STEM Curriculum Planning Guide

This instructional design guide serves as the template for the design and development of STEM units of instruction at the Dayton Regional STEM Center in Dayton, Ohio. The guide is anchored to the *STEM Education Quality Framework* also developed at the Dayton Regional STEM Center.

STEM Unit Title	**Fractured Fairy Tales - Composites to the Rescue!**
Economic Cluster	Advanced Manufacturing and Materials
Targeted Grades	Pre-K & Kindergarten
STEM Disciplines	Science, Technology, Engineering, and Math
Non-STEM Disciplines	Language Arts, Social Studies

Section I: STEM Unit Overview

Unit Overview

In this unit, students will conduct scientific investigations and use the engineering design process to solve a problem related to the Three Little Pigs. The scientific investigations will engage students in understanding composite materials and how they improve the performance of an end product. The students will form generalizations using their prior knowledge and scientific investigations about materials. Students will create and test their own composite materials. Students will use the engineering design process to test which composite materials will create the strongest end product. They will engage in collecting, analyzing and recording data throughout this collaborative inquiry based unit.

Essential Question

How can different materials be combined to create a stronger new material?
How can we collect information and share what we have learned?

Enduring Understanding

All materials have inherent properties. These properties can change when two different materials are mixed together.
Collecting data is used to help us make informed decisions.

Engineering Design Challenge

Students will use composite materials to create a structure that can both stand in a windy environment without failing and stand up to weights falling on top of it without failing.

Time and Activity Overview

Day	Time Allotment	Actvities
1	20 minutes	The Other Three Little Pigs
2	30 minutes	What are Composites?
3	45 minutes	Making Composite Materials
4	30 minutes	Testing Composite Materials
5	30 minutes	Designing a Composite House
6	60 minutes	Building the Prototype Composite House
7	30 minutes	Testing the Prototype Composite House
8	20-45 minutes	Redesigning the Composite House
9	30 minutes	Sharing and Presenting our Results

Pre-requisite Knowledge & Skill	Students should be familiar with the story of the Three Little Pigs. Students would benefit from hearing multiple versions of this story before beginning this unit. Students should know how to mix things together.

Academic Content Standards

Add Standard	**Mathematics**	Ohio
Grade/Conceptual Category	PreK	
Domain	Measurement & Data	
Cluster	Describe and compare measurable attributes	
Standards	Directly compare two objects with a measurable attribute in common to see which object has more or or less of the attribute and describe the difference.	

Add Standard	**Mathematics**	Ohio
Grade/Conceptual Category	PreK	
Domain	Counting and Cardinality	
Cluster	Count to tell the number of objects	
Standards	Understand the relationship between numbers and quantities; connect counting to cardinality	

Add Standard	**Mathematics**	Ohio
Grade/Conceptual Category	Kindergarten	
Domain	Counting and Cardinality	
Cluster	Count to tell the number of objects	
Standards	Understand the relationship between numbers and quantities; connect counting to cardinality	

Add Standard	**Mathematics**	Ohio
Grade/Conceptual Category	K	
Domain	Measurement and Data	
Cluster	Describe and compare measurable attributes	
Standards	Directly compare two objects with a measurable attribute in common to see which object has more or or less of the attribute and describe the difference.	

Add Standard	**Mathematics**	Ohio
Grade/Conceptual Category	Kindergarten	
Domain	Measurement and Data	
Cluster	Classify objects and count the number of objects in each category	
Standards	Classify objects into given categories; count the numbers of objects in each category and sort the categories by count.	

Add Standard	**Mathematics**	
Grade		
Standard		
Benchmark		
Indicator		

Add Standard	English Language Arts	Ohio
Grade	PreK	
Strand	Speaking and Listening	
Group	Presentation of Knowledge and Ideas	
Standard	Describe familiar things, with prompting and support, provide additional detail	

Add Standard	English Language Arts	Ohio
Grade	Kindergarten	
Strand	Speaking and Listening	
Group	Presentation of Knowledge and Ideas	
Standard	Describe familiar things, with prompting and support, provide additional detail	

Add Standard	English Language Arts	Ohio
Grade	PreK	
Strand	Literature	
Group	Range of Reading and Level of Text Complexity	
Standard	Actively engage in group reading activities with purpose and understanding; participate in the recitation of books, poems, chants, songs and nursery rhymes.	

Add Standard	English Language Arts	Ohio
Grade	PreK	
Strand	Writing	
Group	Research to Build and Present Knowledge	
Standard	With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.	

Add Standard	English Language Arts	Ohio
Grade	PreK	
Strand	Speaking and Listening	
Group	Comprehension and Collaboration	
Standard	Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.	

Add Standard	English Language Arts	Ohio
Grade	Kindergarten	
Strand	Literature	
Group	Range of Reading and Level of Text Complexity	
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Standard	Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.	

Add Standard	English Language Arts	Ohio
Grade	Kindergarten	
Strand	Speaking and Listening	
Group	Comprehension and collaboration	
Standard	Ask and answer questions in order to seek help, get information, or clarify something that is not understood.	

Add Standard	English Language Arts	Ohio
Grade	Kindergarten	
Strand	Writing	
Group	Research to Build Knowledge	
Standard	With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.	

Add Standard	English Language Arts	Ohio
Grade	Kindergarten	
Strand	Literature	
Group	Key Ideas and Details	
Standard	With prompting and support, ask and answer questions about key details in a text.	

Add Standard	English Language Arts	Ohio
Grade	Kindergarten	
Strand	Literature	
Group	Key Ideas and Details	
Standard	With prompting and support, retell familiar stories, including key details.	

Add Standard	English Language Arts	Ohio
Grade	Kindergarten	
Strand	Literature	
Group	Key Ideas and Details	
Standard	With prompting and support, identify characters, settings, and major events in a story.	

Add Standard	English Language Arts	
Grade		
Standard		
Benchmark		
Indicator		

Add Standard	Social Studies	
Grade	PreK	
Theme	The Classroom Community	
Strand (pk-8 only)	Government	
Topic	Civic Participation and Skills	
Content Standard	Relationships in schools and communities benefit from cooperative behaviors and problem solving skills	

Add Standard	Social Studies	
Grade	K	
Theme	A Child's Place in Time and Space	
Strand (pk-8 only)	Government	
Topic	Civic Participations and Skills	
Content Standard	Relationships in schools and communities benefit from cooperative behaviors and problem solving skills	

Add Standard	**Social Studies**	
Grade		
Standard		
Benchmark		
Indicator		

Add Standard	**Science**	Ohio
Grade	PreK	
Theme	Physical Science	
Topic	Observations of Objects and Materials	
Content Standard	Objects and materials are described by their properties	

Add Standard	**Science**	Ohio
Grade	Kindergarten	
Theme	Physical Science	
Topic	Observations of Objects and Materials	
Content Standard	Objects and materials can be sorted and described by their properties	

Add Standard	Science	Ohio
Strand		
Course Content		
Content Elaboration		

Add Standard	Science	Ohio
Grade		
Standard		
Benchmark		
Indicator		

Add Standard	Fine Arts	Ohio
Grade		
Subject		
Standard		
Benchmark		
Indicator		

Add Standard	**Technology**	
Grade		
Standard		
Benchmark		
Indicator		

Assessment Plan

What evidence will show that students have acquired the enduring understandings for this STEM unit?

Performance Task, Projects	Design challenge Mixing/Testing composites
Quizzes, Tests, Academic Prompts	Pre-test and Post-test
Other Evidence (e.g. observations, work samples, student artifacts, etc.)	Student journals (optional for lessons 3-4) Rubric Student artifacts
Student Self- Assessment	Student journals (optional for lessons 3-4) Lesson 9 wrap-up

Technology Integration

ADISC Technology Integration Model*

	Type of Integration	Application(s) in this STEM Unit
A	Technology tools and resources that support students and teachers in ***adjusting, adapting, or augmenting*** teaching and learning to meet the needs of individual learners or groups of learners.	Unifix cubes
D	Technology tools and resources that support students and teachers in ***dealing effectively with data***, including data management, manipulation, and display.	Stop watches
I	Technology tools and resources that support students and teachers in conducting ***inquiry***, including the effective use of Internet research methods.	Balance (scale) Meter stick Weights
S	Technology tools and resources that support students and teachers in ***simulating*** real world phenomena including the modeling of physical, social, economic, and mathematical relationships.	Fan/Hairdryer
C	Technology tools and resources that support students and teachers in ***communicating and collaborating*** including the effective use of multimedia tools and online collaboration.	Skype (if available at the school) Digital camera and/or video camera
	**The ADISC Model was developed by James Rowley PhD, Executive Director of the Institute for Technology-Enhanced Learning at the University of Dayton*	

Career Connections

Career Description

Careers in the composites industry can be broadly categorized into fields such as: design engineer, materials/ process engineer, test/analysis engineer, and production engineer to name just a few. A design engineer in the sports equipment industry works within a team to bring to market an improved design for a golf club shaft. We have witnessed the evolution of club shafts from the original wood shaft to the latest carbon graphite resin composite design.

Design engineers working for football helmet manufacturer Riddle work on improved helmet designs to create a more durable and safer helmet.

A materials engineer working for a marine industry company like Sea Ray Boats is involved in trials to evaluate new fiber reinforcements to create a lighter stronger hull.

A process engineer working in the wind turbine industry studies new composite processing techniques to create stronger lighter turbine blades in much shorter production cycles.

A structural analysis composite engineer evaluates and compares composite structures to more conventional metal fabrications. Composites are becoming an accepted construction technique for military and commercial airframe applications because their lighter stronger properties result in significant fuel savings.

A production engineer working in the composite decking industry considers new manufacturing processes to mix reinforcements into resin matrices to create a better decking material.

Careers in the composites industry are almost too numerous to mention. We have seen examples of their connections to sports equipment, aircraft, wind turbines, building materials, marine products, and automotive applications. In each of these industries, an eco-friendly focus can be driven by looking to naturally occurring fibers to replace man made fibers.

Section II: STEM Lesson Plan

Title of Lesson	**Lesson One: “The Other Three Little Pigs”**
Time Required	20 minutes
Materials	“The Other Three Little Pigs” story and pictures Chart paper Markers Pre-/Post-Test data collection sheet (Appendix D)
Objectives	Students will discuss the essential question: How can materials be combined to make something stronger? Students will predict that the pigs should use a mixture of mud and straw to make a stronger house.
Instructional Process	1. Using the pre-/post-test data collection sheet in Appendix D, assess student skills and understanding of the concepts to be covered in this unit. 2. Read: "The Other Three Little Pigs" to the class or group. Have the students think about ways the pigs could have stayed safe during the story. 3. After reading, have students list other things that the three pigs could have done to stay safe. Chart student responses (dictation or shared writing). 4. Have students compare and contrast the original fairy tale to "The Other Three Little Pigs." What are some similarities and differences between the two stories? 5. Ask the question, "What else could the wolf do besides blowing the house to knock it down?" and record student responses. 6. Draw students' attention to the last line of the story, "We're using composites!" Teach students the composites songs (Appendix E).
Differentiation	Extensions to the lesson can be used to incorporate first grade or accelerated learners. These are listed as follows: 1. Have the students re-write the ending to the story. 2. Have the students illustrate the story as a visual arts connection. 3. Have the students act out the story through dramatic play.

Assessments	Partner students up and let them retell the story to each other. Have students act out either their favorite part of the story or a part that was different from the original story using costumes or puppets. If the teacher chooses to use student journals, those can be read by the teacher for student comprehension.

Section II: STEM Lesson Plan

Title of Lesson	**Lesson Two: What Are Composites?**
Time Required	30 minutes
Materials	Story: “The Other Three Little Pigs" 2 balloons (9” round) – filled to capacity and tied 20 yards of yarn, cut in 4 5-yard pieces 1 cup glue and ½ cup water mixture (for premade balloon) Sticky notes, two colors – one of each color per student Balance scale Chart paper – at least 3 pieces Pencils or crayons Markers (for teacher) Needle
Objectives	Students will identify the yarn coated in glue as a composite.
Instructional Process	Preparation: Approximately two days before beginning this lesson, prepare a balloon for demonstration. Fill a balloon with air and tie. Soak two 5-yard pieces of yarn in the glue and water mixture. Save any leftover glue/water to show students. Yarn is cut in sections to keep it from tangling. Wrap each yarn piece around the entire balloon. Yarn should overlap and will be wrapped non-uniformly. Allow to completely dry. See pictures in Appendix C. This balloon is designated as balloon B for future reference. 1. Review story from Day One (3 - 4 minutes). Ask students why the wolf couldn’t blow the straw house down. Review that when some solid materials like the straw and some liquid materials like the mud are mixed, they can become stronger. Tell students they are going to see if they can find another composite in today’s lesson. 2. In front of the students, fill a balloon (designated as balloon A) with air and tie. Use the last two pieces of yarn. Tape one of the ends to the balloon to make wrapping easier. Wrap the entire balloon with the yarn. Yarn should overlap and be non uniform in appearance like the pre-made balloon. Once wrapped, have students feel the yarn on this balloon. 3. Ask students to make a prediction as to what will happen when balloon A is popped. Have students chart if they think the yarn will stay in its spot or if it will fall.

Students will use a sticky note and write Y for yes or N for no and place the sticky note on the chart. Discuss predictions.

4. Show students the pre-made composite balloon (balloon B). Have students feel the yarn.

5. Ask students to make a prediction as to what will happen when balloon B is popped. Have students chart if they think the yarn will stay in its spot or if it will fall. Students will use a sticky note and write Y for yes or N for no and place the sticky note on the chart. Discuss predictions.

6. Ask questions about chart results, for example: How many students think the yarn will fall? How many students think the yarn will stay in its place?

7. Teacher will use a needle to pop the balloon A. If popping will scare some students, gently pierce the balloon with the needle and slowly let the air out. Note changes in yarn. Ask students to look at chart and see which prediction was correct.

8. Before popping balloon B, teacher should squeeze the balloon very gently to completely separate the balloon from the yarn. Teacher will repeat Step 7 using balloon B.

9. Ask students what they think the difference was. What could have made this difference in the yarn?

10. Lead discussion that the first balloon was made with just yarn, but the second one had something added to the yarn. Ask students what they think could have been added to the yarn? Let students know it was glue and water mixed together. (Show students the leftover glue from making balloon B.) We call this a composite. Introduce definition of composite. Add any new words to the classroom word wall.

11. Ask students to think about The Other Three Little Pigs story. Discuss structures in the story. One structure was made without a composite. Can students identify? One structure was made with a composite. Can students identify that structure? Ask students if they can think of another composite that could be used?

12. Teach students the Composite songs. Write the songs on chart paper and post them in the room.

13. Tell students that they will be working to make other composite materials tomorrow.

Differentiation

Review the vocabulary with students with language disabilities or English Language Learner before the lesson so they will understand the terms during the lesson.
Use heterogeneous grouping to allow all students to be successful and have help as needed.

	If a group is struggling, then reteach the lesson with simpler directions. Visuals should be used throughout the lesson to aid students with language disabilities or English Language Learner. Extension: Have students write a sentence about their findings. More concrete learners may need a yes/no response about composites.
Assessments	Students should be able to answer: Which house in the story was made from a composite? Which balloon in today's lesson was made with a composite?

Section II: STEM Lesson Plan

Title of Lesson	**Lesson Three: Making Composite Materials**
Time Required	45 minutes
Materials	School Glue (Elmer's Washable School Glue works best) - 1/2 cup per small group Water - 1/4 cup per small group String - 15 yards cut into 1 yard sections Flour - 1 cup per small group Water - 1 cup per small group Salt - 1 tablespoon per small group (to serve as preservative) Newspaper 1 full sheet per house cut or torn into 1 x 6 inch strips per group Solo plastic cups (9 oz.) - 2 per group Plastic mixing bowls (quart size) - 1 per group Craft sticks - 100 Plastic tablecloths - as needed Art smocks - 1 per child
Objectives	Students will discover and describe the properties of different materials
Instructional Process	Preparation: From the newspaper, tear strips so they are ready for student use. This experience works best if you use a quart sized plastic mixing bowl for each group. Popsicle sticks can be used to stir the mixture. Plastic table cloths on the work area and drying tables will make for easy clean up. Paint smocks will help keep children's clothes from becoming overly soiled. Have the materials in the center or work areas before conducting the meeting time or group explanation. Each work station will have only one solid material and water, glue or paper mache with 2 to 4 students per work station. Schedule this experience during work time so children not at the composite work station will have other work while they are waiting their turn. Prepare a chart with the materials listed across the top with space below for the descriptive words children will provide.

1. In circle or group time, display samples of the materials. Ask children to describe the physical properties of the materials displayed. “What words would you use to describe this material?”

2. As children are talking, record their descriptive terms on the chart. Encourage children to talk about the different proprieties of the materials, are stiff, can they be torn or bent, what is their texture? Have them compare the different materials for similarities and differences.

3. Briefly review the definition of a composite material from lesson 2. Tell children they will be combining these materials to make a composite material. Describe the different composite work stations you have selected and how the children will be permitted to combine the materials.
Example 1: “At the Paper Mache station, you will be tearing paper strips, mixing equal parts of flour and water plus 1 tablespoon of salt to make the paper mache material. Next you will be covering the paper strips with the paper mache “paste”. Then you will take the paper coated with the paper mache and wrap them around the cups, our mold. Make sure to cover the entire outside.”

Explain that the wrapped shapes will then be placed on the plastic covered table to dry overnight.
Example 2: “At the string and glue station, you will be combining 2 parts glue to 1 part water, that means you will be using 2 times the amount of glue to the amount of water. ½ cup of glue and ¼ cup of water. Next, coat the string and cover the outside of the cup. Make sure to cover the entire outside of the cup.

Explain that the wrapped shapes will then be placed on the plastic covered table to dry overnight.
While children are working, encourage them to talk about what is happening to the materials, using different descriptive terms. Encourage them to compare the ingredients properties before and after they are mixed. “How did the material feel before you mixed or coated it with the mixture? What words can you think of to describe the composite material?"

Have them predict what they think will happen to the mixtures after they dry.

Differentiation

Provide non latex gloves for children who may have sensory needs.
Children not able to work in groups may choose to work alone.

Assessments

Use anecdotal notes to gather language samples. As well as language chart and standards check sheet to record children’s learning.

Section II: STEM Lesson Plan

Title of Lesson	**Lesson Four: Testing Composite Materials**
Time Required	30 minutes
Materials	Composite structures built in Lesson Three Weights – blocks will work best, could also use various sized rocks 2" x 2" x 6" wooden blocks - 2 Pencil and paper for each child to record their data Chart completed in lesson three Chart paper, prepared before lesson begins Optional Science Journal for each student
Objectives	Students will compare composite materials by testing the strength of each composite.
Instructional Process	Note, this lesson can only be conducted after the composite materials made by the students in lesson 2 are thoroughly dry. This may take more than overnight. Preparation: Gather a sample of the composite materials made by the students in lesson 2. Have work stations set up with blocks or other weighted materials. Also have paper and pencils available. Conduct this experience during work time with 2 – 4 students per station allowing the other children to work at other stations while they wait for their turn at the composite testing stations. Have the chart made in lesson two displayed. Prepare another chart labeled with the different composite mixtures (i.e. paper mache paste and paper strips, straw, glue and water) with space below for descriptive terms provided by the children. 1. Review composite songs. Have samples of the composite materials on display. Briefly let children describe how they made their material (what they combined and the process). 2. Refer to the two charts, one completed in lesson two and the blank one for lesson 3. Encourage children to now describe the composite materials. Record their descriptions in the appropriate column. Encourage them to compare the two charts. Are there common words on both or have the terms changed?

3. Briefly review the definition of a composite material and tell students that today we are going to test the strength of the material. Model for students how they can rest their material on two or more blocks using their composite as the span section of the bridge. Show how they can begin to place weight materials on the composite. How many blocks can they stack before the composite material breaks? Model how you can remove the cardboard from the string and use the string minus the cardboard in the same way. Does it work better if the cardboard is left inside the string?

4. Let children in small groups go to the work stations and test their materials. Have paper and pencil available for the children and teachers to record how many blocks or other weighted materials the composite materials could hold, also record if material can be bent or torn.

5. Encourage students to compare the different composite materials. Lead a discussion on which composite proved to be stronger? "How do we know it was stronger?"

6. With provided paper and pencil, encourage students to draw a before testing and after testing picture of their composite. Students with higher skills can write about their composite and the results of their test.

Differentiation

For students who cannot write their findings, have a teacher or a student with higher skills serve as a scribe.

Assessments

Use anecdotal notes to gather language samples, language chart and standards check sheet to record students' learning.

Section II: STEM Lesson Plan

Title of Lesson	**Lesson Five: Designing a Composite House**
Time Required	30 minutes
Materials	Notes or charts from previous days Engineering Design Process poster (see appendix A) Small fan or hairdryer Pieces of burlap (6, cut into 1”x6” strips) Flour Water Blank Copy Paper or Science Journal for each student
Objectives	Students will make a plan for how to use composites to strengthen a structure. Students will reflect on what they have learned about materials.
Instructional Process	1. Ask the following questions and discuss the answers with the children in order to set the stage for the day. Review the composite songs. How can materials combine to make something stronger? (Review the results of testing materials from day 4. We mixed two materials together and the liquid soaked into the solid) Think back to the story about the three little pigs that I read on the first day. How could they make their straw house stronger? (They could add mud or a glue mixture to the straw to make it stronger.) What did we add to the materials on our testing day to make it stronger? (Glue and water) What was the product called once we created the mixture? (A composite) How do people use composites in everyday life? (Doctors make casts, Plywood building boards, Fiberglass boat hulls, Skate board platforms, Wind turbine blades, Snow skis, Aircraft fuselages and wing components, Satellite body panels, Golf club shafts, Hockey sticks, Bicycle frames. Pictures of these objects may be shown to students.) 2. Using dry pieces of burlap, set up a small “house” by propping up the pieces of burlap. You will demonstrate how weak the “Three Pigs house” is without any liquid

mixture added to the burlap. Blow (or have a child blow) the fan/hair dryer on the burlap and let the children watch it blow away. Point out how easily it blew away before it was mixed with anything.

3. Explain that the students are going to be engineers today and they will design a stronger house for the three pigs. Introduce the Engineering Design Process using the poster provided in Appendix A. We identified a problem, today we will develop ideas to solve the problem, tomorrow we will build a prototype, and the next day we will test.

4. Assign children the task of designing a stronger house using the materials from our testing day (glue/water). They will use a piece of paper or science journals to sketch a drawing and write their materials down. Before they go to work on their journals, ask for a few examples of ideas to check for general understanding. Record ideas on chart paper for students to refer to during the lesson.

Differentiation	Use heterogeneous grouping to allow all students to be successful and have help as needed. Encourage student to write a numerical list of materials. If a group is struggling, then reteach the lesson with simpler directions. Peer buddies may be used to complete the task. Provide gloves for sensitive students.
Assessments	Observation of students work Design Challenge rubric

Section II: STEM Lesson Plan

Title of Lesson	**Lesson Six: Building the Prototype Composite House**
Time Required	60 minutes
Materials	Charts and posters from previous lessons All materials from testing day: White, school glue mixed with water (2 glue:1 water ratio) String (cotton, 6” pieces) Strips burlap or terry cloth (1” wide x 6”length) Strips of paper (1” x 6”) Clear plastic, 9 oz Solo cups (as mold for house)- 1 for each group
Objectives	Students will make composite structures.
Instructional Process	1. Using the same directions from lesson three, prepare strips of paper, cut pieces of string, and cut pieces of burlap for the children to use. You will also prepare the glue/water mixture. (have these materials set up and ready to use before meeting time or large group explanation so the students can get to work after the explanation.) 2. Review the composite song and the previous lessons in order to understand the process of getting to today. 3. Explain to the students that they are going to be engineers today and they will make a prototype of their design. Refer to the Engineering Design Process poster. Explain the expectations and steps below. 4. Follow the suggested steps below for building of the prototypes/houses. - Students should work in teams of 2-4 to build their prototypes. - The group can reflect on the strongest composites from the testing day. They will decide if they want to use the paper composite, the burlap composite, or the string composite to build their house. - The cup (upside down) will be used as a base/mold for the composite materials. Composite materials will be set on the cup and will make a small dome shaped house. - All of their work could be done in center/station time.

	5. Allow the prototypes to dry for testing the next day. (you may need to do this on a Friday and test on Monday)
Differentiation	Use heterogeneous grouping to allow all students to be successful and have help as needed. Encourage student to write a numerical list of materials. If a group is struggling, then reteach the lesson with simpler directions. Peer buddies may be used to complete the task. Provide gloves to touch sensitive students.
Assessments	Observation of student work Design Challenge rubric

Section II: STEM Lesson Plan

Title of Lesson	**Lesson Seven: Testing the Prototype Composite House**
Time Required	30 minutes
Materials	Houses that have dried Fan or hairdryer to test strength of structure Meter stick One rock (3-5 oz. Use the same rock for all testing) class chart, prepared before lesson begins
Objectives	Students will test the strength of their structures. Students will collect and record their data.
Instructional Process	Before the lesson, mark a meterstick with colored tape at 10cm intervals, starting at 20cm (20 cm, 30cm, 40 cm...) up to 90cm. This will allow students to see the marks easily during the rock drop testing. 1. Gather the students to discuss the plan for the day. They will test their houses in two ways. First, they will try to blow the house down with the fan/hairdryer. Second, you will use a rock to try to knock the house down by dropping it on the house. (Decide how you will manage the testing of structures; one by one, a few at a time, or in small groups). 2. Review the test done on day five where you showed the children how weak a house was with out the glue/water mixture. Using dry pieces of burlap, set up a small “house” by propping up the pieces of burlap. Blow the fan/hair dryer on the burlap and let the children watch it blow away. Point out how easily it blew away before it was mixed with anything. *Practice with stopwatches before starting the next part if students have not used them before. 3. Using the fan or hairdryer, test each group’s house to see if the house will fall apart. Have students use the stopwatch to time how long it takes to blow it down. (No longer than one minute) Create a chart to record the results. Your chart should include columns for: Group name, Composite used, Did the house stay up?, and How long did it stand? 4. Have students imagine that the wolf in the story "The Other Three Little Pigs"

	decided to try throwing rocks at the pigs' composite house to break it. Explain that they will simulate that by dropping rocks on top of their houses until they break. 5. Stand the meter stick next to one house at a time. Beginning at 20cm, and moving up 10 cm each time, drop the rock on top of the house. Continue until you have structural failure (the roof caves in or the house no longer stands upright). 6. After all the groups have finished lead a group discussion and brainstorm possible solutions for increasing structural quality. Ask them to think about how they could make their houses stronger. Note: more time will be given in the next lesson for redesign. 7. End the day with a review of the composite song.
Differentiation	Students with sensitivity to sound should use ear protection when using a fan or hair-dryer. If a group is struggling, then reteach the lesson with simpler directions. Provide assistance to help any students who may need addition support. Rather than using a meterstick, use 10cm segments of same-colored Unifix or other connecting cubes, to help students identify levels for dropping rocks.
Assessments	Design Challenge rubric Observations of student work

Section II: STEM Lesson Plan

Title of Lesson	**Lesson Eight: Redesign**
Time Required	20 minutes (45 if creating a redesign house)
Materials	Engineering Design Process poster (Appendix A) Science journal or drawing paper Pencils or crayons Building materials from Day 6 Other building materials suggested by students Chart with materials listed and written for reference
Objectives	Based on Day 7 observations, students will redesign a composite house that is stronger than their first composite house.
Instructional Process	1. Review lesson 7. Ask students what they did that worked well. Ask students what they did that did not work well. Ask students to give their ideas for improving their structure. 2. Review some of the materials that students were given to make a stronger house. 3. Think about all the houses that were made. How could you make yours better? Would you build it differently? 4. Refer to the Engineering Design Process poster. Point out to students that yesterday they tested their design. What step would be next? 5. Students will redesign their house (by drawing a diagram) showing different composites or a different house design or a combination of both. Students will label the diagram of the new house. 6. If time permits, have students create their redesigned house. Options 1. Students may retest this new design. 2. Students may paint their new house to use in a community unit/lesson or art show. 3. Allow the students to decorate the redesigned houses using paints and other craft materials and keep the houses out in the room to be used during centers or indoor recess.

Differentiation	Students with fine motor issues may need a peer or adult to help label their drawing. Students with fine motor issues may use precut pictures of materials to label their drawing.
Assessments	Design Challenge Rubric. Design has labels and shows a composite.

Section II: STEM Lesson Plan

Title of Lesson	**Lesson Nine: Sharing of Results and Presentation of Composite Structures**
Time Required	30 minutes
Materials	Student design drawings or Science Journals Notes and charts from previous days Redesigned student houses Rubric Posttest
Objectives	Students will present their composite houses. Students will analyze all the houses looking for similarities and differences.
Instructional Process	1. The teacher will explain the goals of the day and review the process the students have gone through to get to this last day. Ask the students to review the entries in the student science journal (if used) or their drawings and be ready to share through discussion their decisions for the composite shelter using the Engineering Design Process. 2. Each student will be given a chance to present their composite house. The student will share why they used the composites for their house. Students share what they would do differently next time. 3. Collect post-test data. (Appendix D) 4. Sing composite songs together.
Differentiation	Front load students on the questions that they should be able to answer. Provide positive encouragement to students as they present.
Assessments	Design Challenge Rubric Data collection sheets Observations in student science journal (if used) Post-test data collection sheet (Appendix D)

Section III: Unit Resources

Materials and Resource Master List	"The Other Three Little Pigs" story and pictures Chart paper Markers 2 balloons (9" round) – filled to capacity and tied 20 yards of yarn, cut in 4 5-yard pieces Water Sticky notes, two colors – one of each color per student Balance scale Pencils or crayons Needle School Glue (Elmer's Washable School Glue works best) - Gallon String – wide gauge cotton string at least 3 skein cut into 1 yard sections Plastic Wrap Straws Paper towels Flour – one 5 lb. bag Salt Newspaper Solo plastic cups (9 oz.) - 2 per group Plastic mixing bowls (quart size) - 1 per group Craft sticks - 100 Plastic tablecloths - as needed Art smocks - 1 per child Weights – blocks will work best, could also use various sized rocks 2" x 2" x 6" wooden blocks - 2 Writing/Drawing Paper Engineering Design Process poster (see appendix A) Small fan or hair-dryer (with "cool" setting) Burlap - 1 square yard Burlap or Terry Cloth (1" wide and 6" long) Meter stick One rock (3-5 oz. Use the same rock for all testing) Rubric Pre/Post-test data collection sheet (Appendix D)
Key Vocabulary	Note: Vocabulary terms included in this unit should be used frequently in discussions with students, and some time should be spent telling students what these words mean, but the goal is to add these terms to children's receptive vocabulary (i.e. students should recognize and understand these terms when they hear them, even if they are not able to use them in conversation). Words can be placed on a classroom word wall for easy reference. Composite - A solid material usually made by mixing a solid and a liquid together

Data - Information that helps you make a decision

Design - A plan that shows how to build something

Engineer - A person who uses science and math to solve problems

Engineering Design Process - The steps an engineer or person takes to solve a problem

Liquid - Matter that takes the shape of its container

Prototype - An original model on which something is patterned

Solid - A kind of matter that takes up space and has its own shape

Strength - A measure of how well an object can resist being pushed or pulled

Test - To try something to see if or how well it works

Technical Brief

Very early in our history man began using materials, initially naturally occurring materials, to make products. A sharp flat stone attached to a stick to make an axe or hammer. Another early example of a man made product using natural materials can be found in ancient Egypt where they mixed mud with straw to make bricks. As time progressed man learned how to combine various chemical structures to create synthetic or man made materials. An example of natural fabric would be cotton fabric and polyester fabric would be an example of a synthetic fabric.

When we combine two or more materials to make a product we create a composite material. Scientist and engineers may differ in their exact definition of composite materials; however, they will usually include a resin matrix combined with a reinforcing agent. So the Egyptian bricks of mud (resin matrix) and straw (reinforcing agent) may be the earliest example of a composite material.

The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions. The reinforcements impart their special mechanical and physical properties to enhance the matrix properties. A synergism produces material properties unavailable from the individual constituent materials, while the wide variety of matrix and strengthening materials allows the designer of the product or structure to choose an optimum combination. In this lesson the resin matrix material is the paper mache or glue and the reinfocing agent is the burlap, yarn, or paper.

Scientists and engineers utilize composites because they desire weight savings, improved strength properties, corrosion resistence, to name a few. Composite technology has an eco-friendly focus in those areas where synthetic polymers are

reinforced with natural fibers to create products for a variety of applications. Some examples of products made with composite materials are: plywood, fiberglass boat hulls, skate board platforms, skis, car body panels, airplane fuselages, wind turbine blades, satelite and space vehicle body panels, and hockey sticks.

Safety and Disposal

During testing, have students wear safety glasses while dropping rocks on composite structures. (Pool goggles are an option if safety glasses are not available).
Students should be supervised by an adult at all times.
Students should wear closed-toe shoes during testing.
Students should be instructed not to consume any materials.
If a hair dryer is used, it should be on cool setting.
If a fan is used, keep students fingers away from fan blades.

References

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Section IV: Appendices

A: Engineering Design Process Poster
B: The Other Three Little Pigs
C: Composite Balloon Tips (Lesson 2)
D: Performance Rubric and Pre-/Post-Test Data Sheet
E: Composite Songs