FLINN STEM

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IMSA Fusion — Out of the Silo STEM Curriculum Module

Table of Contents

Curricular Objectives

- **Explore STEM topics in the context of Agronomy; the science and technology of producing and using plants for food and fuel.**
- **Investigate issues at the forefront of agronomic research, including plant genetics, soil science, crop management systems, and new technologies.**
- **Develop an understanding of the role of agriculture in Illinois and the world.**
- **Engage in efficient process design and problem solving exercises to explore the multiple facets of the agricultural industry.**
- **Collect and analyze real data to make inferences and informed decisions regarding agricultural processes and management systems.**

Curriculum Summary

Out of the Silo: Agronomic STEM is a grade 6 – 8 curriculum which highlights the interplay between science, technology, engineering and mathematics inherent in the field of Agronomy. The growing of plants for commercial use, particularly food, is the essence of agronomy and the heart of this curriculum.

Agronomy in the Illinois region began long before Europeans arrived. Native Americans found the soil and climate well suited to growing corn and so it remains today. Fields for growing corn and soybeans dominate the state, as can be seen easily from the air. Students living in urban centers, who were unaware of Illinois' rural nature, will use satellite imagery to see how dominant agriculture is in Illinois and come to understand just how much we all depend on the state's number one business.

Students who frequently pass through the countryside in an automobile will learn much about what they have been seeing out the window. No longer will it be possible to drive past a silo, combine, or field of corn without remembering what they learned in IMSA Fusion. These students will enjoy explaining to their parents what is happening in these fertile fields and how all the parts of this complex business fit together to keep us fed.

Acknowledgements

Out of the Silo: Agronomic STEM has been a collaborative venture with the generous support, help, and time of several organizations and individuals. We would like to acknowledge their expertise and enthusiasm, and show our gratitude for the insights and support that they have provided throughout the development of this curriculum.

We would like to thank University of Illinois' Department of Crop Sciences graduate students Nicholas Heller and IMSA alumni Jessica Bubert for their expertise and contributions to the genetics unit. These students participated in several curriculum development discussions and provided developmental assistance in the area of epigenetics. The introduction of the epigenetics activity would not have been possible without their input and creativity. They were especially helpful in developing a method for modeling the regulation of gene expression within a cell.

Scott Bretthauer is an extension specialist in the Department of Agricultural and Biological Engineering at the University of Illinois. Scott provided valuable insight into the effects of particle drift during pesticide application during a presentation at the University of Illinois' Agronomy Day 2015. His discussion sparked the idea of providing students the opportunity to examine the relationship between droplet size, boom height and particle drift through observation and data collection.

In addition, we would like to recognize all of the wonderful people we spoke to along the way at the AMC Engineering Conference, the University of Illinois' Agronomy Day, the Illinois State Fair, the Farm Progress Show, and the Northern Illinois Farm Show.

Next Generation Science Standards (NGSS)

MS-ETS1.A – *The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.*

MS-ETS1.B – *A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Models of all kinds are important for testing solutions.*

MS-ETS1.C – *Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process – that is, some of those characteristics may be incorporated into the new design. The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.*

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

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

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

MS-ETS1-4 – *Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process so that an optimal design can be achieved.*

MS-ESS3-3 – *Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*

MS-ESS3.C – *Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.*

MS-LS1.A – *Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.*

MS-LS1.C – *Plants, algae, and many microorganisms use the energy from light to make sugars from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy.*

MS-LS2-1 – *Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.*

MS-LS2-4 – *Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.*

MS-LS1-5 – *Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.*

MS-LS2-5 – *Evaluate competing design solutions for maintain biodiversity and ecosystem services.*

MS-LS3.B – *Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring.*

MS-LS4.B – *In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.*

MS-LS4-6 – *Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.*

MS-LS4-5 – *Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.*

Next Generation Science Standards Reference:

NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States.* Washington, DC: The National Academies Press.

NGSS Cross Cutting Concepts

1. *Patterns*
2. *Cause and Effect: Mechanism and Explanation*
3. *Scale, Proportion, and Quantity*
4. *Systems and System Models*
5. *Energy and Matter: Flows, Cycles, and Conservation*
6. *Structure and Function*
7. *Stability and Change*

NGSS Science and Engineering Practices

SEP1: *Asking questions and defining problems.*
SEP2: *Developing and using models.*
SEP3: *Planning and carrying out investigations.*
SEP4: *Analyzing and interpreting data.*
SEP5: *Using mathematics and computational thinking.*
SEP6: *Constructing explanations and designing solutions.*
SEP7: *Engaging in argument from evidence.*
SEP8: *Obtaining, evaluating, and communicating information.*

Common Core State Standards Mathematics

6.EE.B.8 - *Write an inequality of the form $x > c$ or $x < c$ to represent a constraint or condition in a real-world or mathematical problem. Recognize that inequalities of the form $x > c$ or $x < c$ have infinitely many solutions; represent solutions of such inequalities on number line diagrams.*

6.RP.A.1 - *Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.*

6.RP.A.3 – *Use ratio and rate reasoning to solve real-world and mathematical problems, e.g. by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.*

6.RP.A.3.C - *Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent.*

6.SP.B.5 - *Summarize numerical data sets in relation to their context.*

6.G.A.2 - *Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas* $V = l\ w\ h$ *and* $V = b\ h$ *to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.*

6.NS.C.8 - *Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.*

7.NS.A.3 - *Solve real-world and mathematical problems involving the four operations with rational numbers.*

7.EE.B.4 - *Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.*

7.RP.A.2 - *Recognize and represent proportional relationships between quantities.*

7.G.B - *Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.*

7.G.B.6 - *Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.*

8.F.A.2 - *Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).*

8.F.B.5 - *Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.*

8.G.C.9 - *Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.*

Common Core Mathematical Practices

MP1: *Make sense of problems and persevere in solving them.*
MP2: *Reason abstractly and quantitatively.*
MP3: *Construct viable arguments and critique the reasoning of others.*
MP4: *Model with mathematics.*
MP5: *Use appropriate tools strategically.*
MP6: *Attend to precision.*
MP7: *Look for and make use of structure.*
MP8: *Look for an express regularity in repeated reasoning.*

Common Core State Standards ELA/Literacy

6-8.RI.7 - *Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.*

6-8.RST.3 - *Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.*

6-8.RST.4 - *Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to* grades 6-8 texts and topics.

6-8.RST.7 - *Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).*

6-8.RST.9 - *Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.*

6-8.WHST.1 - *Write arguments focused on discipline-specific content*.

6-8.WHST.4 - *Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.*

6-8.WHST.9 - *Draw evidence from informational texts to support analysis, reflection, and research.*

6-8.SL.1 - *Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.*

6.SL.2 - *Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.*

7.SL.2 - *Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study.*

6-8.SL.4 - *Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.*

6-8.RH.7 - *Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.*

Common Core Mathematics and ELA Standards Reference:
Authors: National Governors Association Center for Best Practices, Council of Chief State School Officers.
Title: Common Core State Standards.
Publisher: National Governors Association Center for best Practices, Council of Chief State School Officers, Washington D.C.
Copyright Date: 2010

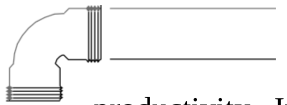
Unit Summaries

Illinois agriculture has a long and rich history. From the introduction of farming practices by the Native Americans to the development of storage facilities, transportation systems and implementation of machinery, the historical evolution of farming has flourished. Today, with over 74,000 farms accounting for approximately 72% of Illinois' land, the state has become a national leader in the production of several crops. In the unit ***Farming Frenzy***, students will race to uncover a variety of agricultural facts in an attempt to collect pentomino pieces needed to complete a puzzle. Many of the concepts featured in this activity serve as a preview of several units featured in this curriculum.

Modern tractors are sophisticated machines, shaped by the physics of their operating requirements. The interface between tire and soil is the focus for this unit. Tires must keep a tractor from sinking into soft soil and allow it to pull heavy loads, all without damaging the essential properties of the soil. By participating in ***Tractor Physics, s***tudents will tackle an engineering challenge by designing, constructing, and testing a set of tractor tires.

For the last several years, Illinois has been the national leading producer of soybeans. With fertile soil and a mild climate, Illinois serves as a perfect environment for this crop. Each year, at the beginning of the growing season, famers develop and execute a management system to achieve their primary goal of optimizing crop yield. In the unit ***G-ROW-in' Soybeans,*** students will explore one agronomic practice related to maximizing crop yield: row spacing. Asked to develop a row spacing recommendation for a hypothetical farmer, students will consider how the distribution of plants provides access to natural resources and nutrients necessary for growth. Students will also determine the economic efficiency of the row spacing models prior to making their recommendation.

The application of chemical fertilizers and pesticides is an important part of crop management used to maximize yield. However, the improper application of these chemicals can have adverse effects on our environment. In the unit ***Drift Mitigation***, students will use a model to investigate the relationship between spray droplet size and drift of chemicals away from a target plant. They will also analyze the trade-off between plant coverage and potential chemical drift and will research and recommend a series of management practices to reduce the impact of chemical drift on animal habitats, water bodies, neighboring plants, and the atmosphere.



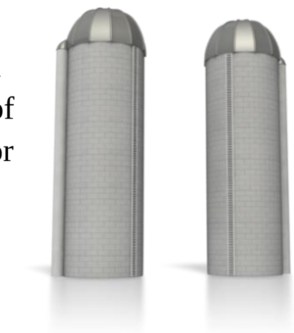
Because Illinois receives abundant rainfall, most farms require no irrigation. Many fields, however, do not drain quickly, which limits their productivity. In ***Water Management,*** students will learn about the variable nature of the water table to identify characteristics of fields which might benefit from drainage tiling. Finally, students will design and build a model tile drainage system for their field.

For over 10,000 years, farmers have been selecting plants with desirable traits and breeding them so that the offspring will also exhibit these desirable traits. With advances in science, techniques exist beyond traditional selective breeding to produce plants with an ever-increasing variety of traits. Genetic engineering has introduced characteristics such as pest and weed resistance, adaptability to climate change, and increased nutritional value into food plants such as corn and rice. Research into manipulating a plant's epigenome in order to induce differences in observable traits has led to some exciting possibilities for modifying a plant's traits without changing the underlying DNA code. In the unit ***It's All About Those Traits***, students will explore traditional selective breeding through analyzing kernel "samples" from two different ears of corn. They will learn about commercially-developed genetic modifications to corn and will research and propose new, novel traits to develop a corn plant of the future. Finally, students will simulate a cell's production of proteins to explore how regulating the rate of transcription and translation impacts the expression of certain proteins, thus leading to variation in phenotypic traits.

Crops don't appear out of thin air, or do they? In the unit ***Nutrient Management,*** students will critically examine the first recorded experiment in biology and learn about the sources of a growing plant's mass. Next they will examine pictures of crops which are experiencing nutrient deficiencies. After diagnosing the deficiencies, students will select the appropriate fertilizers to apply on their fields. Applying fertilizer is one thing, but keeping it in the soil is another challenge. Students will select an actual Illinois farm field and design for it a nutrient retention system.

The United States is one of the most productive agricultural countries in the world. However, according to the book *Know Soil, Know Life*, only about 18% of total land is available for producing crops. As the human population continues to grow, soils used to grow annual crops will be pressed to produce more food per acre. ***Soil Science*** introduces students to the importance of soil in agriculture. Through activities in this unit, students will assume the role of soil scientists and will analyze soil samples to determine the soil's texture. They will then debate which characteristics of the inorganic components of soil are best suited to growing crops. Furthermore, students will perform chemical tests on a soil sample to analyze the pH, nitrogen, phosphorus, and potassium levels in soil to determine its suitability for producing various crops such as corn, soybeans, wheat, and oats.

By carefully observing images of traditional harvesting techniques, students will learn about the three basic phases of harvesting cereal crops in ***Amber Waves of Grain***. Then students will design and build small machines capable of reaping, threshing, and winnowing. Next, students will explore the inner workings of modern combine harvesters. Finally, students will analyze data which highlight the dramatic effect of 200 years of agricultural mechanization.



Following harvest, a farmer must store their grain. Depending on the intended use of the crop, time of year, and supply, a farmer may transfer the crop into a grain silo or grain bin. These large structures, typically cylindrical and made of cement staves and steel panels, house grain at an appropriate moisture level for a designated period of time until needed for feed or market distribution. In the unit ***So High, Silo***, students will be presented with an engineering design challenge to develop a storage container that holds a grain sample. Students will exercise their knowledge of volumetric measurement and properties of three dimensional figures to construct their container, and then evaluate their design for efficiency and optimization level.

In the culminating activity, students will revisit many of the agronomic concepts investigated in this curriculum by applying their knowledge to a real-world problem. By 2050, it is predicted that the world's population will increase by approximately two to three billion people. Already struggling to provide food and nourishment to our current population, there is a growing concern that the demand for more food will surpass the ability to produce. In ***Feed the World***, students will explore the implications of this global crisis and pose potential solutions that increase crop yield while minding the planet's environment. Applying their understanding of science and technology, students will build their own cyber farm using the interactive simulation *Top Crop: Farming for the Future*. Designed by National Geographic Education, this experience will require students to systematically apply multiple agricultural technologies and tools in an effort to produce a high-yielding, sustainable farm.

Unit Objectives

Farming Frenzy

- Determine the impact of the agricultural industry on Illinois' economy.
- Quantify the amount of Illinois land that is used for farming.
- Identify essential farming components (i.e., soil nutrients, treatments and preventative technologies) used in the agricultural industry.

Tractor Physics

- Construct a model tractor which can be used to examine the interactions between tires and soil.
- Redesign a tractor wheel to improve flotation.
- Measure ground pressure and explore the effects of ground pressure on soil compaction.
- Design and fabricate a tread pattern which maximizes traction.

G-ROW-in' Soybeans

- Identify multiple row spacing models used by soybean farmers and determine how these planting arrangements impact crop yield.
- Explore how row spacing influences the amount of access that a plant has to the natural resources it needs to grow.
- Recommend a row spacing model that considers overall yield, economic efficiency, and potential environmental threats for a hypothetical farmer.

Drift Mitigation

- Compare the amount of spray coverage provided to a plant with various droplet sizes of water.
- Determine the relationship between application height and coverage, and hypothesize how adjusting spray nozzles impacts coverage at different heights.
- Investigate the relationship between droplet size and application height to drift.
- Research the impact of particle drift on the environment.
- Develop management practices which will reduce the amount of sprayed chemical drift away from the intended target.

Water Management

- Develop a technique to measure the porosity of soil.
- Explain how a high water table can reduce crop yields.
- Design and test a drainage tiling system.

It's All About Those Traits

- Identify different phenotypes of corn (maize) kernels.
- Use ratios and sampling to determine which of two different ears of corn is most likely to have produced a given sample of kernels.
- Use Punnett Squares to determine the genotypes of the "parents" that produced the different kernel samples.
- Compare and contrast traditional selective breeding techniques with genetically engineering a desired trait in corn.
- Model the regulation of gene expression in a hypothetical cell.
- Discuss the potential role that epigentic variation may play in improving corn crops of the future.

Nutrient Management

- Identify the most important nutrients needed by crops.
- Identify which nutrient deficiency is impacting a stressed corn plant.
- Explore the chemistry of three common fertilizers.
- Design a system to minimize nutrient loss in tile-drained field.

Soil Science

- Understand that soil is composed of inorganic and organic solid material, water, and air.
- Investigate the properties of the inorganic solid components of soil: sand, silt, and clay.
- Recognize that varying proportions of sand, silt, and clay in a soil impact the soil's ability to hold and transmit water.
- Experimentally determine the soil texture of a local soil sample.
- Determine the chemical composition of a local soil sample for pH, nitrate, phosphorus, and potassium levels.
- Analyze a given soil's ability to support crops such as corn, soybeans, wheat, and oats.
- Provide recommendations for amending a given soil to support the needs of various crop plants.

Amber Waves of Grain

- Identify patterns in the process of harvesting cereal crops.
- Quantify the impact of agricultural mechanization on American society.
- Understand the mechanical functions of a modern combine harvester.

So High, Silo

- Determine how grain bins and silos are used in the agricultural industry.
- Identify the geometric features of grain bins and silos, and determine how their characteristics contribute to the function of the structure.
- Engineer a structure to store a given volume of corn.

Feed the World

- Use population data and evaluate mathematical trends to predict the world's population in 2050.
- Discuss the implications of feeding the world's population in 2050, and identify how this global challenge affects the agricultural industry.
- Identify sustainable farming practices that minimize negative impacts on the environment and preserve natural ecosystems.
- Evaluate farming practices that increase crop yield through the management of soil nutrition, pests, weeds and drought.
- Interpret data and use problem-solving skills to identify problems in a real-world agricultural context.
- Create and maintain a sustainable cyber farm through the strategic application of agricultural technology and tools.
- Propose solutions that could potentially help alleviate the challenge of feeding the world's population in 2050 and beyond.

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Objectives:

- Determine the impact of the agricultural industry on Illinois' economy.
- Quantify the amount of Illinois land that is used for farming.
- Identify essential farming components (i.e., soil nutrients, treatments and preventative technologies) used in the agricultural industry.

Background Information

Illinois agriculture has a long and rich history. Approximately 7,000 years ago, Native Americans and settlers from the eastern United States introduced farming practices to the area. Growing corn, squash, grains and other crops, early farmers quickly recognized the fertility of the Illinois soil. Over the next several decades, the development of storage facilities and transportation systems helped propel Illinois into one of the nation's top agricultural states. Finally, in the year 1860, the state was recognized as the top producer of corn and wheat. The rich history of Illinois' agricultural industry continues today.

Today, with over 74,000 farms, approximately 72% of Illinois' land is used for farming. Within the last several years, the state has been a national leader in the production of corn and soybeans, as well as a valuable contributor of pumpkins, grain and other agricultural commodities. The marketing of these items generates more than $19 billion annually, making this industry one of the most significant contributors to the state's economic system.

Inquiry Overview

In this unit, students will explore interesting facts related to Illinois' agricultural industry. Working in small groups, student teams will complete a series of trivia questions evaluating their knowledge of many important components of farming (i.e., soil nutrients, land usage, the economic significance, use of commodities, etc.). Upon successfully answering each question, students will receive one **pentomino** piece. These manipulatives are commonly used in geometry mathematics. Once each student team has

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collected all twelve of their pentomino pieces, they will work together to solve a tractor puzzle. By strategically placing the pentominoes into the silhouette, students will complete the tractor.

Activity

Activity 1: It's Trivia

Objectives:

- Determine the impact of the agricultural industry on Illinois' economy.
- Quantify the amount of Illinois land that is used for farming.
- Identify essential farming components (i.e., soil nutrients, treatments and preventative technologies) used in the agricultural industry.

Standards:

NGSS: SEP8
CCSS Mathematics: 6.RP.A.3.C, MP1
CCSS ELA/Literacy: 6.RI.7, 6-8.RST.4, 6-8.RST.9

***Estimated Time*:**

- **5 Minutes – Introductory Discussion**
- **40 Minutes – Trivia Activity**
- **15 Minutes – Debrief**

***It's Trivia* Materials:**

for each student:
- Student Pages

for each team of 3:
- 1 Set of Pentominoes
- 1 Tractor Puzzle
- Calculator (Optional)

for the teacher:
- Computer with Projector and Audio
- *It's Trivia* Cards
- Tape

Advanced Preparation:

Prior to beginning the activity, prepare the trivia cards by folding them in half so the number is visible on the outside and the question is hidden inside the card. It is suggested that you space the cards throughout the classroom and secure each card to an area where students can easily read the questions.

Also, prepare the pentomino sets. Each set consists of twelve pieces. Students will work in ten teams, with each team having their own set of pentominoes. You may choose to number each set (1-10) and then designate each team a corresponding number. Please note that several teams will have the same colored pentomino set, and should keep their pieces separated.

Finally, determine where you will be located within the classroom. This should be an area that is easily accessible to all students (such as the center of the classroom).

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Suggested Inquiry Approach:

To begin, arrange the students into small groups of 3. At this time, you may choose to assign each team the number that corresponds with their pentomino set. Distribute the student pages to each learner and ask for a volunteer to read the Introduction aloud.

Explain to the students that they will begin their study of Agronomic STEM by completing a trivia challenge. At this time, review the procedure with each team. By correctly answering a series of trivia questions about Illinois agriculture, students will collect pentomino pieces that will then be used to complete a tractor puzzle.

Finally, before students begin their challenge, take several minutes to review the rules of the activity. Answer any questions that students may have regarding the regulations of the game at this time. Also, verbally set your expectations in terms of student behavior and explain the consequences of failing to meet these expectations.

Allow plenty of time for students to complete the activity and provide appropriate hints when necessary. When student teams have collected all of their pieces, provide each team with a puzzle. Encourage them to work collaboratively to solve the tractor puzzle.

Note: A PowerPoint with the tractor puzzle solution is available in the Teacher Resources file in the Content Classroom for this unit.

Finally, when all teams have completed the trivia questions and tractor puzzle, take several minutes to debrief their experience. Direct students back to their student pages to answer the included questions.

Debrief Activity 1:

- ***What trivia fact surprised you the most?***
- ***After answering all of the trivia questions, what would you like to learn more about?***
- ***What "pieces" make up agriculture?***
- ***What do you think the title of this curriculum means?***

This final debrief question allows students to make predictions and reference their prior knowledge to define a potentially unfamiliar term. You may choose to record student ideas on chart paper to refer back to at the end of this curriculum. This would provide students with an opportunity to evaluate the knowledge they have gained by participating in Agronomic STEM.

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Answer Key with hints:

Question One: Approximately 72%

Question Two: (Any combination of) Iowa, Illinois, Indiana, southern Michigan, western Ohio, eastern Nebraska, eastern Kansas, southern Minnesota and Missouri.

Question Three: They are made of corn.

Question Four: An Illinois farmer feeds approximately 156 people.

Question Five: Nitrogen, Phosphorus, and Potassium (*HINT: If students are familiar with the Periodic Table, these elements are identified as N, P and K respectfully)*

Question Six: The average age of an Illinois farmer is 56 years old.

Question Seven: (Any combination of) Canada, Mexico, Peru, Columbia, Israel, Egypt, Taiwan, and Japan.

Question Eight: #1 Soybeans, #2 Corn, #3 Potatoes, #4 Grain (or Wheat) (*HINT: For this question, you may choose to tell students how many of their choices are correct)*

Question Nine: There are approximately 800 corn kernels on an ear of corn. Students should be within 50 kernels. (*HINT: You may choose to tell students if they need to estimate "higher" or "lower")*

Question Ten: Tractors are used in the agricultural industry to pull machinery.

Question Eleven:

Irrigation	Bugs
Fertilizer	Drought
Pesticides	Weeds
Herbicides	Soil Nutrition

Question Twelve:

Planting Seed, Fertilizer and Chemicals – **Blue**

Farm Machinery – **Red**

Farming Services and Rent – **Green**

Taxes - **Purple**

EXTENSIONS

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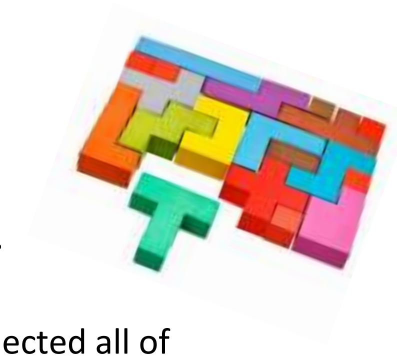
Students could further investigate the mathematical relationships of pentominoes. Additional information on this concept can be located at:

- https://www.scholastic.com/blueballiett/games/pentominoes_game.htm
- http://www.neok12.com/games/pentominoes/pentominoes.htm

Also, two additional pentomino puzzles are available in the Teacher Resources file of the Content Classroom, at learning.imsa.edu, for this unit. If time allows, students may enjoy completing these truck puzzles.

Introduction: Illinois agriculture has a long and rich history. Generating more than $19 billion dollars annually, this industry has flourished and is now nationally ranked in the production of many crops and raw materials. Illinois' fertile soil and climate enable farmers to grow, raise and maintain a variety of agricultural commodities. In the following activity, you will test your knowledge of Illinois' agricultural industry by participating in a trivia challenge!

Procedure:



Working in a small group, your team will be responsible for answering **twelve** trivia questions. Each question will evaluate your knowledge of the agricultural industry and Illinois farming. Upon correctly answering each question, you will receive a **pentomino** piece from your instructor. Once your team has collected all of the pieces, arrange your pentominoes correctly to complete a tractor puzzle. Good luck!

Rules:

- All team members must work on the same question at the same time. You cannot "divide and conquer".
- You may answer the questions in any order.
- After answering a question, you must check your solution with the instructor before attempting to answer another question. If your answer is incorrect, return to the question and determine a new solution.
- Some questions will require you to solve mathematical problems. All work must be shown.
- All team members must record the answers to the trivia questions on their student pages.
- All pentomino pieces must be collected before you begin solving the tractor puzzle.

QUESTION ONE

Solve:

QUESTION TWO

1. ____________________________________

2. ____________________________________

3. ____________________________________

QUESTION THREE

____

QUESTION FOUR

Solve:

QUESTION FIVE

____

____

____

QUESTION SIX

Solve:

QUESTION SEVEN

1.______________________________

2.______________________________

3.______________________________

4.______________________________

QUESTION EIGHT

1.______________________________

2.______________________________

3.______________________________

8.______________________________

QUESTION NINE

Solve:

Estimate:____________________

QUESTION TEN

QUESTION ELEVEN

Irrigation	Bugs
Fertilizer	Drought
Pesticides	Weeds
Herbicides	Soil Nutrition

QUESTION TWELVE (RECORD THE COLOR)

Planting Seed, Fertilizer and Chemicals ________________________

Farm Machinery ____________________

Farming Services and Rent ______________

Taxes ____________________________

Complete the Puzzle:

After you have collected all of your pentomino pieces, your instructor will provide you with a tractor puzzle. Work as a team to complete the puzzle. Strategically place the pieces according to the following rules:

- **All 12 pieces must be used.**
- **All pieces must lay flat.**
- **All pieces must touch.**
- **No pieces can overlap.**

Debrief Questions:

Answer the following questions with your team members. Be prepared to share your ideas with the class.

- ❖ **What trivia fact surprised you the most?**
- ❖ **After answering all of the trivia questions, what would you like to learn more about?**
- ❖ **What "pieces" make up agriculture?**
- ❖ **What do you think the title of this curriculum (Agronomic STEM) means?**