your district's ELA curriculum, students may or may not already be well versed in evaluating source credibility. If students need additional support you may choose to show students examples of credible sources, where to look for clues regarding credibility, etc. Use your best judgement here.
Student Independent Research Time *(can be completed during school hours or independently at home)*	Once students complete their background research plan and they are comfortable evaluating sources for credibility, they should begin their own independent research. This can start in the classroom with the remaining class time or it can be assigned as independent at home work.

Applying Solutions: *How students can practice what you taught:*
Students will complete the research plan worksheet to plan out the specific research they will be conducting on their topic. Once students have completed their research plan, students can begin independently researching their topic. Students must evaluate the credibility of their sources as they complete their research.

Evaluation: *How you assess what they learn:*
Students can create a thorough and comprehensive

research plan to conduct research on their chosen topic. Students use credible sources when conducting their own research independently and students use this knowledge to build a scientific investigation of their own.

Building Middle School SAEs & AFNR Research

Lesson 3– Building Background

Student Learning Objectives:

- ✘ Explain the importance of background research for an experiment.
- ✘ Create appropriate background research questions.
- ✘ Determine credibility of potential resources.

Why is background research important?

- ✘ To better understand the theory and science you will be studying
- ✘ Discover what techniques and equipment are best for investigating your topic (or industry standard)
- ✘ Discover what kinds of research are already being done by scientists
- ✘ Who knows –your question may have already been answered !

Keep in mind today we are referring to the bulk of your research. You may need to utilize research earlier on to better understand an observation and develop a scientific question. You may also need to come back and conduct research again when setting up your experiment or when you are analyzing your data.

Prerequisites for conducting background research:

- ☑ Make an observation & pick topic of
- ✓ study
- ❑ Ask a Scientific Question
- ❑ Write Background Research Questions (AKA make a Research Plan)

Steps to Building a Research Plan

1. Identify the keywords in a question or problem for your project

Example: If azaleas are fertilized with organic compost, then there will be a greater number of seasonal blooms.

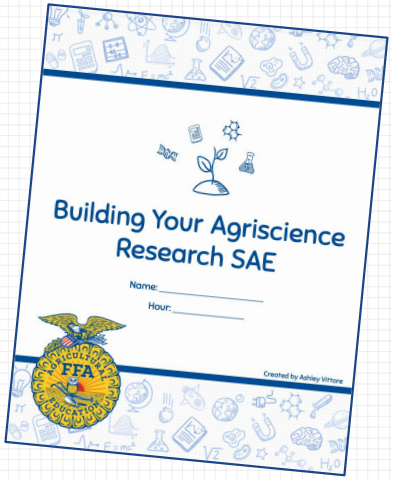
https://unsplash.com/photos/3k-QDD3JRAA?utm_source=unsplash&utm_medium=referral&utm_content=creditShareLink

Steps to Building a Research Plan

2. Brainstorm additional question you would need to set up your research (who, what, when, where, why and how)

What is the difference between a series and parallel circuit?
When does a plant grow the most, during the day or night?
Where is the highest concentration of migrating birds in Michigan?
How does a soil fumigation work?
Does a truss make a bridge stronger?
Why are moths attracted to light?
Which cleaning products kill the most bacteria?

- Look at the planning sheet on Pg 10 of your workbook and begin to plan possible research questions for your scientific question



Research plan is ready, now what?

After completing your research plan, you are ready to begin your research! Keep in mind you want to find **credible** sources for your research.

Credible sources are trustworthy, accurate, unbiased and supported or created by experts in their fields.

Always be a Skeptic

In determining if the source you found fits your purpose and is credible, you can ask yourself these questions:

- Is this site relevant to my needs and purpose?
- What is the purpose of this site?
- Who created the information at this site, and what is this person's level of expertise?
- When was the information at this site updated?
- Where can I go to check the accuracy of this information?
- Why did this person or group put this information on the internet?
- Does the website present only one side of the issue, or are multiple perspectives provided?
- How are information and/or images at this site shaped by the author's stance?

When all else fails use the CRAAP Test

Credibility Table

In general, do not use a source if it doesn't pass the CRAAP test! For our purposes, do not use any sources that score less than 6 points using the credibility table.

Factors to consider	Least reliable (0 points)	Possibly reliable (1 point)	Most reliable (2 points)
Currency	No date of publication or revision given	Outdated for this particular topic	Recently published or revised
Reliable source	Unreliable website, no additional info available	Possibly reliable	Official government or organization, institutional sites, academic journals
Author	No author is given / the author is not qualified to write about this topic	Author is educated on topic or is staff of an organization assumed to be knowledgeable on this specific topic	Specifically identified expert in this field with degrees / credentials in this subject
Accuracy	No review process and information is not supported by evidence from cited sources	The information may have been reviewed or edited by someone knowledgeable in the field. It mentions but does not directly cite other sources	The information has been peer reviewed and is supported by evidence from cited credible sources
Purpose	Obviously biased or trying to sell you something	Sponsored source; may present unbalanced information	Balanced, neutral, presents all sides of the issue fully

The credibility table is adapted from The CRAAP Test, created by Sarah Blakeslee, of the University of California at Chico's Meriam Library.

Title of Unit: Building Middle School SAEs & AFNR Research

Title of Lesson: Writing a Hypothesis (Lesson 4 of 6)

Situation: The purpose of this lesson is to introduce students formally to the scientific method and to demonstrate the importance and purpose hypotheses play in scientific research. Students will also be introduced to the concept of variables and controls. This is the fourth of six lessons that will outline the scientific process and prepare students so they can plan and implement their own agriscience research project/SAE.

Objective(s): Identify testable questions and
write hypotheses.
Determine variables and controls in an experiment.

Core Standards: NGSS Science and Engineer Practices (6-8th grade)
Practice #1 Asking Questions and Defining Problems
Practice #3 Planning and Carrying Out Investigations

Materials:

Students:
Building Your Agriscience Research SAE Workbook

Teacher:
Lesson 4_Writing a Hypothesis Google Slide Presentation
Computer with internet access & projector

References: *http://ffa.cccs.edu/agriscience-research-curriculum/*
https://www.sciencebuddies.org/science-fair-projects/science-fair/steps-of-the-scientific-method

Interest Approach: Refer back to the previous lesson, reminding students that they finished the last class period by coming up with their own scientific questions. Ask students to revisit the questions they wrote and ask them to think about what scientists do after they come up with a scientific question. Students can discuss with an elbow partner or you can survey the entire class about their ideas.

Student/Teacher Planning: *What is the Problem?*

Students need to be able to proceed in their learning surrounding the scientific method. Specifically, students do not know how to write a scientific hypothesis or how to differentiate between variables and constants in an experiment (which is the next step).

Why is it important we solve it?
In order for students to conduct a proper experiment they must be able to identify their research question/hypothesis and determine variables to manipulate, measure and hold constant.

How should we solve it?
Students will first learn the criteria for writing hypotheses and they will practice identifying variables in research examples. Finally, students will create their own hypothesis and identify related variables.

Problem Solution: *How you teach it and what you teach*

Teacher Task	Instructions/Guidance
Interest Approach *Google Slide #3* *(5 minutes)*	Refer back to the previous lesson, reminding students that they finished the last class period by coming up with their own scientific questions. Ask students to revisit the questions they wrote and ask them to think about what scientists do after they come up with a scientific question. Students can discuss with an elbow partner or you can survey the entire class about their ideas.
Student/Teacher Planning *Google Slide #4-5 & Student Workbook* *(5 minutes)*	Student ideas regarding the next steps after a scientific question will likely include various steps of the scientific method. Continue to discuss with students that the scientific method is a process used to gain knowledge about the world around us. Point out that the scientific method is not a linear process and it may vary across disciplines. Students should record the steps of the scientific method in their workbook (pg 12). Slide 5 will also cover differences in quantitative and qualitative. Discuss that the scientific method will look different depending the type of research be conducted. Also point out that variables (which you will discuss with them next) can also be quantitative or qualitative.

Defining & Practicing Variables *Google Slide #5-8 & Student Workbook (20 minutes)*	Work through slides 5-8 with students. Discuss the definitions of the variables and provide examples for students. Students will record the definitions in their workbooks as you progress through the slides. After recording definitions, students will work through several practice problems on variables (pg 14) and they will be asked to brainstorm possible constants for their own scientific questions. Finally students will compare answers with their elbow partner.
Defining & Writing Hypotheses *Google Slide #10-12 & Student Workbook (20 minutes)*	Complete slides 10 & 11 being sure highlight purpose, format and criteria for hypotheses. Reinforce independent and dependent variables here. Students will continue recording information in their guided notes and finally they will practice writing their own hypotheses in the given scenarios on pg 16 of their workbooks.

Applying Solutions: *How students can practice what you taught:*
Students will practice identifying dependent variables, independent variables, constants and controls in examples in their workbook. Students will also practice creating their own hypotheses with the criteria provided.

Evaluation: *How you assess what they learn:*
Students can create a scientific hypothesis and identify variables in an experiment. Students will use this knowledge to build a scientific investigation of their own.

Building Middle School SAEs & AFNR Research

Lesson 4– Writing a Hypothesis

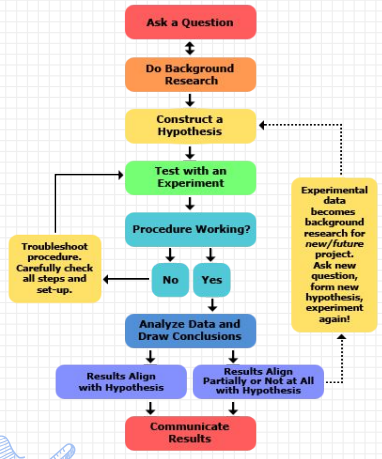
Student Learning Objectives:

- ✘ Identify testable questions and write hypotheses.
- ✘ Determine variables and controls used in an experiment

Think about the questions you came up with last class period.

What are the next steps scientists would take to answer these questions?

Scientific Method



- The scientific method is a process used by scientists to better understand the world around us.
- This process can be used to guide experimentation or it can be modified to guide thinking and collection of other types of evidence.
- This process is not linear. It can be reordered and restructured depending on the discipline of study or the desired outcome.

Determining The Type of Research You Will Conduct

Quantitative

–Data includes measurements or numerical quantities

Qualitative

–Data/Evidence is driven by descriptions, characteristics & non–numerical items

Defining Variables

Independent Variables:

- ✘ These are the variables you will manipulate or test in your experiment.

Example: the amount of fertilizer you give a plant

Dependent Variables:

- ✘ These are the variables you will measure as a result of the changes in the independent variable
- ✘ Dependent variables are dependent on the independent

Example: the plant growth you measure (height, diameter, number of leaves, etc)

Defining Variables

Constant:

- ✘ Variables that are unchanged in an experiment
- ✘ Important to manage so they do not influence DVs

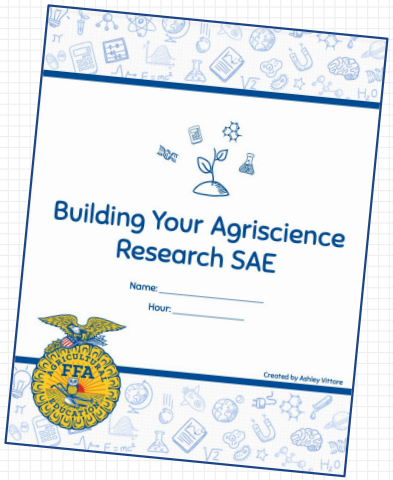
Example: type of plants, size of plants you start with, amount of sunlight and amount of water given to plants should all be the same so they do not influence the outcome observed in dependent variables.

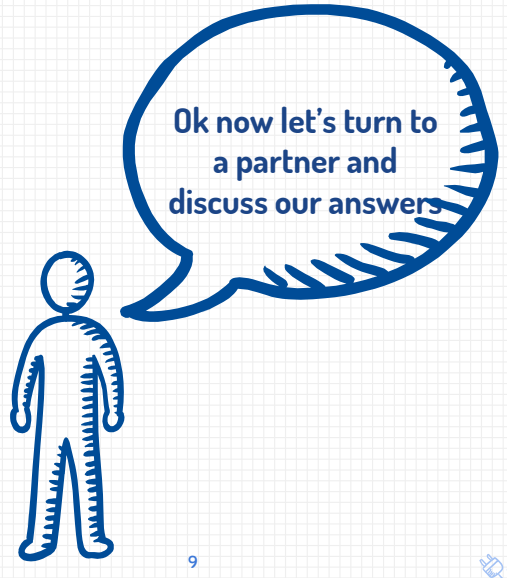
Controls:

- ✘ An unchanged group is conducted simultaneously to compare against and detect unanticipated changes

Example: A plant is not given any fertilizer in the trial to measure unmanipulated plant growth.

Practice Identifying Dependent and Independent Variables pg 14





What Is A Hypothesis?

An educated guess or scientific prediction about what you think the outcome of your experiment will be.

A good hypothesis has these four elements:

1. Restates the question
2. Provides an educated guess about what will happen in the experiment (predicts the answer to the question)
3. Explains why you think this will happen and uses ideas from research to back it up
4. Can be tested with an experiment.

How to Write a Hypothesis:

Poor Hypothesis Examples:

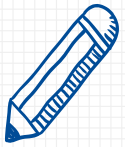
1. Plant growth may be affected by the color of the light.
2. Temperature may cause leaves to change color.

Better Hypothesis Examples:

1. If plants are supplemented with red light, then plant growth will increase.
2. If plants are exposed to low temperatures, then leaf color will change.

Hypothesis Format:

If __(Independent variable)__, then __(Dependent variable)__.



It's your turn! Create your own hypotheses on Pg. 16 of the workbook.

Title of Unit: Building Agriscience Research & SAEs

Title of Lesson: Planning & Conducting Your Experiment (Lesson 5 of 6)

Situation: The purpose of this lesson is to help students develop procedures and material lists for their agriscience research project. This lesson will also help students plan comprehensively for their SAE with budget basics, journal and time entries. This is the fifth of six lessons that will outline the scientific process and prepare students so they can plan and implement their own agriscience research project/SAE.

Objective(s): Formulate specific and replicable procedures/ methods.
Assemble a comprehensive materials list.
Identify best practices for journaling, data collection and reporting in record keeping systems (such as AET).

Core Standards: NGSS Science and Engineer Practices (6-8th grade)
Practice 2 Developing and Using Models
Practice 3 Planning and Carrying Out Investigations

Materials:

Students:
Building Your Agriscience Research SAE Workbook
Notebook or half sheet of paper
Optional: Access to a device with internet access
Optional: AET Student Login

Teacher:
Lesson 5_Planning & Conducting Your Experiment Google Slide Presentation
Computer with internet access & projector
Optional: AET Student Logins (Set up ahead of time)
1 Loaf of Bread
Butter knife and several other miscellaneous kitchen utensils
1 Jar of Peanut Butter
1 Jar Jelly
Optional: Other miscellaneous condiments

References: *Specific texts, web sites etc. (so you can find it)*

This “Exact Instructions Challenge” video is so Hilarious
https://www.youtube.com/watch?v=Ct-lOOUqmyY&t=4s
Teacher AET Guides:
https://www.theaet.com/teacherhelp
Student AET Guides:
https://www.theaet.com/studenthelp

Interest Approach:

On a half sheet of paper, ask students to write out step by step how to make a peanut butter & jelly sandwich. After students have written their directions, randomly select 2 or 3 sets of instructions. Proceed to make a PB&J in front of the class exactly as the student wrote the directions. If they don’t specify how many pieces of bread need peanut butter perhaps you put it on more than 1 slice of bread, if they don’t specify which utensil to use to spread the PB or Jelly use one of the random utensils you brought instead of a butter knife, set the peanut butter jar on top of the loaf of bread when the instructions read to “put PB on bread”, etc. The “Exact Instructions Challenge Video” models the activity for you.

Student/Teacher Planning:

What is the Problem?
Students do not know how to write clear and concise experimental procedures. Students also do not know what other considerations need to be accounted for in planning and conducting an agriscience research SAE.

Why is it important we solve it?
Students must think through and plan out their experiment prior to jumping right in. Experimental procedures must be written in a clear and concise manner that is replicable.

How should we solve it?
Students will practice writing experimental procedures and a material list for their experiment. Students will also develop a budget and other planning tools that will be used for their agriscience research SAE.

Problem Solution:

How you teach it and what you teach

Teacher Task	Instructions/Guidance

Interest Approach *(5 minutes)*	On a half sheet of paper, ask students to write out step by step how to make a peanut butter & jelly sandwich. After students have written their directions, randomly select 2 or 3 sets of instructions. Proceed to make a PB&J in front of the class exactly as the student wrote the directions. If they don't specify how many pieces of bread need peanut butter perhaps you put it on more than 1 slice of bread, if they don't specify which utensil to use to spread the PB or Jelly use one of the random utensils you brought instead of a butter knife, set the peanut butter jar on top of the loaf of bread when the instructions read to "put PB on bread", etc. The "Exact Instructions Challenge Video" models the activity for you.
Student/Teacher Planning *(5 minutes)*	After creating the sandwiches, pose this question to students: "What could've been done differently to create sandwiches closer to the result intended?" Guide students to look closer at the procedures they wrote. Discuss what was successful and unsuccessful about them. Share examples of good procedures and poor procedures. Transition discussion to how and why experimental procedures are used.
Writing Quality Procedures & Material Lists *Google Slide #3-8* *& Student Workbook* *(15 minutes)*	Work through slides 3-5 with students. Students will continue to follow along in their guided notes and brainstorm materials they will need for their experiment. Proceed to work through slides 6-8 with students. Discuss why it's important to plan experimental procedures ahead of time, qualities of good experimental procedures and finally give students the opportunity to draft experiment procedures they will use in their experiment on pg 18 of their workbook. (This should not be the sole time students spend developing their experimental procedures).
Importance of Recordkeeping (10 Minutes) *Google Slide #9*	Display slide 9 and ask students to turn and discuss the questions on the slide with an elbow partner. Select students to share their responses for each question. Continue through slides 9-11 discussing with students the importance of data collections, record keeping,

	applications to both SAEs and research projects and anything additional you or their specific science fair may require in terms of records. Students will be following along in their guided notes during this time.
Independent Work Time & Continuation of Lesson (Remainder of class or additional class period)	This time can be spent allowing students to continue to draft their procedures and material lists or it can be spent setting up student record books (either a physical notebook or via AET). Additional AET resources have been linked above and are included in the Student Workbook.

Applying Solutions: *How students can practice what you taught:*
Students will write experimental procedures and material lists for their own experiment. Students will also develop a budget and implement other planning tools that will be used for their agriscience research SAE.

Evaluation: *How you assess what they learn:*
Student's experimental procedures are written clearly and concisely in a manner that is replicable. Material lists are comprehensive of the entire project. Student's use of detailed journaling and records allow for interpretation of data, profit/loss statements and identification of errors.

Building Middle School SAEs & AFNR Research

Lesson 5 – Planning & Conducting Your Experiment

Student Learning Objectives:

- ✘ Formulate specific and replicable procedures/methods.
- ✘ Assemble a comprehensive materials list.
- ✘ Identify best practices for journaling, data collection and reporting in AET.

Creating a Materials List

https://unsplash.com/photos/3eDjj4dmC0s

What will you need to conduct the experiment?

–Include amounts

–Include brands, if important

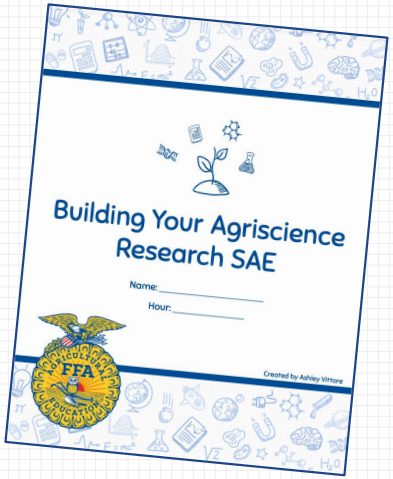
–Be as specific as possible!

Fresh Spaghetti:

- 1- 12 inch frying pan
- 1- 2.5 qt soup pot
- 5 ripe on the vine tomatoes
- 1 bulb of fresh garlic
- ¼ cup fresh chopped basil leaves
- 1 lb uncooked Barilla spaghetti noodles
- 1 tsp sea salt
- 1 tsp black pepper

Usually these are written as a bulleted list

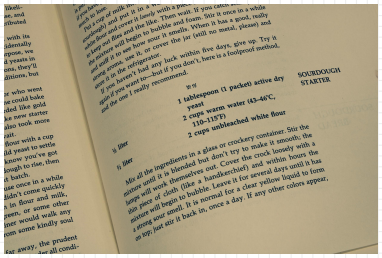
Look at the planning section on Pg 18 of your workbook and begin drafting your materials list for your experiment.



Experimental procedures are defined as the specific techniques used in conducting a particular experiment.

Designing Experimental Procedures

- ✘ Write out every step to be taken
- ✘ Start with an action word
- ✘ Include every single step so that someone other than you could replicate your experiment.
- ✘ Usually written as a numbered list



Imagine you are writing your own recipe

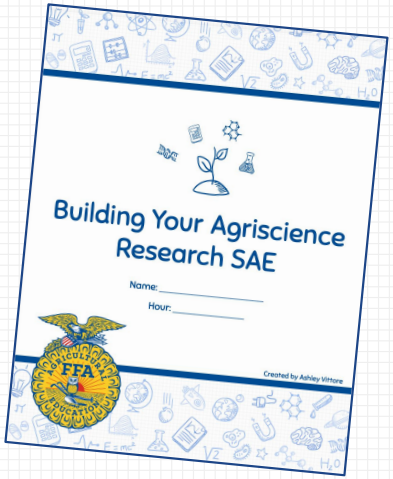
https://unsplash.com/photos/VPrVFrh5JLc

Designing Experimental Procedures

When designing experimental procedures you must ALWAYS consider…

- ✘ Experimental Group: groups that are being tested
- ✘ Repeated Trials to:
  - –Ensure the results aren't due to chance
  - –Eliminate any errors
  - –Ensure the data is precise

- ✔ Look at the planning section on Pg 18 of your workbook and begin drafting your procedures for your experiment.



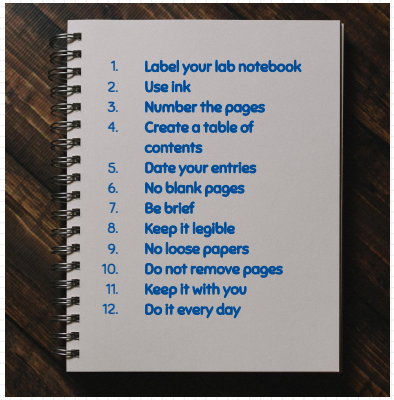
Turn & Talk: Records & Data Collection

- ✘ Why are records and data collection an important thing to consider?
- ✘ What kinds of records and data do you think we should keep track of?
- ✘ How should we keep track of that information?

Setting Up Records For Success

The records book is one of the most important pieces of a research project. It will contain accurate and detailed notes of a well-planned, implemented research project.

- ✘ Should be a consistent and thorough record of the project
- ✘ Organize and record collected data in charts
- ✘ Note any challenges, changes, errors or abnormalities
- ✘ Keep track of any expenses for your budget



https://unsplash.com/photos/dgVSuJu58C0

Recordkeeping For SAEs VS Research

Recordkeeping for SAEs	Records for Research & Experimentation
• Keep accurate record of income and expenses (cash flow) • Track time invested into SAEs • Gather evidence to be used for FFA Awards & Degrees • Keep track of capital items such as equipment, animals and supplies • Upload data records, photos and other evidence that will used in project report	• Keep an exact record of steps taken and observations made during experimentation • Documents exactly what you did and when you did it • Record questions that arise as you go • Keep track of other ideas, product design, challenges, and data (great to look back on when writing final report • Keep accurate record of supplies, expenses and time vested.

Setting Up Records For Success

Depending on your teacher's requirements or the requirements of the science fair you will be participating in, records may be kept in a dedicated notebook or logged online in AET.

https://www.theaet.com/about

Title of Unit: Building Agriscience Research & SAEs

Title of Lesson: Sharing Your Findings (Lesson 6 of 6)

Situation: The purpose of this lesson is to prepare students so they can share the findings of their agriscience research SAE. Students will practice analyzing data, learn how to write a results discussion, conclude the results of their own research and prepare to share their agriscience research SAE with appropriate audiences.

Objective(s):
Students can summarize, represent and interpret data with one or more variables.
Students can use evidence collected during research and thorough reasoning to support or refute a hypothesis.
Students can communicate findings within community and appropriate audiences.

Core Standards:
NGSS Science and Engineer Practices (6-8th grade)
Practice 2 Developing and Using Models
Practice 4 Analyzing and Interpreting Data
Practice 6 Constructing Explanations and Designing Solutions
Practice 7 Engaging in Argument from Evidence
Practice 8 Obtaining, Evaluating, and Communicating Information

Materials:

Students:
Building Your Agriscience Research SAE Workbook
1 piece of graph paper
Writing utensil and colored pencils

Teacher:
Lesson 6_Sharing Your Findings Google Slide Presentation
Computer with internet access & projector
Individual/snack size pack of M&Ms or Skittles - 1 per student
Napkins - 1 per student

References: *Specific texts, web sites etc. (so you can find it)*
National FFA Agriscience Fair Resources

https://www.ffa.org/participate/awards/agriscience-fair/

Interest Approach: Distribute packs of M&M/Skittles to students. Instruct students to open their bag of candy and dump them onto a napkin so they can visibly see all of the candy. Instruct students to not eat any of the candies yet. Ask students for ideas on how we could represent the number of candies and colors each person in the class received. Students will likely suggest that we could count the candies and create a table or graph. Instruct students to count their candies and colors and create a table on their graph paper. Then ask students how they could visibly display their data for others to see. Students will likely suggest graphs and charts. Next ask students to think about what kind of graphs or charts would best fit this kind of data. Student consensus will likely be bar graphs or pie charts. Give students time to create both a bar graph and pie chart on their paper for the candy data. Students can eat their candies when this is done.

Student/Teacher Planning:

What is the Problem?
Students have completed their agriscience research SAEs and must now prepare to share the findings of their research.

Why is it important we solve it?
Sharing results and data is an integral part of the scientific process and the science community. Sharing results and data allows for scientists to collaborate, replicate experimentation, and can result in new findings within the field.

How should we solve it?
Students will learn how to compose results and a conclusion for their research. Students will also learn best practices for displaying data and will begin to create a written report for their project that can be shared or presented.

Problem Solution: *How you teach it and what you teach*

Teacher Task	Instructions/Guidance
Interest Approach	Distribute packs of M&M/Skittles to students. Instruct

M&M candies, napkins, graph paper & Google Slide *(10-15 minutes)*	students to open their bag of candy and dump them onto a napkin so they can visibly see all of the candy. Instruct students to not eat any of the candies yet. Ask students for ideas on how we could represent the number of candies and colors each person in the class received (Slide #3). Students will likely suggest that we could count the candies and create a table or graph. Instruct students to count their candies and colors and create a table on their graph paper. Then ask students how they could visibly display their data for others to see. Students will likely suggest graphs and charts. Next ask students to think about what kind of graphs or charts would best fit this kind of data. Student consensus will likely be bar graphs or pie charts. Give students time to create both a bar graph and pie chart on their paper for the candy data. This is an excellent opportunity to conduct an informal assessment of student abilities and identify students who will need extra assistance in graphing. Students can eat their candies when this is done.
Student/Teacher Planning *(5 minutes)*	Transition by discussing with students that now that they are done with their research, they can begin gathering their data together into tables and graphs such as the ones we created for the M&Ms. Graphs and tables such as these make it easier to share the data collected from research and it also makes it easier to analyze trends and outcomes of the research when drawing conclusions about the hypothesis they put to the test.
Creating and Using Tables & Graphs *Google Slide & Student Workbook* *(15 minutes)*	Go over slides 4-9 with students discussing the purpose of a results section, data tables and graphs/charts. Students will follow along in the student workbook with condensed guided notes. After completing slide 9, direct students to pg 21 of the workbook. Students will analyze the data presented and fill in the discussion of results. You may choose to show students other written examples of results.
Writing Results & Conclusions *Google Slide & Student Workbook*	Go over slides 10 & 11 with students discussing the purpose and components of a conclusion. There is one example included in the google slide presentation but you

(5 minutes)	may choose to show students additional written examples.
Creating a Written Report & Preparing for the Next Steps *Google Slide & Student Workbook* *(remainder of class period or additional time inside/outside of class)*	Go over slides 12-14 with students. This is where you can go over the written report and display requirements you are requiring from students. The outline in the google slide presentation and the written report template in the workbook is from the National FFA Agriscience Fair Handbook. Visit https://www.ffa.org/participate/awards/agriscience-fair/ for other resources, guides & scoring rubrics.

Applying Solutions: *How students can practice what you taught:*
Students will create their own tables and graphs using data from their own experiments. Students will also write a written report on the research including results and conclusion.

Evaluation: *How you assess what they learn:*
Students have created and conducted their own agriscience research project which they will now be writing a written report for. Depending on class requirements and the student, the development of a science fair project, display board, etc. can also be evaluated.

Building Middle School SAEs & AFNR Research

Lesson 6– Sharing Your Findings

Student Learning Objectives:

- Summarize, represent and interpret data with one or more variables.
- Use evidence collected during research and thorough reasoning to support or refute a hypothesis
- Communicate findings within community and appropriate audiences.

- How can we represent the number of candies and the colors each person received?
- How could you visibly display your data for other to see?
- What kind of graphs or charts would best fit this kind of data?

https://unsplash.com/photos/ugV_7iiFRxM

Results

Results (actual numbers/info itself)

- Collect data in an organized form during an investigation *(Ex. data table)*
- Present data in an easy-to-read way, such as a graph

Analysis (Discussion of results)

- Only make statements about what the data shows
- Highlight any trends or patterns seen in the data
- Discuss any potential errors in the data

Data Tables

- ✘ Descriptive Table Title
- ✘ Titles for both rows and columns
- ✘ Units

Dairy products: Per capita consumption, United States (pounds per person) [1]

Year	Fluid beverage milk [2]	Cheese			Butter	Dry products				Frozen products					Yogurt, other than frozen	Evaporated and condensed milk			All products, milk-fat milk-equivalent basis
		American type	Other-than-American	Cottage		Dry whole milk	NDM and SMP [3]	Dry butter-milk	Dry whey and WPC [4]	Ice cream		Frozen yogurt	Sherbet	Other frozen dairy plus water and juice ices [5]		Whole		Skim	
										Regular	Low-fat and nonfat [5]					Canned	Bulk	Bulk and canned	
2010	177	13.3	19.4	2.3	4.9	0.2	3.2	0.3	1.9	14.0	6.5	1.0	1.0	1.6	13.4	1.5	0.5	5.2	605
2011	173	13.0	20.0	2.3	5.4	0.2	3.0	0.3	2.0	13.2	6.4	1.2	0.9	1.6	13.6	1.5	0.4	5.2	604
2012	169	13.3	20.0	2.3	5.5	0.2	3.0	0.3	2.2	13.2	7.0	1.1	0.8	1.6	14.0	1.4	0.6	5.3	615
2013	164	13.4	20.1	2.1	5.5	0.2	2.9	0.4	2.2	13.1	6.0	1.4	0.9	1.6	14.9	1.4	0.5	5.3	608
2014	158	13.7	20.5	2.1	5.5	0.2	3.1	0.3	2.2	12.5	6.2	1.3	0.9	1.6	14.9	1.0	0.5	5.4	616
2015	155	14.0	21.1	2.1	5.8	0.3	3.3	0.3	2.7	12.9	6.5	1.4	0.8	1.7	14.4	1.4	0.8	5.5	630
2016	153	14.4	22.1	2.2	5.7	0.3	3.0	0.3	2.4	12.9	6.4	1.2	0.8	1.6	13.8	1.4	0.7	5.4	646
2017	149	15.1	21.9	2.1	5.7	0.3	2.8	0.3	2.2	12.3	6.7	1.2	0.8	1.7	13.7	1.1	0.6	5.1	645
2018	145	15.4	22.6	2.1	6.0	0.3	2.4	0.4	2.4	12.0	6.6	1.0	0.7	1.8	13.6	1.3	0.7	4.9	646
2019	141	15.5	22.8	2.1	6.2	0.3	2.7	0.3	2.8	12.1	6.6	1.1	0.8	1.8	13.4	1.2	0.7	4.8	653

[1] Resident population plus armed forces overseas estimates (as reported by the U.S. Department of Commerce, Bureau of the Census) were used for all products except fluid milk. For fluid milk products, resident population estimates, not including armed forces overseas, were used.

[2] Fluid beverage milk includes the milk-content weight of beverage milks: whole, reduced fat, low fat, skim, flavored, buttermilk, eggnog, and miscellaneous.

[3] NDM = nonfat dry milk. SMP = skim milk powder.

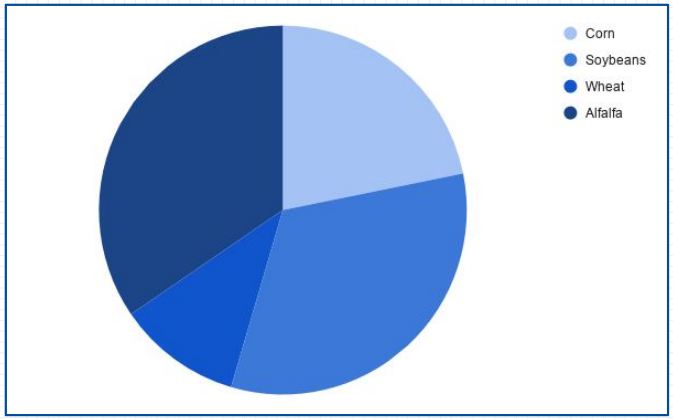
[4] WPC = whey protein concentrate

[5] Before 1995, nonfat ice cream was not reported.

[6] Other frozen products include mellorine from 1975 to 1995.

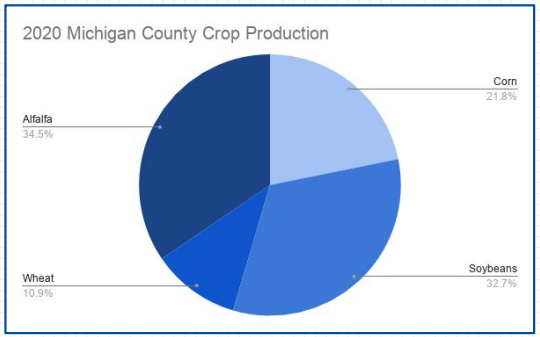
Sources: USDA Economic Research Service calculations using data from USDA, National Agricultural Statistics Service; USDA, Farm Service Agency; USDA, Foreign Agricultural Service; USDA, Agricultural Marketing Service; U.S. Department of Commerce, Bureau of the Census; and California Department of Food and Agriculture.

What is Missing??



Components of a Graph

- ✘ Descriptive title
- ✘ Labels on the Horizontal & Vertical Axis
- ✘ Legend
- ✘ Data Points



**Place your independent variable on the x-axis of your graph and the dependent variable on the y-axis

Types of Graphs

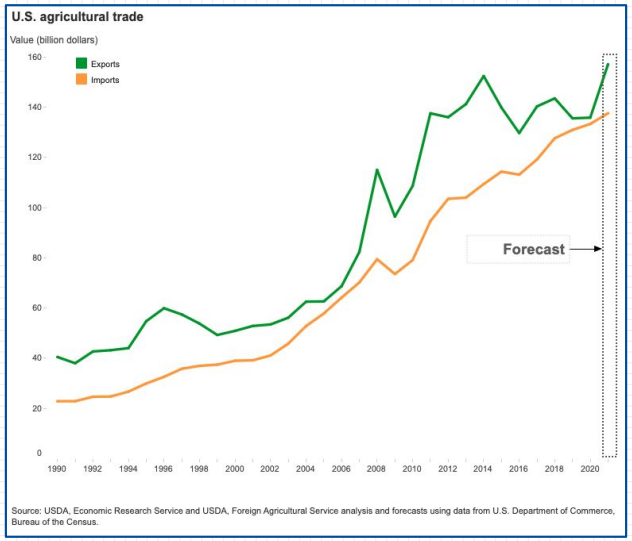
Different types of graphs are appropriate for different experiments.

A bar graph might be appropriate for comparing different trials or different experimental groups. It also may be a good choice if your independent variable is not numerical.

A time-series plot can be used if your dependent variable is numerical and your independent variable is time.

An xy-line graph shows the relationship between your dependent and independent variables when both are numerical and the dependent variable is a function of the independent variable.

A scatter plot might be the proper graph if you're trying to show how two variables may be related to one another.



Drawing Conclusions

Your conclusions summarize how your results support or refute your original hypothesis:

- ✘ Summarize results in a few sentences and use summary to support your conclusion. Include key facts from your background research to help explain your results as needed.
- ✘ State whether your results support or contradict your hypothesis.
- ✘ State the relationship between the independent and dependent variable.
- ✘ Summarize and evaluate your experimental procedure, making comments about its success and effectiveness.
- ✘ Suggest changes in the experimental procedure (or design) and/or possibilities for further study

NOTE: Data does NOT prove/disprove!!

Conclusion

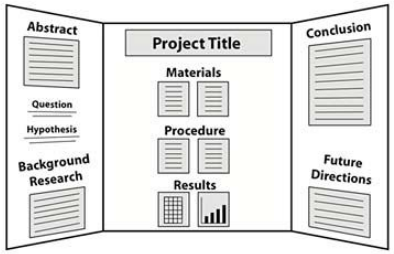
The hypothesis that perlite would yield the largest average growth of radish plants was rejected. At the end of the experiment, the perlite actually had the slowest growth rate of all three mediums. Vermiculite had the largest growth rate. The main source of error could be the wicks not working properly to transfer water. If the mediums became either too wet or too dry, then the height of the plants would differ. The vermiculite may have yielded a better growth rate for radishes because perlite allows too much air to flow and did not retain enough water. The vermiculite worked best because it allowed a good amount of air and water for flow through it. The average growth of the radishes that were grown in vermiculite was 11 inches, while soil and perlite were 76.9 and 7.2 inches respectively. More and more people are starting to use hydroponics systems to grow vegetables. With the rising cost of hydroponics mediums, as well as seeds, the consumer needs to know what will work best for them. In order to save the most money on mediums and seeds, a consumer should use vermiculite to grow their vegetables.

Communicating Your Research:

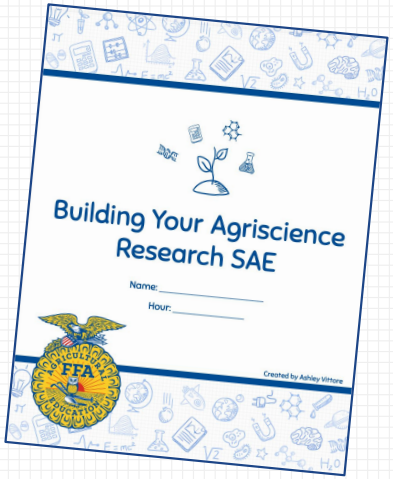
Generally when competing in a science fair you will have to write a written report. Below is an example outline. Be sure to check with your event rules for specifics

- Title Page
  - Project Title
  - Includes student's name(s), chapter, state, category Division
- Importance
  - Why is this topic important to the agriculture industry?
  - What problem does the investigation solve for agriculture?
- Other's work
- Materials and Methods
- Hypothesis/Anticipated Results
- Results
- Discussion
  - What do the results of the study mean?
  - How are they related to what others found in the "Other's Work" section?
- Conclusions
- Summary
- Acknowledgements

Display Board



- A written report template is located on Pg 36 of the workbook. You can use this to guide your report if your teacher or the event you are participating in has not provided you with a template.



https://www.sciencebuddies.org/science-fair-projects/science-fair/science-fair-project-display-boards

https://www.ffa.org/participate/awards/agriscience-fair/

Building Your Agriscience Research SAE

Name: _____

Hour: _____

Created by Ashley Vittore

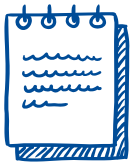


Table of Contents

Lesson 1: What is Agriscience?

Student Learning Objectives:

- ❏ Define agriscience and explain why agriscience research is important to AFNR systems.
- ❏ Describe skills and characteristics used by scientists.
- ❏ Create a scientific question and describe its purpose.

Define Agriscience:_____

_____

Brainstorm: What are skills and characteristics you think you will need in order to conduct your own agriscience research?

-
-
-
-

Skills that scientists use to think scientifically include :

1.
2.
3.
4.
5.
6.

True or False : Questions are an essential part of the scientific process.

True or False : Questions usually start specific and get broader.

Lesson 1: What is Agriscience?

Good Scientific Questions	Poor Scientific Questions
✓	✘
✓	✘

Read each of the following questions and check yes if the question is a good scientific question. Check no if the question is not a good scientific question.

Yes	No	
		How does my cat feel about its diet?
		Does salt negatively affect the rate of radish seed germination?
		Will fertilizer make grass grow greener?
		What type of soil filters water best?
		Which national park is the best?

Lesson 1: What is Agriscience?

Create your own scientific question: _____

_____

What is the purpose ? *(why is answering this question important)*

_____

_____

_____

Create your own scientific question: _____

_____

What is the purpose ? *(why is answering this question important)*

_____

_____

_____

Create your own scientific question: _____

_____

What is the purpose ? *(why is answering this question important)*

_____

_____

_____

Lesson 2: Intro to Agriscience SAEs

Student Learning Objectives:

- ❏ Explain the purpose of an SAE.
- ❏ Describe the differences between an experimental, analytical and and invention agriscience research SAEs.

Describe Supervised Agricultural Experiences. What are SAEs? _____

_____

_____

You foundational SAE Includes:

1.
2.
3.
4.
5.

Explain how an Immersion SAE is different from a Foundational SAE: _____

_____

_____

Specifically, describe your tentative Research SAE. Use the following prompts:

I am unsure if....
I predict that....
I think this will be true because...
I plan to investigate this by....

The next step is to identify which variation of Research SAE best fits the investigation you would like to complete. Read through the definitions and additional insights, then choose which best fit what you want to investigate. Explain your choice in the table below.

Adapted from The National Council for Agriculture Education, 2018.

Lesson 2: Intro to Agriscience SAEs

Definition of Research SAE Variations	Additional Insights	Explanation of Why You Choose This Variation
An EXPERIMENTAL RESEARCH SAE involves the application of the scientific method to control certain variables while manipulating others to observe the outcome. You will define a hypothesis, determine an appropriate experimental design, conduct the research, collect the data, draw conclusions from the data and recommend further research that can be done.	This is a great starting point if research is new to you. The goal is to limit your investigation to ONE independent and ONE dependent variable and compare your findings to a control. You will repeat the investigation with dozens of trials to make sure your data is sound. It is likely your initial investigation will lead to new insights and ideas to further test! Check out Science Buddies "What is the Scientific Method" for a framework in Experimental design If the question or problem you are investigating requires you to build something or create a new process, this is the variation for you. You will likely identify one dependent variable and apply multiple independent variables through iterations of prototypes. When complete, you will be able to make recommendations of how your product or process helps solve the identified problem. If your investigation is designed to gather data to gain further understanding and perspective of the relationship between existing variables, then analytical is for you. Large groups of data (minimum of 36 data points) will need to be collected and statistically analyzed to offer insight into the question being studied. Check out the American Statistical Association "Guidebook for Student Projects in Data Analysis" for a framework in Analytical design.	Circle the variation you chose: Experimental Invention Analytical
An INVENTION RESEARCH SAE applies the engineering design process to create a new product or service. This type of research often begins with the identification of a need and the development of a product followed by a design process of prototyping and testing that results in a product that meets the identified need.		Why did you choose this variation?
An ANALYTICAL RESEARCH SAE often begins with a question that asks why or how something occurs, followed by a period of data collection using qualitative and/or quantitative methodologies. You will conduct analysis of data, facts and other information to determine the answer to the question posed.		

Adapted from The National Council for Agriculture Education, 2018.

Lesson 2: Intro to Agriscience SAEs

How does your Research SAE relate to specific components within your AFNR career area of interest?

How can the knowledge and skills you develop through your Research SAE help you meet your career preparation goals? Hint: Consider your goals related to the following:

·Career exploration
·Employability skills
·Personal financial management
·Workplace safety
·Agricultural literacy

SAE Intended Outcomes: Below, record at least three intended outcomes for your Research SAE, which could look like goal statements. These should be specific and measurable. Consider the following:

- *How this Research SAE could help you progress toward achieving the career goals outlined in your career plan*
- *How this Research SAE could help you progress toward meeting any training and experiential requirements for pursuit of a career in your AFNR pathway of interest*
- *Knowledge that could be gained specific to the career area or, in general, related to trends in the AFNR system*
- *Skills that could be developed related to the career area*
- *Financial goals*
- *Professional networking opportunities*

Intended Outcome Statement	Relationship to Career Plan	How to Measure Progress
1.		
2.		
2		

Adapted from The National Council for Agriculture Education, 2018.

Lesson 3: Building Background

Student Learning Objectives:

- ❑ Explain the importance of background research for an experiment.
- ❑ Create appropriate background research questions.
- ❑ Determine credibility of potential resources.

What are a few reasons why background research is important?

What are the steps to building a research plan?

1.
2.

Credible Sources are...

Credibility Table

In general, do not use a source if it doesn't pass the CRAAP test! For our purposes, do not use any sources that score less than 6 points using the credibility table.

Factors to consider	Least reliable (0 points)	Possibly reliable (1 point)	Most reliable (2 points)
Currency	No date of publication or revision given	Outdated for this particular topic	Recently published or revised
Reliable source	Unreliable website, no additional info available	Possibly reliable	Official government or organization, institutional sites, academic journals
Author	No author is given / the author is not qualified to write about this topic	Author is educated on topic or is staff of an organization assumed to be knowledgeable on this specific topic	Specifically identified expert in this field with degrees / credentials in this subject
Accuracy	No review process and information is not supported by evidence from cited sources	The information may have been reviewed or edited by someone knowledgeable in the field. It mentions but does not directly cite other sources	The information has been peer reviewed and is supported by evidence from cited credible sources
Purpose	Obviously biased or trying to sell you something	Sponsored source; may present unbalanced information	Balanced, neutral, presents all sides of the issue fully

The credibility table is adapted from The CRAAP Test, created by Sarah Blakeslee, of the University of California at Chico's Meriam Library.

Lesson 3: Building Background

Creating a Research Plan

What is the Question you are going to try to answer:

_____

_____

Brainstorm keywords and phrases from your question and the topic in general? (what would you have to know to understand the full question and topic?)

_____	_____	_____
_____	_____	_____
_____	_____	_____

Use the keywords you came up with to guide your research. Try to come up with a minimum of two questions per category. Don't worry whether or not you already know the answer to the questions. These are intended to guide you to the big picture.

Possible Questions (you can come up with others)		Substitute keywords for the blanks in the previous column. Write down other relevant questions and use them to guide your research.
Why	Why does ___ happen? Why does ___ ___? Why _____?	
How	How does ___ happen? How does ___ work? How does ___ detect ____? How does one measure ___? How does we use ____? How _____?	

Adapted from: Science Buddies, 2007

Lesson 3: Building Backgrounds

Possible Questions (you can come up with others)		Substitute keywords for the blanks in the previous column. Write down other relevant questions and use them to guide your research.
Who	Who needs ___? Who discovered ___? Who invented ___? Who _____?	
What	What causes ___ to increase/decrease? What is ___ made of? What are the characteristics of ___? What is the relationship between _ and __? What do we use ___ for ? What _____?	
When	When does ___ cause ___? When was ___ discovered? When _____?	
Where	Where does ___ occur? Where does ___ get used? Where ____?	

To analyze the results from your experiment, you may need to consider key formulas or equations. Are there any steps in your project that will require either? List steps or tasks below that may require formulas or equations:

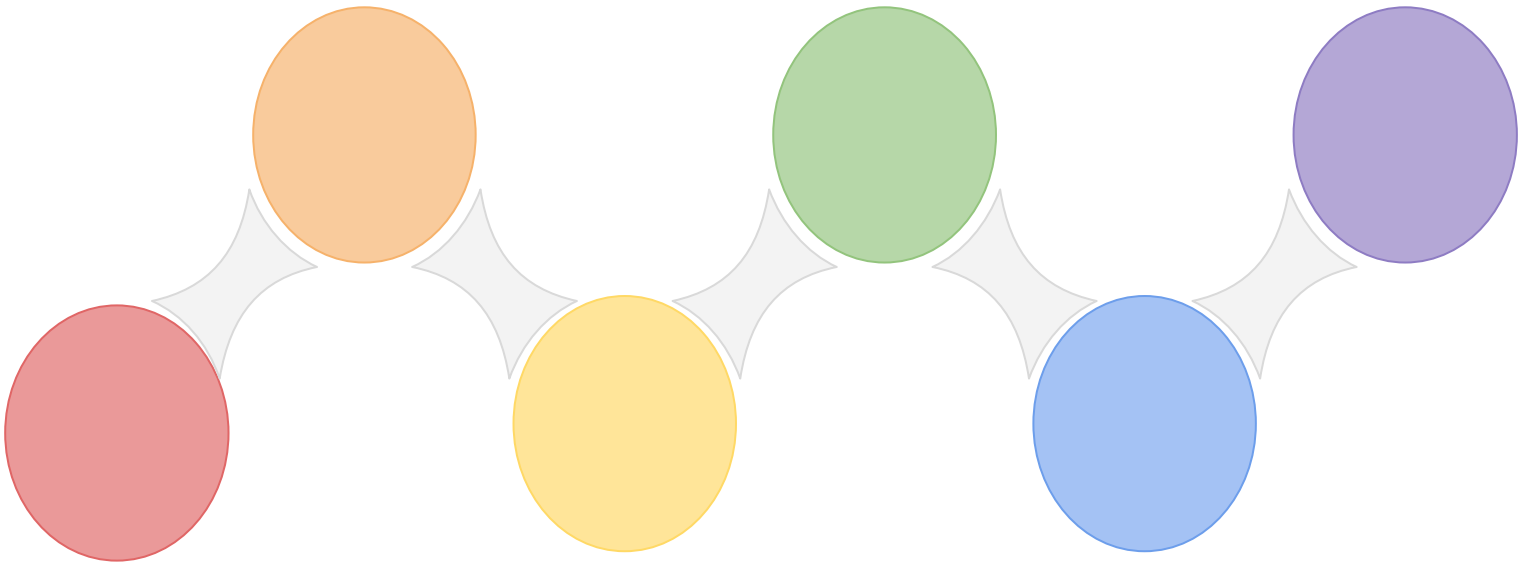
Adapted from: Science Buddies, 2007

Lesson 4: Writing a Hypothesis

Student Learning Objectives:

- ❑ Identify testable questions and write hypotheses.
- ❑ Determine variables and controls used in an experiment.

The Scientific Method:



Why is the scientific method used? _____

_____

Qualitative VS Quantitative	
•	•
Example:	Example:

Lesson 4: Writing a Hypothesis

Independent Variable VS Dependent Variable	
•	•
Example:	Example:

Constant:_____

_____

Example:_____

Control:_____

_____

Example:_____

Pause & Think

What are several constants you would have to consider in an investigation of one of your scientific questions?

-
-
-

What would your control look like?

Lesson 4: Writing a Hypothesis

Practice Identifying Dependent and Independent Variables

Circle the Independent Variable and Underline the Dependent Variable.

Animal Science

1) A diet high in concentrate will increase the rate of gain in cattle.
2) Increasing frequency of handling will decrease stress in animals.
3) The microbial count in food processing facilities will differ based on the sanitation technique used.
4) The total amount of growth will increase depending on grazing frequency.
5) Different breeds of dairy cattle will produce different levels of butterfat in their milk.

Plant Science

6) Longer periods of exposure to sunlight will increase plant growth.
7) The rate of germination will vary depending on the type of seed.
8) Different levels of nutrients in the soil will affect plant growth.
9) Seeds stored at different temperatures will have different levels of viability.
10) Spoilage of fruit will increase at higher temperatures.

Adapted from: Colorado FFA & Agricultural Education, 2013

Lesson 4: Writing a Hypothesis

What is a Hypothesis?_____

_____

_____

_____

Formatting your Hypothesis:

" IF _____ (_____) _____ , THEN _____ (_____) _____ ."

Remember: The independent variable is the one you, the "scientist" control and the dependent variable is the one that you observe and/or measure the results.

Elements of a Good Hypothesis:

1.

2.

3.

4.

Example of a poor hypothesis:	Example of a good hypothesis:

Lesson 4: Writing a Hypothesis

Writing Hypothesis and Identifying Variables

Write an "If Then" hypothesis for each of the following experiments and identify the independent and dependent variables.

Experiment #1: Pigs will produce higher quality meat if they are handled in groups.

Independent Variable:

Dependent Variable:

Hypothesis:

Experiment #2: Free Range vs. Conventional Chickens

Independent Variable:

Dependent Variable:

Hypothesis:

Experiment #3: Nitrogen and Plant Growth

Independent Variable:

Dependent Variable:

Hypothesis:

Now think about your own Experiment:

Independent Variable:

Dependent Variable:

Hypothesis:

Lesson 5: Planning & Conducting Your Experiment

Student Learning Objectives:

- ❑ Formulate specific and replicable procedures/methods.
- ❑ Assemble a comprehensive materials list.
- ❑ Identify best practices for journaling, data collection and reporting in AET.

Define Experimental Procedure:_____

_____

When designing experimental procedures:

-
-
-
-

What is the purpose of a materials list?_____

_____

What should you do when creating a materials list?

1.
2.
3.
4.

Lesson 5: Planning & Conducting Your Experiment

MATERIALS: List the materials needed for your project. Make sure to include quantities and brands if applicable.. Don't forget to include measurement tools if you used any (example: ruler, measuring cup).

PROCEDURES: Write the procedures for setting up and conducting your experiment. Someone else should be able to follow your procedure and complete the experiment just as you did. Use another sheet if necessary.

Lesson 5: Planning & Conducting Your Experiment

Why are records and data collection important? _____

_____

Things to remember when setting up your record book:

-
-
-
-

Provide examples below showing similarities and differences between the two types of record keeping.

Recordkeeping for SAEs	Records for Research & Experiments

I will be keeping my records in the following location: _____

Lesson 6: Sharing Your Findings

Student Learning Objectives:

- ❑ Summarize, represent and interpret data with one or more variables.
- ❑ Use evidence collected during research and thorough reasoning to support or refute a hypothesis
- ❑ Communicate findings within community and appropriate audiences.

Results: _____

_____

Analysis: _____

_____

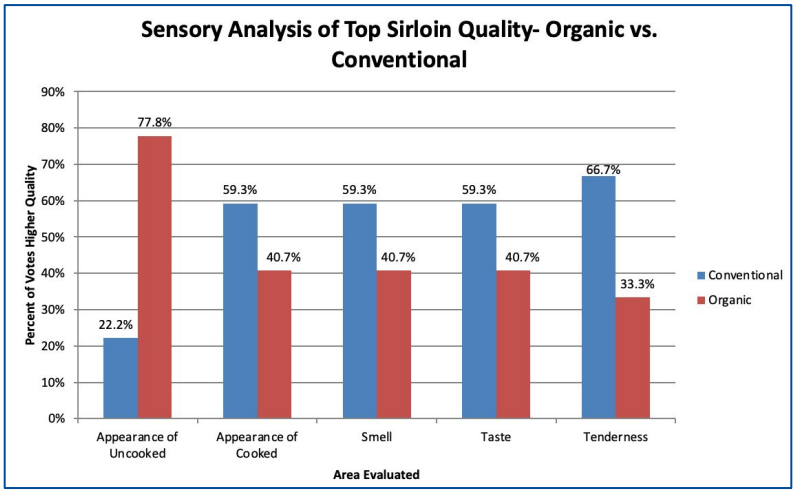
Checklist for Data Tables:	Checklist for Graphs:
❑	❑
❑	❑
❑	❑
	❑

Your conclusions summarize how your results support or refute your original hypothesis:

-
-
-
-
-

Lesson 6: Sharing Your Findings

Fill in the blanks with data from results:



Sensory Analysis of Top Sirloin Quality- Organic vs. Conventional

Total Number of Participants: 27

Top Sirloin

Area Evaluated	Number of Votes Higher Quality Sample A	Number of Votes Higher Quality Sample B	Percent of Votes Higher Quality Conventional	Percent of Votes Higher Quality Organic	Total
Appearance of Uncooked	6	21	22.2%	77.8%	100%
Appearance of Cooked	16	11	59.3%	40.7%	100%
Smell	16	11	59.3%	40.7%	100%
Taste	16	11	59.3%	40.7%	100%
Tenderness	18	9	66.7%	33.3%	100%

Class Experiment: Organic vs. Conventional

Discussion of Results

A total of _____ individuals participated in this study. Organic and conventional samples
(Number)

of _____ were evaluated by the participants. Participants evaluated the samples
(Food being evaluated)

based on five areas: _____, _____, _____, _____, and _____. Participants
(Area 1) (Area 2) (Area 3) (Area 4) (Area 5)

showed a preference for the _____ product in the area of _____ with
(Conventional or Organic) (Area 1)

_____ % choosing the sample over the _____ sample. In the area of _____
(Conventional or Organic) (Area 2)

individuals preferred the _____ sample (_____%). _____ percent of
(Conventional or Organic) (% in words)

participants ranked the _____ sample as superior in _____ . The participants
(Conventional or Organic) (Area 3)

preferred the _____ of the _____ over the _____ sample. _____
(Area 4) (Conventional or Organic) (Conventional or Organic) (% in words)

percent of participants responded that the _____ product had a more
(Conventional or Organic)

desirable_____. The majority of participants preferred _____ out of five qualities of
(Area 5) (Number of Areas)

the _____ sample while they only favored _____ of five qualities of the _____
(Conventional or Organic) (Number of Areas) (Conventional or Organic)

sample.

Adapted from: Colorado FFA & Agricultural Education, 2013

Building Your Agriscience Research SAE

Agriscience Research & SAE Planning

Planning Your Own Agriscience Research SAE

Initial Observation/Problem/ Scientific Question:

How does this pertain to Agriculture, Food and Natural Resource Systems?

What is the purpose of your project/experiment?

PURPOSE: _____

Check the box to indicate which type of agriscience SAE this project will be:

- ❑ Experimental
- ❑ Analytical
- ❑ Invention

Create an interesting and catchy title that relates to your purpose and project topic.

Title of your Project: _____

Planning: How long will your project take to complete? When will you need to start your project so that it is ready in time for your deadline or science fair?

Planning Your Own Agriscience Research SAE

Research your project topic. You can use books, encyclopedias, magazines, the internet, and other sources.

Topic: _____

RESEARCH:

REFERENCES: Where did you find your information? Write the names and authors of the books and websites you used to find your facts below.

Planning Your Own Agriscience Research SAE

Write a hypothesis for your project. This is an educated guess about what you think the outcome of your experiment will be. Once you complete your experiment your hypothesis will either be proven (you were right) or rejected (what you thought would happen didn't).

Hypothesis: _____

_____

_____

_____

_____

_____

List the materials and write a procedure.

MATERIALS: List the materials needed for your project. Make sure to include amounts with units. Don't forget to include measurement tools if you used any (example: ruler, measuring cup).

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

_____ _____

PROCEDURE: Write the directions for completing your experiment. Number each step. Be very detailed in what has to be done. Someone else should be able to follow your procedure and complete the experiment just as you did. *Use your own words!*

_____

_____

_____

_____

Planning Your Own Agriscience Research SAE

PROCEDURE Continued:

Use another sheet if you need more space.

Conduct your investigation and collect data. Record the data from your experiment below. Use another sheet if you need to.

- Write down all of your observations and measurements below.
- Be sure to write your data in an organized like in a table or chart.
- Draw pictures of your experiment on another sheet. Don't forget labels!
- *Take photos of the experiment and yourself performing the experiment.*

Journal of Data and Observations:

Planning Your Own Agriscience Research SAE

Journal of Data and Observations Continued:

Planning Your Own Agriscience Research SAE

Write your results. Create a table and graph to display your data.

RESULTS:

Table: *Tables should be typed into Microsoft Excel or Google Sheets and used to create digital graphs.*

Planning Your Own Agriscience Research SAE

CONCLUSION: What happened in your experiment? What do your data and observations tell you? Was your hypothesis proven or rejected? What did you learn from this project? Look back at your research and include science concepts and ideas in your conclusion. After doing this experiment do you have any new questions that you would like to explore?

Planning Your Own Agriscience Research SAE

CONCLUSION Continued::

SUPERVISED AGRICULTURAL EXPERIENCE (SAE) RESEARCH PLAN

SAE is a student-led, instructor supervised, work-based learning experience that results in measurable outcomes within a predefined, agreed upon set of Agriculture, Food and Natural Resources (AFNR) Technical Standards and Career Ready Practices aligned to your career plan of study.

A Research Plan must be completed and approved for all **Research Immersion SAEs**. Its intent is to define the scope of the research, clarify responsibilities and roles and identify any safety issues to address.

A. This **Research Plan*** is in effect for the _____ school year.

1. **Type:** (Experimental, Analytical or Invention)
2. **Title of Research Project:** (Provide a clear and descriptive title for your research project.)
3. **Abstract**: (Present a summary of what you will be researching. Include why you are researching this topic or area and what you hope to discover.)
4. **Introduction**: (Summarize in two to three paragraphs the problem you are addressing or invention you are creating. Be sure to include the reason behind your proposed research. Explain why it is important and what you hope to accomplish by completing the work. This is also where you can include predictions about your potential outcomes.)
5. **Literature Review:** (In this section, highlight the findings of research by credible sources on the topic or issue in question. The literature review will provide proposal reviewers insights into what experts already know about the topic.)
6. **Methods and Results:** (Describe your hypothesis and proposed research methods. Be as descriptive as possible.
7. **Discussion:** (In this section, include any potential weaknesses or complications you may face with your research.)

B. SAE Risk Assessment Results: (Student, guardian, teacher and employer will complete the *Safety in Agriculture for Youth SAE Risk Assessment* and include findings and action items here.)

C. [Add school district specific or employer specific requirements here.]

SIGNATURES

Student _____

Parent/Guardian _____

Agriculture Instructor _____

SAE Goals

Create two goals for you SAE by completing the following activities.

Goal 1:

What will you accomplish with your goal?

(Specific)

How will you measure the progress of you goal? Will you have people holding you accountable to your progress?

(Measureable)

Is you goal attainable (doable) and do you have the time and resources to achieve it?

(Attainable)

How and why is this goal important to your SAE?

(Relevant)

When will your goal be complete? Be specific!

(Time-Bound)

Now, put this all together so that you have a clear goal that is specific, measurable, attainable, relevant, and time-bound.
Goal #1:

Adapted from the National FFA Organization, 2015.

SAE Goals

Create two goals for you SAE by completing the following activities.

Goal 2:

What will you accomplish with your goal?

(Specific)

How will you measure the progress of you goal? Will you have people holding you accountable to your progress?

(Measureable)

Is you goal attainable (doable) and do you have the time and resources to achieve it?

(Attainable)

How and why is this goal important to your SAE?

(Relevant)

When will your goal be complete? Be specific!

(Time-Bound)

Now, put this all together so that you have a clear goal that is specific, measurable, attainable, relevant, and time-bound.
Goal #2:

Adapted from the National FFA Organization, 2015.

SAE Planning & Timeline

Fill in the table to develop a timeline of specific activities that must be completed to plan, implement and evaluate your SAE.

Phase (Planning, Implementation, Evaluation)	Strategies and Action Steps	What goal is this related to?	Resources Needed	Timeline (at least 1 per month)
Is this action step a part of the planning, implementation, or evaluation phase of the SAE?	*What steps/activities are needed to move forward with the SAE?*	*What goal will this step help achieve?*	*What resources (money, time, equipment, other people, etc.) are needed to complete this step?*	*On what month and day will this be completed?*

Adapted from the National FFA Organization, 2015.

SAE Budget

Determine what you need to make your SAE happen and if it has a cost associated with it. Even if you will not end up paying money for an item, but will exchange labor or goods to receive the item include that here.

Capital Items

What long term items such as equipment, building, breeding animals, etc. do you need related to this SAE?

Item Name of Item *Example: Broiler Chicks*	Description Describe the item and why it's needed for the SAE. *Example: 50 Broiler chicks that will be raised on experimental feed ration*	Cost How Much will the item Cost? *Example: $1.32 per chick plus $5 shipping*

Operational Items

What items are needed to carry through with you SAE, but will be consumed during the project? Operational items include feed, vet services, repairs, gas, rent, etc.

Item Name of Item *Example: Chicken Starter Feed*	Description Describe the item and why it's needed for the SAE. *Example: Chicken feed needed to feed birds for the 8 week duration of the project.*	Cost How Much will the item Cost? *Example: $23.99/ bag*

Adapted from the National FFA Organization, 2015.

Written Report Template: National FFA Agriscience Fair

<<Project Title precisely describes the work. All numbers, chemical elements and compounds should be spelled out.>>

Student Researcher(s): <<enter here>>
Chapter: <<enter here>>
State: <<enter here>>
Category: Choose an item.
Division: Choose an item.

Importance

Why is the topic important to the agriculture industry?

<<Provide one clear, detailed paragraph answer here. The importance section is worth 10 points.>>

What problem does the investigation solve for agriculture?

<<Provide one clear, detailed paragraph answer here. The importance section is worth 10 points.>>

Other's Work

<<Clearly details what information currently exists concerning the research project. Reference where the information was found (website, book, article, etc.) is listed, then a paragraph written by the student researcher(s) clearly describing the reference and information it provided for each publication used. The other's work section is worth 15 points.>>

Materials and Methods

<<Clearly written to enable others to replicate the study and results. Section is written in first person and encompasses all materials required. If used, the statistical procedures are included. This section should be a narration of steps taken to complete the experiment. Do not list your steps. The materials and methods are worth 10 points.>>

Hypothesis/Anticipated Results

<< Student researcher(s) clearly states the hypothesis and/or anticipated results. This section is worth 5 points.>>

Results

<<Written results of the project are summarized. Trends and relationships are clearly addressed. No conclusions are made in this section. Data that can stand alone in the form of tables and/or figures are included. The results are worth 20 points.>>

Discussion

What do the results of the study mean?

<<Provide a clear, detailed answer here. The discussion section is worth 10 points.>>

How are they related to what others found in the "Other's Work" section?

<<Provide a clear, detailed answer here. The discussion section is worth 10 points.>>

Conclusions

<<The conclusion clearly states what should be done and/or changed as a result of the research. Clearly states what the next steps are to continue the research. Conclusions are worth 10 points.>>

Summary

<<The summary is two to three paragraphs describing the study conducted. Describes why the student researcher(s) chose to conduct the study, why the study is important to the agriculture industry, how the study was conducted, what was found by conducting the study and how the results apply within the agriculture industry. The summary is worth 5 points.>>

Acknowledgements

<<Detailed list or paragraph is included acknowledging anyone who assisted with any aspect of the project and how they helped. The acknowledgements are worth 5 points.>>

Notes:

Notes: