TGC Unit: Geometry and Design

Prepared by: Bryan Dickinson	**School/Location:** South Valley Academy, Albuquerque, NM
Subject: Math	**Grade:** 8
Time Needed: 8 weeks	**Interdisciplinary Unit Title:** Transformations and Application

Unit Summary: Students will begin studying the idea of rigid transformations, dilations, and solving real-world problems involving area, volume, and the Pythagorean Theorem. They will do this within the context of designing an approach to farming that utilizes alternative techniques such as hydroponics or aquaponics. Students will be studying farming techniques in their science class and constructing the models in math class using the concepts they master throughout this unit. The designs will be done in TinkerCad and Geogebra and final designs will be printed on our 3D printer. This unit culminates in a presentation to families and community members on global food, which will include their prototype. This math unit is happening in unison with students' humanities and science classes where they will be learning about sustainable development goal 2: zero hunger as well as the engineering process. This will allow students to develop an understanding of food at the local level and how this connects to food on a global scale. The engineering process will be centered on learning about local solutions to growing food as well as innovations happening globally. The goal is to have a truly interdisciplinary unit.

Stage 1: Desired Results

Established Goals:

CCSS Standards:

1. Verify experimentally the properties of rotations, reflections, and translations.
2. Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations.
3. Given two congruent figures, describe a sequence that exhibits the congruence between them.
4. Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.
5. Understand that a two-dimensional figure is similar to another if the second can be obtained form the first by a sequence of rotations, reflections, translations, and dilations.
6. Given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.
7. Explain a proof of the Pythagorean Theorem.
8. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world, mathematical problems, and for the distance between two points in a coordinate system.

Standards for Mathematical Practice:

1. Attend to precision.
2. Use appropriate tools strategically.
3. Model with mathematics.
4. Construct viable arguments and critique the reasoning of others.
5. Make sense of problems and persevere in solving them.

Next Generation Science Standards (to be completed jointly with students' science class):

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.
2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
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.
4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Global Competency:

1. Understanding the world through interdisciplinary study.
   - Identifying environmental sustainability and world hunger as issues that can be put in context through the humanities and solved with the help of math and science.
2. Communicating ideas.
   - Breaking down complex mathematics ideas for a general audience in English and Spanish.
3. Taking action.
   - Applying math and science to address unsustainable farming and food shortages.

Technology Used/Resources:

1. MakerBot 3D Printer/Software: https://www.makerbot.com/print/
2. Chromebooks
3. TinkerCad: https://www.tinkercad.com
4. Desmos: https://www.desmos.com/
5. Geogebra: https://www.geogebra.org/
6. Global Concerns Classroom: https://gcc.concernusa.org/about-us/
7. World Smarts STEM Challenge: https://www.irex.org/project/world-smarts-stem-challenge
8. Ron Finley: https://www.youtube.com/watch?v=EzZzZ_qpZ4w
9. NASA: https://www.nasa.gov/missions/science/biofarming.html
10. Script Graphic Organizer: https://docs.google.com/document/d/1LABqM0NNu-M3ZMEUwDutMK07bBHlWCE6ACByohsYsJs/edit?usp=sharing

Transfer

Students will be able to independently use their learning to identify an area of need that potentially has a technical solution, apply geometric concepts and problem-solving skills to design a solution, and then communicate that solution to a professional audience.

Meaning

Understandings:

1. Students will understand that geometry is a crucial part of the engineering process, but understanding the needs of clients and design requirements is a critical first step.
2. Students will understand that applied mathematics is only possible because of the work of mathematicians around the world that have participated in the rigorous proof of theorems.
3. Students will understand the potential for mathematics as a public good through the use of open source software such as Geogebra and TinkerCad.
4. Students will understand the importance of breaking down complex concepts for effective communication to an audience.

Essential Questions:

1. How do mathematicians take abstract mathematics and apply it through modeling?
2. What are the responsibilities of pure and applied mathematicians regarding global issues such as climate change and food supplies?
3. What errors appear when mathematical principles are applied to real world situations and how are these exposed through the use of mathematical software?
4. How can complex mathematical concepts be communicated to the general public in such a way that they gain a basic understanding?

Acquisition

Students will know…

1. Rigid transformations such as translations, rotations, and reflections preserve structure and produce congruent shapes.
2. Dilations preserve structure, but scale an object to create similar shapes.
3. Unknown distances can be found through the application of geometry and algebraic principles.
4. Area and volume are critical concepts for the design and production of functional prototypes.
5. What shapes will be required for a design and the appropriate area and volume formulas.
6. The value of ideas can only be assessed through quality communication.

Students will be able to…

1. Identify and apply the necessary transformations to map a figure onto a congruent or similar figure.
2. Explain a proof of the Pythagorean Theorem, identify appropriate applications, and apply it.
3. Recognize simple and composite figures and apply the appropriate area or volume formula.
4. Working within a group of 3-4 students:
   A. design a prototype and prove that it meets volume and/or area requirements.
   B. Produce a prototype through the use of open source software and 3D printing.
   C. Communicate the need for their design, the process, and the final design to a professional audience.

Stage 2: Evidence

Assessments for Learning	• Observation: Students will be observed while working in groups completing problem sets and creating scalable designs for their prototypes. • Discussion: Students will be working in groups to create prototypes and to create "how-to" posters for content like rigid transformations, which will aid in content retention. • Exit Tickets: Periodically, at the end of each week, students will complete brief exit tickets on the big ideas from the week.
Assessment of Learning	1. Students will complete a written exam on the core content of the unit in order for me to gain an understanding of individual mastery. 2. Students, in groups of 3-4, will present their prototypes, including an explanation of the design process, to an audience of staff, families, and professionals • This will include progress checks along the way: submission of prototype designs for feedback, outlining a script, and practice presentations in front of peers.

Stage 3: Learning Plan

This unit makes up the geometry section of eighth grade math with the hope students will recognize the direct applicability of the topics we cover.

Weeks 1 and 2: Students will work with rigid transformations and dilations, understanding what structures are preserved (i.e. angles, side lengths. We will then look at structures such as buildings, electronics, and water filtration systems to identify thees properties in the engineering process.

Weeks 3 and 4: Students will work with the area of regular, irregular, and composite figures to develop techniques for finding area more quickly such as breaking composite figures into simpler figures. We will then apply this to calculating how much material will be needed to build their farming designs. For example, some students will be containing their system in wooden boxes, which makes it essential to know how much material is needed.

Weeks 5 and 6: We will break down the volume of triangular and rectangular prisms, cylinders and spheres, and composite figures made of these common 3D shapes. An essential part of alternative farming designs is often how they contain soil and water, meaning students will have to ensure that the dimensions of their designs will provide enough volume to meet their needs.

Week 7: Having checked their design dimensions, students will make revisions and sketch a final design through math and science class that includes dimensions, supply needs, and volume calculations. After teacher review, these will be returned with approval or areas for additional revision.

Week 8: Students will begin the construction of prototypes, including printer special components designed on TinkerCad. In humanities and art classes, students will construct their visual aids, which could be posters, PowerPoints, Prezis, or an alternative with prior approval. At the end of this week, students will be presenting to a live audience of families, parents, and professionals in a science fair style setting.

Lesson: Communicating to the Public

Subject: Math 8	**Prepared by:** Bryan Dickinson
Materials Needed: • Computer/Projector • Script Graphic Organizer: https://docs.google.com/document/d/1LABqM0NNu-M3ZMEUwDutMK07bBHlWCE6ACByohsYsJs/edit?usp=sharing • Time: 100 minutes • Word Wall containing terms from the unit.	**Global Competency:** • Communicate ideas using appropriate verbal and nonverbal behavior, languages, and strategies. • Select and use appropriate technology and media to communicate with a diverse audience.

Where is the lesson going?	Students will be able to communicate the geometric principles present in their crop prototypes using mathematical vocabulary.

Hook:

I will open up this lesson by showing the TedTalk with Ron Finley. As they are watching, students will record any aspect of the presentation that stood out to them: presentation style, information, hope for the future, etc. We will finish with a brief whole class sharing.

Equip:

Students will be given the script graphic organizer listed in the materials needed section, which we will walk through as a class. Students will then be asked to pull out their folders of research materials as well as their design sketches. After taking last minute questions, they will be released to delegate parts of the scripts among their 3-4 group members. This will be a silent activity to start once sections have been assigned.

Rethink and Revise:

Individuals will read their section outlaid to their small groups. Other group members will record strengths and critiques. Once every individual has gone through this process, each group member will revise their section based on the feedback received. These second drafts will be submitted to me for review.

Evaluate:

Students will submit their speech drafts for review, which will give me insight into their progress and necessary interventions.

Tailored Differentiation:

- The video at the beginning demonstrates presentation methods instead of a vague rubric.
- The built-in peer review process is a chance for all students to engage with the ideas independently at first, but then allows for students who may struggle with writing to receive immediate feedback to strengthen the group's work.
- The class EA and I will be circulating to answer individual questions and provide additional prompting as needed.

Notes:
This is just the beginning of the drafting process for the science and math component. Students will be choosing the media platform to display images and other relevant information in their humanities classes.

Organization:
- Students will staple their final drafts together and submit them into the turn-in box for their class period.
- All research materials and sketches will be put back into their research folders, which will be carried with them to their next class and then dropped off with their last period teacher.