Course: Enrichment

Enrichment Unit 1: Origami

Grade Level(s): 4	**Length of Unit: Approximately 14-16 sessions**

Unit Rationale:
Fourth grade students will explore the basic principles of plane and solid geometry by folding a variety of origami models. Emphasis will be placed on students' development of spatial sense through examination and transformation of the models they create, as well as communication about the processes they experience while creating them. Attention will be paid to mathematical ideas relating to perpendicularity, parallelism, similarity, congruence, symmetry and fractional parts. Students will also explore lines, types of angles and angle measurement in addition to problem solving related to geometry. Students will be introduced to the Platonic solids and will have the opportunity to fold a number of Platonic solid models.

Stage 1 - Desired Results

Understandings:

Students will understand that…

- Through the folding of polyhedral origami we can better understand fractions, measurement, and geometric principles relating to perpendicularity, parallelism, similarity, congruence, and symmetry.

Essential Questions:

-How is origami related to math?
-How does understanding geometric principles, fractions and angle measurement help in the folding of origami and help us improve origami structures?

Content:

Students will know..

- a point is an exact location in space.
- a line is a straight path continuing without end in two opposite directions.
- a line segment is a part of a line with two endpoints.
- a ray is a part of a line that continues without end in one direction and has one endpoint.
- an angle is formed by two line segments or rays with a common endpoint (vertex) or when two sides of a figure meet.
- an angle is measured in degrees on a protractor.
- an angle with a measure of less than 90 degrees is an acute angle, an angle with a measure of greater than 90 degrees but less than 180 degrees is an obtuse angle and an angle that is exactly 90 degrees is a right angle. An angle with a measure of 180 degrees is a straight angle or line.
- perpendicular lines are two lines that intersect at right angles
- parallel lines are lines that will never meet no matter how long they are drawn
- in order to classify shapes and models of origami we must look at patterns in their lines and angles.
- a line of symmetry is a line that divides a figure

Skills:

Students will be able to…

- identify equivalent fractional parts within origami models and between models.
- create platonic solid origami models using principles of geometry, fractions and measurement.
- compare and contrast various shapes and models to identify similarities,differences and patterns
- categorize figures based on their lines and angles
- use a protractor to measure various angles
- use an origami model to explain equivalent fractions
- recognize parallel, perpendicular, and intersecting lines within a figure
- find lines of symmetry in shapes

into two congruent parts; the parts match when the figure is folded along this line. - a figure has rotational symmetry if it can be rotated less than a full turn (360 degrees) about a point and looks the same as it did before the turn. - a fraction model can be used to show equivalence. While the number and size of the parts differ, the two fractions themselves are the same size.	

NJ Student Learning Standards - Math

4.G.A.1Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.

4.G.A.2 Classify two-dimensional figures based on the presence or absence of parallel or perpendicular lines, or the presence or absence of angles of a specified size. Recognize right triangles as a category, and identify right triangles.

4.G.A.3 Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.

4.MD.C.5.A An angle is measured with reference to a circle with its center at the common endpoint of the rays, by considering the fraction of the circular arc between the points where the two rays intersect the circle. An angle that turns through 1/360 of a circle is called a "one-degree angle," and can be used to measure angles.

4.MD.C.5.B An angle that turns through *n* one-degree angles is said to have an angle *n* degrees.

4.MD.C.6 Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure.

4.MD.C.7 Recognize angle measure as additive. When an angle is decomposed into non-overlapping parts, the angle measure of the whole is the sum of the angle measures of the parts. Solve addition and subtraction problems to find unknown angles on a diagram in real world and mathematical problems, e.g., by using an equation with a symbol for the unknown angle measure

4.NF.A.1 Explain why a fraction a/b is equivalent to a fraction $(n \times a)/(n \times b)$ by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions.

Career Education (Career Readiness, Life Literacies, and Key Skills Practices and 9.2 Standards)

CLKS Practices:

4.Demonstrate creativity and innovation
5.Utilize critical thinking to make sense of problems and persevere in solving them

Explanation of how **CLKS Practices** connect to the unit:

9.2 Standards

• 9.2.5.CAP.1: Evaluate personal likes and dislikes and identify careers that might be suited to personal likes.

Explanation of how 9.2 standards connect to the unit:

In exit tickets students will evaluate their likes and dislikes related to origami folding. Students will participate in discussions about careers related to those likes and dislikes, and learn how we can decide upon careers based on interests.

Interdisciplinary Standards

• 6.1.5.HistoryUP.7: Describe why it is important to understand the perspectives of other cultures in an interconnected world.
6.1.5.CivicsPI.1: Describe ways in which people benefit from and are challenged by working together, including through government, workplaces, voluntary organizations, and families.

Explanation of how interdisciplinary standards connect to the unit:

Students will learn about Japanese culture and discuss similarities and differences in culture, government, schools, etc.

Technology Integration (9.4 Standards) -

- **9.4.2.CI.2:** Demonstrate originality and inventiveness in work
- **9.4.5.GCA.1:** Analyze how culture shapes individual and community perspectives and points of view

Explanation of how 9.4 standards connect to the unit:

Students will learn how to fold polyhedra origami, and will also have opportunities to create their own unique pieces of origami. Students will learn about Japanese culture and discuss similarities and differences in culture, government, schools, etc.

Stage 2- Assessment Evidence:	
Assessment:	
Formative	Student exit tickets, student origami

Summative	Geometry end of unit assessment
Alternative	Audio/video response, origami book response
Benchmark	Geometry pre and post assessment google form

Stage 3 - Learning Plan

Learning Activities:

- Using purposefully selected polyhedral origami models, students will learn to create units for origami models. Prior to folding students will receive mini-lesson in mathematical topics outlined in above standards, content and skills. Students will work in partners and groups to complete folding, answer math questions and come up with their own thought questions related to the mathematics behind origami.

-Differentiated high level learning activities:

-Problem based learning activities that relate to content and objectives but are open-ended. For example, students may take a constructed origami cube and find the fraction of red units is 2/6 of the total. They may then investigate whether this same fraction pattern continues if they create a stellated octahedron (uses the same base unit as a cube).

- Students may choose to create their own unique origami structures that require research and investigation of folds, angles and other geometry components

-Students may use a variety of resources to investigate the geometric folds and objectives, including specific origami folding problem solving games.

-Authentic research of Japanese folding experts' techniques which can be applied to students own self-selected products.

-Small group advanced teaching could ask students to choose two origami structures and compare the fractional parts, angles, etc. and discuss the differences between them. Next, students can create their own origami structure that follows the same "geometric rules" as one of the structures they studied.

-Create a piece of origami that is one foot wide and will have to create a conversion table for inches to feet, and discuss how to create individual units of origami to create a larger scale model.

Differentiation:

ELL:

- Extend time requirements
- Preferential seating
- Check often for understanding
- Oral/visual directions/prompts when needed
- Provide hands-on materials and/ manipulatives for students to practice using new content knowledge

G&T:

- Explore origami extension activities (see learning activities)

Special Ed:

- Utilize a multi-sensory approach during instruction
- Reinforce visual directions with verbal cues
- Extend time requirements
- Allow verbal rather than written responses
- Provide hands-on materials and/ manipulatives for students to create origami
- Provide additional visual cue cards for origami folding
- Preferential seating as needed

504:

- Review, restate and repeat
- Frequently ask questions to engage student
- Provide graphic organizers as needed

Students at Risk:

- Deliver instruction utilizing varied learning styles including audio, visual and tactile/kinesthetic
- Provide individual instruction as needed
- Meet with students frequently to ensure understanding
- Allow verbal rather than written responses

Core Instructional Resources

Teacher Pedagogical Resources:
Polyhedral origami folding websites and books
District Math textbooks

Student Materials:
Origami paper, BES library origami books

Notes:
Career Exploration: Students will discuss careers related to the mathematics of origami, and learn how we can decide upon careers based on interests.

Course: Enrichment

Enrichment Unit 2: Engineering and Problem Solving

Grade Level(s): 4	**Length of Unit: Approximately 14-16 sessions**

Unit Rationale:

In this unit, students will use a variety of problem solving skills to work individually,in partnerships and groups to solve real-world word problems and complete engineering based task challenges. For the problem solving portion of this unit, students will explore Exemplars, logic games and puzzles (via board games, web, pencil and paper), and real-world application word problems to strengthen their critical thinking and problem solving skills. Students will share results and explanations, and will re-evaluate and synthesize their understandings. Students will also learn background information about engineering and architecture as they use group communication skills to explore challenges related to towers, bridges, and other structures. Students will learn how to use the design process to brainstorm ideas, track and evaluate their results and test and redesign their structures. Students will understand the importance of a growth mindset in order to learn from mistakes and make improvements to their designs.

Stage 1 - Desired Results

Understandings:	**Essential Questions:**
Students will understand that… ● -they can use a variety of problem solving strategies to solve real world word problems and engineering design tasks. ● -in order to become critical problem solvers or engineers, we must evaluate various strategies and solutions to formulate the best possible solutions.	-How do engineers improve their ideas? -Why do we use the engineering design process to solve design challenges? - How can the engineering design process benefit us in solving problems in our daily lives? -What are the forces that act on bridges and towers, and how can we take those into consideration when designing an engineering project? -How can we use the design process to assess which engineering shapes, designs and materials are the strongest?
Content: *Students will know…* -the design process is a systematic way to solve problems and make improvements. - an engineer invents and builds for the benefit of society -engineers create new products and improve existing products -engineers use a growth mindset in order to learn from mistakes and make improvements -a force is a push or pull on an object, and forces can affect the physical structure of a building. -the forces that act on tower and bridge structures are tension, torque, gravity and compression. -gravity is the force that attracts a body toward the center of the earth -tension describes the pulling force exerted by each end	**Skills:** *Students will be able to…* -Use multiple strategies to solve multistep word problems, logic puzzles and mathematical games. -Explain their mathematical thinking and steps involved with problem solving -Assess the reasonableness of answers using mental computation and estimation strategies including rounding. -Apply the area and perimeter formulas in real world and mathematical problems -Generate a number or shape pattern that follows a given rule. -Identify apparent features of the pattern that were not explicit in the rule itself. -Work collaboratively to reach a common goal.

of a string, cable, chain, or similar one-dimensional continuous object, or by each end of a rod, truss member, or similar three dimensional object. -compression is a force that squeezes objects together. - torque is a twisting force that tends to cause rotation. -acceleration is the rate of change of velocity of an object. -velocity is the speed of something in a given direction. -a beam bridge can take great weight over a short distance, truss bridges take advantage of the strength of the shape of a triangle, while suspension bridges can handle torque (the moment of a force or system of forces tending to cause rotation), and tension across a long distance.	-Use the design process and physics knowledge to develop a structure that meets task requirements (i.e.: tower at certain height, bridges that can support certain weights, etc). -Evaluate structures and engineering process in order to assess the strengths and weaknesses of structural design. - Use the design process and growth mindset to improve designs/structures

NJ Student Learning Standards - Math

.4.OA.C.5

Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself.

.4.MD.A.2

Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.

4.MD.A.3

Apply the area and perimeter formulas for rectangles in real world and mathematical problems.

4.OA.A.2

Multiply or divide to solve word problems involving multiplicative comparison, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem, distinguishing multiplicative comparison from additive comparison.

4.OA.A.3

Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.

NJ Learning Standards Science

3-5- ETS 1-1 Define a simple design problem reflecting a need or want that includes specified criteria for success and constraints on materials, time or cost.

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

NJSLS-Career Readiness, Life Literacies,and Key Skills:Standards & Disciplinary Concepts (Career Readiness, Life Literacies, and Key Skills Practices and 9.2 Career Awareness, Exploration and Preparation Standards)

CLKS Practices:

4.Demonstrate creativity and innovation

5.Utilize critical thinking to make sense of problems and persevere in solving them
9.Work productively in teams while using cultural/global competence

Explanation of how **CLKS Practices** connect to the unit:

Students use creativity, innovation, critical thinking and collaborative teamwork while completing problem solving and engineering challenges.

9.2 Standards

9.2.5.CAP.3:
Identify qualifications needed to pursue traditional and non-traditional careers and occupations.

Explanation of how 9.2 standards connect to the unit:
Throughout lessons students will explore different careers, qualifications and skills associated with engineering (electrical engineer, mechanical engineer, structural engineer, etc)

Interdisciplinary Standards

• **6.1.2.CivicsPD.1:** Engage in discussions effectively by asking questions, considering facts, listening to the ideas of others, and sharing opinions.
• **6.1.2.CivicsPD.2:** Establish a process for how individuals can effectively work together to make decisions.

Explanation of how interdisciplinary standards connect to the unit:

Students work in collaborative teams to evaluate designs, come up with a team design plan, build, give feedback and improve designs.

Technology Integration (9.4 Standards) -

• **9.4.2.CI.1:** Demonstrate openness to new ideas and perspectives
• **9.4.2.CI.2:** Demonstrate originality and inventiveness in work

Explanation of how 9.4 standards connect to the unit:
Each engineering and problem solving challenge requires students to demonstrate openness to other students' ideas. Students must demonstrate originality and inventiveness in all engineering challenges.

Stage 2- Assessment Evidence:	
Assessment:	
Formative	Exit tickets, students' oral and written responses to challenges
Summative	Engineering task challenge reflections, student journals

Alternative	Audio or video response/reflections; poster, google slides
Benchmark	Engineering lab response

Stage 3 - Learning Plan

Learning Activities:

-Students work in collaborative groups to complete instant task challenges (Ex: paper scraper challenge, penny bridge, popsicle stick bridge challenge) using various materials. Students will go through the design process to evaluate ideas and make changes accordingly for improvement. Students will synthesize their work and write reflections to illustrate understanding of the physics involved with structural engineering.

-Students will work independently, in partnerships and in groups to solve a variety of real world word problems, logic puzzles, and problem solving games. Students will discuss possible strategies and solutions to each, and will reflect on their understanding.

Differentiation:

ELL:
- Extend time requirements
- Preferential seating
- Check often for understanding
- Oral/visual directions/prompts when needed
- Provide hands-on materials and/ manipulatives for students to practice using new content knowledge

G&T:
- Allow students to take an active role in exploring additional information on simple machines (history, application in real world, etc)
- Propose simple machines extension activities (ex: create a machine from two simple machines)

Special Ed:
- Utilize a multi-sensory approach during instruction
- Reinforce visual directions with verbal cues
- Extend time requirements
- Allow verbal rather than written responses
- Preferential seating as needed

504:
- Review, restate and repeat
- Frequently ask questions to engage student
- Provide graphic organizers as needed

Students at Risk:
- Deliver instruction utilizing varied learning styles including audio, visual and tactile/kinesthetic

	• Provide individual instruction as needed • Meet with students frequently to ensure understanding • Allow verbal rather than written responses

Core Instructional Resources

Teacher Pedagogical Resources:
Engineering Instant Challenge Library:
http://www.cre8iowa.org/team-support/instant-challenge-library/
STEM Design Challenge book
Exemplars on district google drive
Games and logic puzzles in classroom and web

Student Materials:
Student engineering challenge response sheets, design challenge materials

Notes:
Career Explorations:
Throughout lessons students will explore different careers, qualifications and skills associated with engineering (electrical engineer, mechanical engineer, structural engineer, etc)