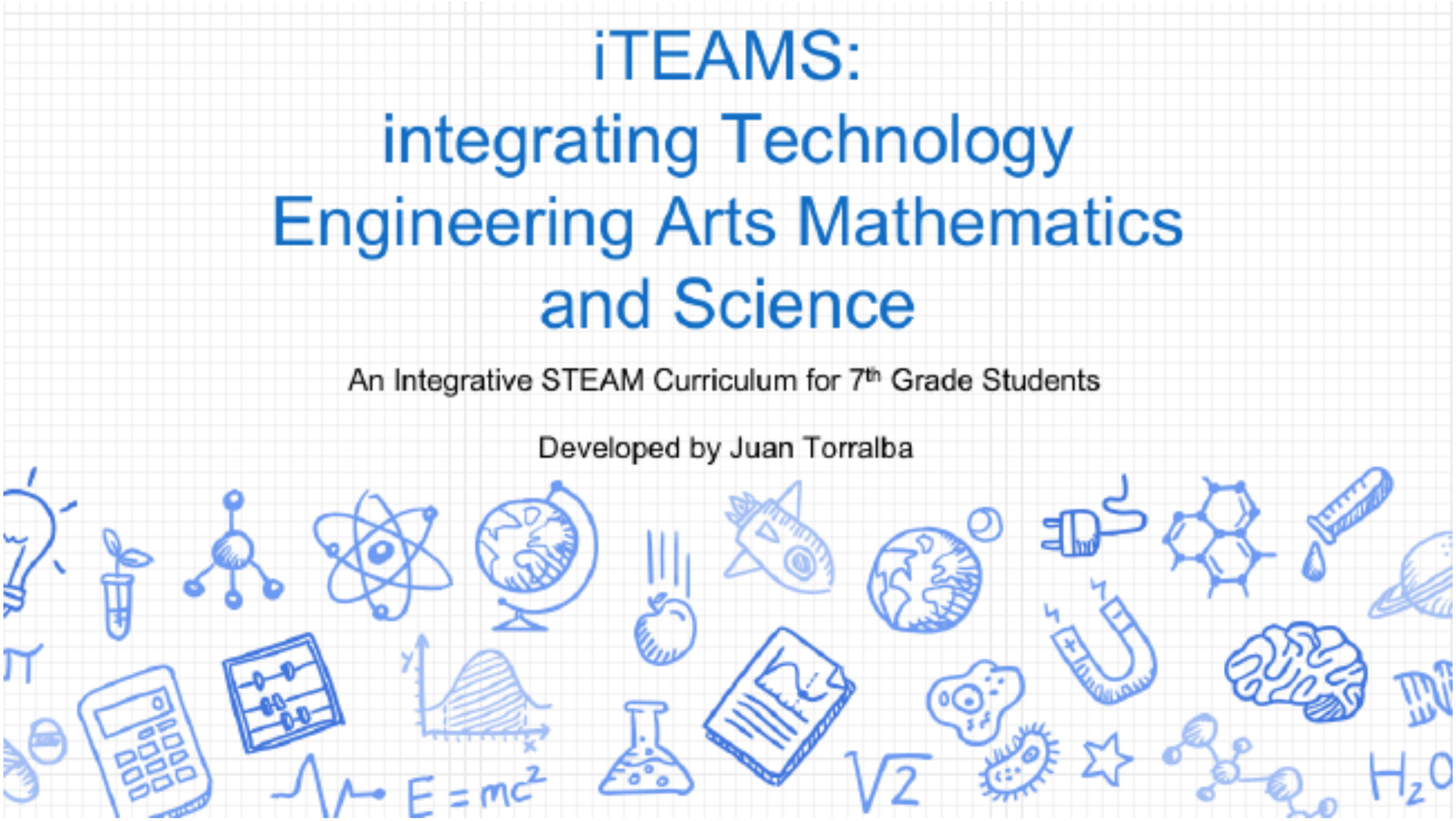

SOURCE: Torralba, J, iTEAMS: Integrating technology engineering arts mathematics and science, An integrative STEAM curriculum for 7th grade students.

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Curriculum Overview

The iTEAMS curriculum is designed to be implemented as an elective course for 7th grade students. The duration of the course is approximately 18 weeks, or a full semester. iTEAMS stands for integrating Technology, Engineering, Arts, Mathematics, and Science. The acronym is meant to emphasize the integrative and collaborative nature of the course. Throughout the course, students work in collaborative teams of four or five members to complete each of the four projects designed in the curriculum. Within their teams, students take different roles and work with members of diverse levels and areas of expertise. At the beginning of each project, students have the opportunity to regroup with different students, take different roles, and experience different forms of teamwork. They also collaborate with professionals who work in the STEAM fields relevant to each project and receive guidance from the STEAM content teachers when necessary.

In each project, integration is emphasized not only in the STEAM content covered, but also in the integration of student talent within the teams formed. The STEAM teachers only serve as facilitators during each project; assisting students in clarifying the expected final product, reviewing necessary STEAM content, troubleshooting technology, and coaching them for presentation. This means students have to rely mainly on each other to complete each project. This strategy is meant to address one of the goals of STEAM education: to provide opportunities for students to develop STEAM knowledge, skills, and practices through just-in-time technological training, personalized scaffolding, and gradual removal of expert assistance.

Theoretical Foundations

The iTEAMS curriculum is composed of the following four 4-5 week integrative projects: (a) designing an ideal home on 3D modeling software, evaluating the cost of the home, investigating the STEAM professions that will provide sufficient income to afford the home, and presenting the final product to the class (The Dream Home); (b) designing a geometric garden and planting it on one of the schools' green areas (The Geometric Garden); (c) designing and constructing geometric moving art using microcontrollers and displaying it around the school (The Geometric Art); (d) and designing and creating a scale model of an ideal classroom and presenting it at a STEAM conference (The Ideal Classroom). All four projects in the curriculum are based on the constructionist principles of designing, making, and publicly sharing (Papert, 1991). A constructionist view of learning emphasizes on students' full engagement and collaborative participation in the learning process and posits "that the construction of knowledge happens remarkably well when students build, make, and publicly share objects" (Blikstein, 2013). Additionally, the theme in each project is student-centered and informed by experiential learning theories. These theories emphasize that education should be based on real-world tasks that are more connected to students' lives and interests (Blackley et al., 2017). The literature shows that when students know that their final work will be shared with an audience larger than the class, they become more motivated to meaningfully engage with the tasks presented in the project (Blikstein, 2013). Therefore, the sharing of the final product and the explaining of the making process through an end-of-project presentation are emphasized in each project.

Integrative STEAM Projects as Making Activities

In addition to its theoretical foundations, the iTEAMS curriculum is also informed by the principles of Maker Education. More specifically, the implementation of the curriculum is designed to take place within a modified *makerspace*, where students engage in meaningful *making* activities, through which they can develop *maker* identities. The modified makerspace is space where the basic making tools and materials are available for students to use. Items in the makerspace can be as common as a tool box filled with crafting supplies and materials, screwdrivers, adhesives, and cutting supplies, or high-tech machinery such as 3D printers, laser cutters, vinyl cutters, carving machines (CNC), and power tools. The making activities are ones where students learn a skill such as sketching, prototyping, digital modeling, 3D printing, or laser cutting, to a name a few, in order to make something meaningful. Lastly, maker identities are those students develop as they become more knowledgeable, skilled, and confident with both using the tools in the makerspace and their application of STEAM content.

Throughout the semester, students are to deliver four different final products: a digital 3D model of their ideal home, a completed geometric garden, a physical piece of geometric moving art, and a physical 3D model of their ideal classroom. Each of those products are to be presented at the culmination of each project. For their presentations, students are asked to follow a rubric (see Table 1) covering five categories: organization, delivery, content knowledge, accuracy, and model. The categories of organization and delivery are meant to help students structure their presentations. The last three categories were designed to assess student understanding of the mathematical concepts embedded in the curriculum projects.

Project Presentation Rubric

Presenters:

Criteria					Points
	1 Below Expectations	2 Developing	3 Knowledgeable	4 Advanced	
Organization	Audience cannot understand presentation because there is no sequence of information.	Audience has difficulty following presentation because student jumps around.	Student presents information in logical sequence which audience can follow.	Student presents information in logical, interesting sequence which audience can follow.	
Delivery	Students mumbles, incorrectly pronounces terms, and speaks too quietly for students in the back of class to hear.	Student incorrectly pronounces terms. Audience members have difficulty hearing presentation.	Student's voice is clear. Student pronounces most words correctly.	Student used a clear voice and correct, precise pronunciation of terms.	
Content Knowledge	Students show no understanding of mathematical concepts within the final product.	Students are visibly uncomfortable with the mathematical concepts within their final product.	Students are at ease with the mathematical concepts within their final product, but lack a deep conceptual understanding.	Students demonstrate a complete and comprehensive understanding of the mathematical concepts within their final product and the relationships among them.	
Accuracy	Students' final product displayed unrealistic or non-proportional measurements for more than half the major components.	Students' final product had a few major components with unrealistic measurements or scaling.	Students' final product had a few minor items or parts that were not proportionate to the rest of the design.	Students' final product displayed accurate and realistic measurements and every item in the design had proportionate measurements within itself.	
Scale	The final product (digital or physical) being presented does not look like the scale drawing designed for it.	The final product (digital or physical) being presented looks like the scale drawing designed for it, but it is not scaled correctly.	The final product (digital or physical) being presented looks like the scale drawing designed for it, but has a few cosmetic errors.	The final product (digital or physical) being presented looks like the scale drawing designed for it, has no cosmetic errors, and accurately represents the entire project.	
				Total	

Table 1 - Grading Rubric for Final Projects - Developed by Juan Torralba

Through an aesthetic symptomatic analysis of the student artifacts and the process of creating the final products we can identify the activities in each project as making activities (Clapp, 2017). In each project, a wide variety of materials are used for the completion of one tangible final product, whether physical or digital (symptom 1); notes, measurements, cables, servo motors, Arduino microcontroller, irrigation pipes, ridges from 3D printing, and practically everything involved in the final product is exposed to exhibit the variety of STEAM disciplines involved in each project (symptom 2); each final product is unconventionally aesthetic, in the sense that it is not necessarily meant to look professionally finished, rather student-made (symptom3); the final products reflects the team members' personal touch, as each product will be created based on the team's collective and individual vision (symptom 4); finally, the aesthetics of the final product will depend on its intended functionality, meaning the exposed cables, motors, measurements, pipes, also serve a purpose beyond the display of STEAM discipline involved in the final product (symptom 5). It is important to note that not every activity in each project is a making activity. And that does not have to be the case. The affordances of using Clapp's symptomatic approach to identify the projects in the iTEAMS curriculum as making activities is that it does not constraints the projects to meet a set of requirements on a list, rather, the presence of several making characteristics in the projects is what identifies them as making.

STEAM Knowledge, Skills, and Practices

Overarching Concepts. The projects in the iTEAMS curriculum were developed to meaningfully and purposively address specific STEAM content standards. All four projects require the explicit application of proportional reasoning (mathematics CCSS) during the designing stages, and principles of design (engineering NGSS) during the building stages. The explicit applications of proportionally and principles of design are to help students apply and reinforce their understanding of those standards in real-word activities that are meaningful and relevant to them. While the context for each project in the iTEAMS curriculum is different, the process of designing-to-building and the academic content required for completion is the same.

Project-Specific Concepts. In addition to proportionality, the projects also address other STEAM standards. The Dream Home explicitly addresses technology standards (ISTE) in the modeling of the home on the 3D software, and personal and financial literacy standards (TEKS) during the evaluation of the home and income required to afford it. The Geometric Garden addresses geometry standards (CCSS) in the design of the garden, and science and engineering standards (NGSS) in the selection of plants and construction of the irrigation system. The Geometric Art addresses geometry standards (CCSS) in the design stage, visual arts standards (CVACS) in the construction stage, and technology standards (ISTE) in the programming of microcontrollers. Lastly, the Ideal Classroom addresses art and engineering standards (CVACS; NGSS) in the construction of the physical model and technology standards (ISTE) in the modeling of the classroom on the 3D software and 3D printing.

Practices. According to the *Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (2012) and the *Common Core State Standards for Mathematics* (2010), there is a set of practices that are essential for all students to learn. These science, mathematics, and engineering practices are embedded in the iTEAMS curriculum and are explicitly highlighted in the lesson plans for each project. Rather than attempting to address every practice, the curriculum focuses on the following selected few, which are the most salient in the activities:

- *a.* Make sense of problems and persevere in solving them (CCSS) / Asking questions (for science) and defining problems(for engineering) (NGSS)
- *b.* Construct viable arguments and critique the reasoning of others (CCSS) / Constructing explanations (for science) and designing solutions (for engineering) (NGSS)
- *c.* Model with mathematics (CCSS) / Developing and using models (NGSS)
- *d.* Use appropriate tools strategically (CCSS)
- *e.* Attend to precision (CCSS)
- *f.* Using mathematics and computational thinking (NGSS)
- *g.* Engaging in argument from evidence (NGSS)
- *h.* Analyzing and interpreting data (NGSS)
- *i.* Planning and carrying out investigations (NGSS)
- *j.* Obtaining, evaluating, and communicating information (NGSS)

Practices *a-f* are embedded in all four projects. For each of those projects, students need to make sense of what they are being asked to do, define what is meant by certain words (e.g., what is meant by “ideal,” “dream home,” etc.), develop several viable solutions, model with scale drawings, use tools strategically (e.g., one software program over another, hand-drawn sketch over computer-assisted one, etc.), and be very precise with the measurements. Practices *g-j* are only substantially emphasized in the Dream Home project, during the cost evaluation of the home and necessary income to afford it.


Project 1: The Dream Home
F = mc2
H2O

Project 1: The Dream Home - Lesson Plan

Overview:

The Dream Home project is designed to cover concepts of geometry and measurement (composite figures), proportionality (scale drawings and scale factor), and personal and financial literacy (cost of living and sources of income). In this project, students are asked to design their dream home using an online 3D software, evaluate the cost of the home they design, investigate which STEAM professions will allow them to afford the home, and develop an academic plan to attain that profession. The software needed for the first part of this project is very user friendly and allows students to create a blueprint and a 3D model of the home simultaneously. One of the goal of this project is to allow students to apply their understandings of composite figures and scale drawings in a real-world activity that focuses on their interests. When designing their dream homes, students will need to use realistic measurements for the dimensions, and those measurements will need to be accurately represented on their scale drawings. The applications of geometry and measurement concepts in this project are integral to the completion of the home.

The second part of this project focuses on personal and financial literacy. After students design and create their dream home models, they will need to evaluate the cost of their homes, based on square footage and geographical location. This will require them to use various real estate websites to find the closest estimate. Once an estimate has been found, students will need to investigate which STEAM professions will allow them to earn enough money to afford the home. During this process, students will evaluate the pros and cons of each profession in terms of income and personal interest. After students determine which profession is best for them, they will need to develop an academic plan to follow in order to attain that profession.

The concepts covered in the second part of this project come from the personal and financial literacy standards (TEKS). These concepts are explicitly embedded in the activities and allow students not only to work with real data to evaluate the cost of the home, but also to explore STEAM professions that are relevant to their interests and will meet their possible future financial needs. This entire project covers a variety of STEAM concepts explicitly and implicitly, while at the same time it remains deeply personalized and engaging from the design stage to the final presentation. The benefits students might gain from participating in this project go beyond the development of STEAM knowledge and skills; students will also learn how to work in multi-layered projects that require them to utilize a wide variety of tools, an environment that is similar to what architects and real estate professionals normally work in.

Project Duration: 4-5 Weeks

Tools and Materials	Sketching tools (paper, pencil, rulers) Computers with 3D modeling and software installed Presenting materials (e.g., tri-fold board, printer, scissors, glue)
Math, Science, and Engineering Practices	*a.* Make sense of problems and persevere in solving them (CCSS) / Asking questions (for science) and defining problems (for engineering) (NGSS) *b.* Construct viable arguments and critique the reasoning of others (CCSS) / Constructing explanations (for science) and designing solutions (for engineering) (NGSS) *c.* Model with mathematics (CCSS) / Developing and using models (NGSS) *d.* Use appropriate tools strategically (CCSS) *e.* Attend to precision (CCSS)

	f. Using mathematics and computational thinking (NGSS) *g.* Engaging in argument from evidence (NGSS) *h.* Analyzing and interpreting data (NGSS) *i.* Planning and carrying out investigations (NGSS) *j.* Obtaining, evaluating, and communicating information (NGSS)
STEAM Content	**Project-Specific and Overarching Concepts** **CCSS Mathematics:** 7.G.A1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale 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. 7.RP.A2 Recognize and represent proportional relationships between quantities. 7.NS.A3 Solve real-world and mathematical problems involving the four operations with rational numbers. 7.EE.B3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. **NGSS Engineering:** 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 such that an optimal design can be achieved. **Project-Specific Concepts** **International Society for Technology in Education (ISTE)** T1. Empowered Learner Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences. T2. Digital Citizen Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical. T3. Knowledge Constructor Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others. T4. Innovative Designer

<table>
<tr><td></td><td colspan="2">Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions.
T5. Computational Thinker
Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.
T6. Creative Communicator
Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.
T7. Global Collaborator
Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally.</td></tr>
<tr><td colspan="3">Project Goal: Design a version of your dream home using an online 3D software, evaluate the cost of the home you design, investigate which STEAM professions will allow you to afford the home, and develop an academic plan to attain that profession.</td></tr>
<tr><td>Week 1</td><td>Day 1</td><td>Day 2</td></tr>
<tr><td>Planning and Sketching</td><td>Objective (s):
Students will be able to create a detailed description of their future house using 3D models on a 3D modeling software.

Process
The class will begin with the teacher providing an overview of the project, a brief explanation of each step, a description of the tools and materials that will be needed, and what is expected as a final product.
The teacher will lead a discussion, in a brainstorm format, about how students envision their future houses. This discussion will help set the tone for the final product, the house of their dreams.
The teacher will show models on Sweethome3D.com of houses varying in architectural design, size, geographic location, décor.
After the overview, the teacher will introduce the experts who will guide the students throughout this project.
Each of the experts will introduce themselves to the class, and describe:
What they do for a living
What type of education they completed to obtain their current job
The average salary in those professions</td><td>Objective (s):
Students will be able to develop a scale drawing (blueprint) of their ideal home.

Process
Student will begin to work on their scale drawings.
Experts will meet with each team to go over the plan for creating the scale drawing.
If necessary, the teacher will revisit the concepts of proportionality, measurement, and scale drawings.
Students will spend the first hour working on their scale drawings.
The second hour will be dedicated to students familiarizing themselves with the 3D modeling software.
The teacher will meet with students to make sure the scale drawings are complete, before they can move on to the 3D modeling software.
Evaluation
The teacher will visit each team and go over the scale drawings and make sure they are completed.</td></tr>
</table>

	▪ How they normally begin a project such as the one the students will be working on (what things does an expert think about before starting such a project?) ▪ How they plan to assist the teams in this project • Following the expert introductions, students will form teams and begin to work on their projects. ○ Students will navigate the software to see other models and find the ones they feel are similar to the ones they envision having in the future. • Students will explain their reasoning for selecting the models they select. • The teacher will show an example of previous work from other students on a similar project and expand on what each student had to do to complete it as well as what was presented. • Students work in pairs to formulate a plan to complete the project and the various ways that it can be completed. ○ They will explore the different designing tools on the Swethome3D software and determine which tools they will need to understand in order to use it effectively. ○ They will also explore other 3D designing software available online and evaluate the advantages and disadvantages of using that program instead. • Students will explain what their plan is and why they chose that particular plan. They will also explain their reasoning for selecting a particular 3D software program. • The teacher will clarify that there are many things that need to be completed before moving to the creation of the 3D model. • The students will elaborate once again on what needs to be completed today in order to move on to the next part. **Evaluation** Students will complete a short description of their houses, including an explanation for the characteristics of the house.	
Teacher Tips	***To be added after implementation***	

Week 2	Day 1	Day 2
Creating and Finalizing	**Objective (s):** **Students will be able to create a 3D model of their future houses using their understanding of the 3D modeling software.** **Process** • If necessary, the teacher will revisit the concepts of similarity, congruency, and scale factor. ○ This will help solve commonly encountered problems on what items in the project are congruent, similar and which ones need to be scaled to match everything else in the room. • Students will begin working on their 3D models on Sweethome3d.com, or another 3D software program in the computer lab and learn how to use it. They will use their scale drawings for their 3D model. • Students will verbalize to the teacher and each other what the goal of the project is and what the requirements are to make sure that they have a clear focus on the "big picture." • Students will look at the models shown on the first day to understand the details of what they saw so they can replicate it. They will also consider the time restrictions. **Evaluation** Both students and teacher will evaluate the progress on 3D model and explain what the students have learned so far.	**Objective (s):** **Students will be able to finalize their 3D models.** **Process** • Students will spend the entire class period finalizing their 3D models. • If necessary, the teacher will show how to solve commonly encountered problems when using 3D technology and the students will analyze what they have completed so far to see if they have encountered any of those problems. • The teacher will also address any software problems the students may have encountered. • The students will analyze their model to make sure that what has been done and what is being completed is addressing the driving question as well as the restrictions given. • The teacher will explain what is expected of the completed 3D model, as well as the project as a whole. **Evaluation** Both teacher and students will evaluate the final product and make any suggestions if necessary.
Teacher Tips	***To be added after implementation***	
Week 3	**Day 1**	**Day 2**
Evaluating Home and Determining Professions	**Objective (s):** **Students will be able to evaluate the value of their Dream House in several parts of the US and the pros and cons of living in each of those places.** **Process** • Students will share in pairs a description of the location for their ideal home.	**Objective (s):** **Students will be able determine which professions will allow them to earn enough money to afford their Dream Home and live comfortably.** **Process** • Teacher will brainstorm with students a list of items that would need to be factored in when determining an income that will allow them to live comfortably.

	• Students should be asked to focus their conversation around the location of the home, whether the home will be in an urban, suburban or rural setting. • Students should consider if they will be living next to a body of water, on the plains or in a mountainous region. • Based on their conversations, students will investigate on the internet locations that fit their descriptions. • Students will then research the locations and list the pros and cons of living in each place. • The teacher will prompt students to consider taxes, schools and crime rates as factors. **Evaluation** Students will summarize their findings in writing.	○ Examples might include available transportation, insurance and health care costs, and cost of food. • Based on the ideas generated from the brainstorming session, the teacher will explain to students what monetary expenses are necessary to live comfortably. • Students will research on the internet different professions and compare their average incomes. • Students will be asked to select a profession that will provide enough income to allow them to purchase their dream home and live comfortably. **Evaluation** Students will summarize their findings and selected profession in writing in their "My Dream Home" workbook.
Teacher Tips	***To be added after implementation***	
Week 4	**Day 1**	**Day 2**
Evaluating Cost of Living and Developing an Academic Plan to Follow	**Objective (s):** **Students will be able to evaluate the overall costs of living in their area of preference, given their future income and Dream House cost.** **Process** • Students will investigate on the internet cost of homes in various locations throughout the United States. • Teacher will lead a discussion with students as to which factors contribute to the differences in cost. • Students will continue to research areas for their future dream home based on the income from their chosen profession. • With income as a constraint, students will select affordable areas and compare and contrast the differences between their researched locations. **Evaluation** Students will summarize their findings in writing in their "My Dream Home" workbook.	**Objective (s):** **Students will be able to create an academic plan to follow in order to have the profession necessary to afford their Dream House.** **Process** • Students will share their chosen profession with the class. • Teacher will lead students in a discussion as to what is necessary in achieving a chosen profession and the cost of an education. • Students will work in pairs to create an academic plan they would need to follow in order to work in their chosen profession. • Students should also ascertain the cost of their academic plan. **Evaluation** Students will summarize their findings in "My Academic Plan" worksheet.
Presentation Day	**Objective (s):**	

	Students will be able to present a 3D model of their future houses using 3D modeling software. They will also include an evaluation of the cost of their house, the income necessary to afford the home and live comfortably, and the careers that will allow them to earn that income. They should be able to talk about: • Their roles in their teams and their contributions. • The process of exploration, brainstorming ideas, developing a plan, building, redesigning, rebuilding, editing, and finalizing. • How they applied STEAM knowledge, skills, and practices throughout the creation of their 3D models. • Why their final product best meets the goals of the project	
Teacher Tips	***To be added after implementation***	

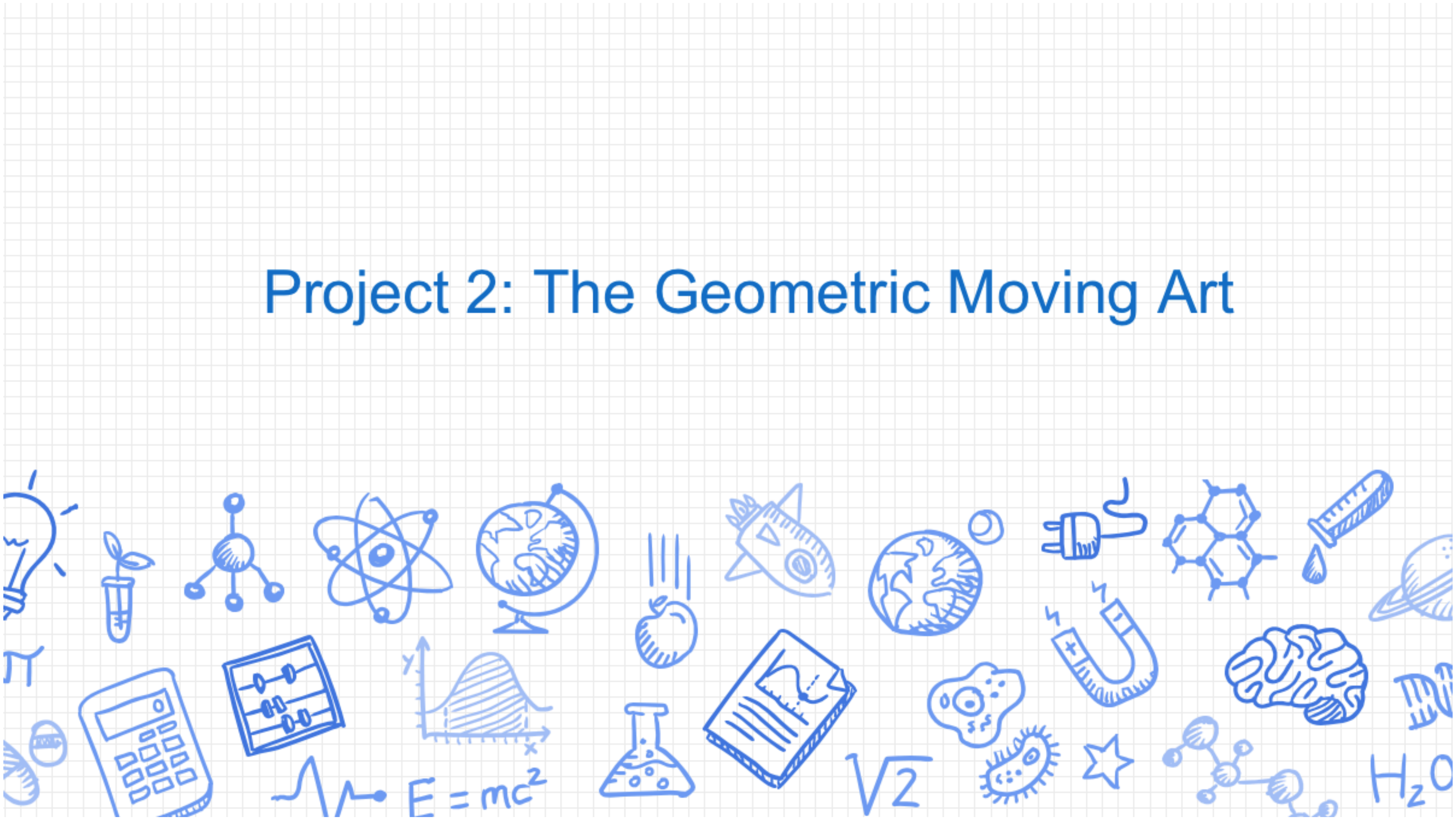
Overview Calendar and STEAM Practices and Concepts

The Dream Home Overview Calendar		
Week 1	**Monday (Planning and Sketching)**	**Thursday (Planning and Sketching)**
	Teacher introduces students to project and Sweethome 3D software. Students develop a plan for completing the 3D model. Experts and teachers will assist.	Students will develop a scale drawing of their dream home. Experts and teachers will assist.
	Concepts: **T1a/b/d** Practices: **P1.a/b, P2.a/b, P3.a-c, P4.a, P5.a/b**	Concepts: **7.G.A1, 7.G.B6, 7.NS.A3, 7.EE.B3, 7.RP.A2** Practices: **P1.a/b, P2.a/b, P3.a-c, P4.a, P5.a/b**
Week 2	**Monday (Creating)**	**Thursday (Finalizing)**
	Students will begin to create the 3D model of their dream home. Experts will lead and teacher will facilitate.	Students will complete the 3D model of their dream home. Teacher and student will review and make any necessary revisions. Experts will lead and teacher will facilitate.
	Concepts: **7.G.A1,7.G.B.6,7.RP.A2** **MS-ETS1-4** Practices: **P1.a/b, P2.a/b, P3.a-c, P4.a, P5.a/b**	Concepts: **7.G.A1,7.G.B.6,7.RP.A2** Practices: **P1.a/b, P2.a/b, P3.a-c, P4.a, P5.a/b**

Week 3	Monday (Research)	Thursday (Research)
	Students will pair-share their work. They will research the comparative value of a similar home in different locations of the United States. Teacher and expert will facilitate. Teacher will facilitate.	Students will research which profession will allow them to afford their dream home. Teacher will facilitate.
	Concepts: **7.NS.A3,7.EE.B3** Practices: **P1.a/b,P2.b, P3.a/c, P4.a-c, P5.a/b, P6-10**	Concepts: **7.NS.A3,7.EE.B3** Practices: **P1.a/b,P2.b, P3.a/c, P4.a-c, P5.a/b, P6-10**
Week 4	**Monday (Research)**	**Thursday (Research)**
	Students will evaluate the overall cost of living in their area of preference based on their future income and dream home costs. Teacher will facilitate.	They will create an educational plan for a chosen profession from their research. Teacher will facilitate.
	Concepts: **7.NS.A3,7.EE.B3** Practices: **P1.a/b,P2.b, P3.a/c, P4.a-c, P5.a/b, P6-10**	Concepts: Practices: **P1.a/b,P2.b, P3.a/c, P4.a-c, P5.a/b, P6-10**
	Presentation	
	Students present a 3D model of their future houses. They will also include an evaluation of the cost of their house, the income necessary to afford the home and live comfortably and an education plan for a chosen profession that will allow them to afford their dream home.	

Practices and Concepts

Practices	Overarching Concepts	Project-Specific Concepts
Math, Science, and Engineering Practices **P1.** Make sense of problems and persevere in solving them (CCSS) / Asking questions (for science) and defining problems (for engineering) (NGSS) **P2.** Construct viable arguments and critique the reasoning of others (CCSS) / Constructing explanations (for science) and designing solutions (for engineering) (NGSS) **P3.** Model with mathematics (CCSS) / Developing and using models (NGSS) **P4.** Use appropriate tools strategically (CCSS) **P5.** Attend to precision (CCSS) **P6.** Using mathematics and computational thinking (NGSS) **P7.** Engaging in argument from evidence (NGSS) **P8.** Analyzing and interpreting data (NGSS) **P9.** Planning and carrying out investigations (NGSS) **P10.** Obtaining, evaluating, and communicating information (NGSS) **See "Practices" in the Appendix for detailed descriptions of practices.**	**PROJECT-SPECIFIC AND OVERARCHING CONCEPTS** **CCSS MATHEMATICS:** **M7.RP** Analyze proportional relationships and use them to solve real-world and mathematical problems. **M7.RP1** Compute unit rates associated with ratios or fractions, including ratios of lengths, areas and other measured in like or different units. **M7.G** Draw, construct, and describe geometrical figures and describe the relationships between them. **M7.G1** Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. **NGSS ENGINEERING:** **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 such that an optimal design can be achieved.	INTERNATIONAL SOCIETY FOR TECHNOLOGY IN EDUCATION (ISTE) T1. Empowered Learner Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences. T2. Digital Citizen Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical. T3. Knowledge Constructor Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others. T4. Innovative Designer Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions. T5. Computational Thinker Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions. T6. Creative Communicator Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals. T7. Global Collaborator Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally. **See "Standards" section in the Appendix for detailed descriptions of standards**. CCSS MATHEMATICS: 7.G.A1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale 7.G.B6 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. 7.NS.A3 Solve real-world and mathematical problems involving the four operations with rational numbers. 7.EE.B3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. 7.RP.A2 Recognize and represent proportional relationships between quantities.


Project 2: The Geometric Moving Art
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Project 2: The Geometric Moving Art - Lesson Plan

Overview:

The Geometric Moving Art project is designed to cover geometry and measurement concepts (composite figures, volume, nets, and 3D shapes) and proportionality (scale drawings and scale factor). Additionally, it is meant to provide a different, and non-intimidating, entry point to these mathematics concepts through the creation of visual art. The project asks students to design and build a piece of artwork that only uses the 3D shapes covered in seventh-grade geometry and involves movement using a microcontroller. This project is structured similarly to the other projects in the iTEAMS curriculum in the design and building stages. However, this project is a substantially more open-ended in terms of the final product. Considering that art can be very subjective, students have the ability to create any type of art as long as it is based on seventh grade geometry and uses microcontrollers.

The designing stage of this project will require students to be very precise with their measurements. They will be sketching, modeling, cutting out, and putting together nets for each geometric 3D shape needed for the artwork. This means they will need to have a strong understanding of the relationship between nets and 3D shapes. In this stage, students will also have to determine the overall size of the artwork in order to proportionally construct every 3D shape to scale.

The building stage of this project is mainly arts and engineering focused. Experts in the field of visual arts will visit the class to provide basic training on a variety of art tools and materials. The teams will have a wide selection to choose from and decide which tools and materials will work best for their designs. During the training session, the experts will emphasize on artistic expression, creative expression, and connections, relationships, and applications of art in other STEAM subjects. All of which are defined as the main standards for visual arts (CVACS). The engineering component emerges when students decide which types of movements will be included in their artwork. They will need to be strategic in determining how the artwork will be presented (e.g., hanging, on a platform, on a side, etc.) and in evaluating the several types of materials available to accomplish the desired position (e.g., if hanging, use fishing line, different types of threads, plastic strings, etc.). They will additionally need to consider weight and size constraints. For example, if they use heavy material to construct the 3D shapes, and their artwork is meant to be hanging, then cotton thread might not be the best material to use to hold the shapes in place. The building of the pieces together stage will require them to develop several viable solutions, in a trial-and-error fashion, to determine which one will work best and will be most durable.

The last stage of this project will be programming microcontrollers (Arduino-type) to perform movements in the artwork. This stage will require students to learn how to use the Arduino programming software, which is based on HTML coding. Experts in computer science will provide basic training on coding and troubleshooting the microcontroller and will assist students during this stage to ensure no time is wasted on technical issues. The programming part of this project explicitly highlights several technology standards (ISTE) relevant to computer literacy (e.g., using coding software, accessing online tutorials, searching for programming information, etc.) and digital citizenship (e.g., appropriate use of the internet, using existing code, claiming authorship, etc.). Additionally, the programming of the microcontroller will need to also consider the physical attributes of the artwork. For example, if the artwork is meant to turn, a specific type of motor and coding will need to be used (servo motors, for instance, will not turn 360 degrees, unless they are physically modified).

The final product for this project will be a piece of artwork that represents the students' creativity and competency in geometry, measurement, proportionality, visual arts, and computer programming. While the main focus of this project was to provide a review of mathematics concepts using student interest as the main driver, several other STEAM concepts were embedded in different stages of the project. The integration of those concepts is meant to provide a working environment similar to that of many STEAM professionals, where their work does not solely depend on the application of one area of expertise. This project will allow students to work with different tools and materials, and also with a variety of talents found within their teams and from the visiting STEAM experts.	
Project Duration: 4-5 Weeks	
Tools and Materials	Sketching tools (paper, pencil, rulers) Arduino Microcontrollers Computers with the Arduino software installed Various arts and crafts materials (e.g., paints and brushes, construction paper, scissors, glue, colored pencils)
Math, Science, and Engineering Practices	*k.* Make sense of problems and persevere in solving them (CCSS) / Asking questions (for science) and defining problems (for engineering) (NGSS) *l.* Construct viable arguments and critique the reasoning of others (CCSS) / Constructing explanations (for science) and designing solutions (for engineering) (NGSS) *m.* Model with mathematics (CCSS) / Developing and using models (NGSS) *n.* Use appropriate tools strategically (CCSS) *o.* Attend to precision (CCSS) *p.* Using mathematics and computational thinking (NGSS)
STEAM Content	**Project-Specific and Overarching Concepts** **CCSS Mathematics:** M7.RP Analyze proportional relationships and use them to solve real-world and mathematical problems. M7.RP1 Compute unit rates associated with ratios or fractions, including ratios of lengths, areas and other measured in like or different units. M7.G Draw, construct, and describe geometrical figures and describe the relationships between them. M7.G1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. **NGSS Engineering:** 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 such that an optimal design can be achieved.

	Project-Specific Concepts **California Visual Arts Content Standards:** A1.0 Artistic Perception Processing, Analyzing, and Responding to Sensory Information Through the Language and Skills Unique to the Visual Arts Students perceive and respond to works of art, objects in nature, events, and the environment. They also use the vocabulary of the visual arts to express their observations. Develop Perceptual Skills and Visual Arts Vocabulary Analyze Art Elements and Principles of Design A2.0 Creative Expression Creating, Performing, and Participating in the Visual Arts Students apply artistic processes and skills, using a variety of media to communicate meaning and intent in original works of art. A5.0 Connections, Relationships, Applications Connecting and Applying What Is Learned in the Visual Arts to Other Art Forms and Subject Areas and to Careers Students apply what they learn in the visual arts across subject areas. They develop competencies and creative skills in problem solving, communication, and management of time and resources that contribute to lifelong learning and career skills. They also learn about careers in and related to the visual arts. **International Society for Technology in Education (ISTE)** T1. Empowered Learner Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences. T2. Digital Citizen Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical. T3. Knowledge Constructor Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others. T4. Innovative Designer Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions. T5. Computational Thinker Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions. T6. Creative Communicator Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals. T7. Global Collaborator Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally.

<table>
<tr><td colspan="3">Project Goal: Design and build a piece of artwork that only uses the 3D shapes covered in seventh-grade geometry and involves movement using a microcontroller.</td></tr>
<tr><td>Week 1</td><td>Day 1</td><td>Day 2</td></tr>
<tr><td>Designing and Editing</td>
<td>Objective (s):
Students will be able to create several designs for a geometric moving at that is limited to regular 3D shapes, and determine which one is the best for this project. Once a design has been selected, students will determine the types of movements to include in their designs.

Process

The class will begin with the teacher providing an overview of the project, a brief explanation of each step, a description of the tools and materials that will be needed, and what is expected as a final product.
After the overview, the teacher will introduce the experts who will guide the students throughout this project.
Each of the experts will introduce themselves to the class, and describe:

What they do for a living
What type of education they completed to obtain their current job
The average salary in those professions
How they normally begin a project such as the one the students will be working on (what things does an expert think about before starting such a project?)
How they plan to assist the teams in this project

Following the expert introductions, students will form teams, assign member roles and tasks, and begin to work on their designs. The math teacher will explain the constraints regarding the geometry, measurement, and scale that needs to be present in their designs.
Once each team has created at least three designs, they will select the one they believe to the best one for this project.
After a design has been selected, students will determine the types of movements they would like to include in their designs.

Evaluation</td>
<td>Objective (s):
Students will be able to determine the feasibility of their designs and make adjustments to their scaled model where necessary.

Process

Students will return to work on their scaled models, but this time, they will be working with the experts to determine the feasibility of their designs, considering the size, range of motion allowed by the Arduino motors, and complexity of the design.
The experts will meet with each team to go over their final design and offer any input they can in terms of feasibility. They will find ways to improve their designs if necessary.
Students will use the entire period to finalize their scaled models, make adjustments, or redesign if necessary.
The teacher will assist in revisiting any geometry, measurement, or scale ratio with those teams that may need it.

Evaluation
Once students have finalized their scaled models, and verified their feasibility with the experts, the teacher will lead a discussion where each team will present their final models to the class. Additionally, students will create a list of all the materials they will need for their design.</td></tr>
</table>

	Students will write a brief paragraph explaining why they chose their specific design from the selections they had, what makes it the best, the geometry involved, and the scale ratio for their final model.	
Teacher Tips	***To be added after implementation***	
Week 2	**Day 1**	**Day 2**
Working with Arduinos, Testing Movements, and Learning the Basics of Painting	**Objective (s):** **Students will be able to learn how to use and code Arduino motors and test the movements for their geometric art designs.** **Process** • The teacher will begin class by reviewing what students worked on the previous week. The teacher will then introduce and explain today's objectives and what is expected to be completed by the end of the day. • The teacher will introduce students to the Arduino kit and the coding software. • Students will go through a series of self-paced tutorials to understand the basics of coding and programming. • Once students are able to code, program, and debug on their own, they will begin to program the motors to perform the movements they included in their final design. • Students will spend the remainder of the class period programming the motors and testing the movements. **Evaluation** Students will successfully program at least one-fourth of the movements they included in their designs.	**Objective (s):** **Students will be able use their scaled-model of the geometric moving art to begin working on the actual design.** **Process** • For the first hour of the class, an arts experts will provide a basics tutorial on how to use the painting materials. • Students will learn how to work with different types of paint, brushes, and other materials that are relevant or necessary for the completion of their art design. • After the tutorial, students will work independently on sharpening their newly acquired skills, using pre-constructed models. • The experts will visit each team to assist them in anything they may need. • Once students have successfully painted a model, they will begin working on their final design. **Evaluation** By the end of the day, students should have completed at least one-fourth of their designs.
Teacher Tips	***To be added after implementation***	
Week 3	**Day 1**	**Day 2**
Programming and Painting	**Objective (s):** **Students will be able to determine which members will work on programming and which ones on painting. Once those roles are determined, students will begin to work on their final design.**	**Objective (s):** **Students will be able to finish programming their movements and painting their designs.**

	Process • Students will begin this day by determining which members will be working on programming the Arduinos and which ones will be painting. Students have the option to tackle each task as a group, as opposed to splitting the work. • The experts will continue to assist the teams with both the painting and the programming components. • Students will spend the remainder of the class period working on their final designs. **Evaluation** By the end of this day, students should have completed at least half of their designs and programmed at least half of their movements. The experts and the teacher will meet with each team to check on their progress and determine what needs to be done the following day.	**Process** • Students will continue programming their movements. They will use the entire class period to complete all of them. • The experts and the teacher will assist the teams with any problems they may encounters and/or provide guidance when needed. • Students working on painting should also be able to finish by the end of the class period. • The teacher and experts will continue to monitor the teams' progress and assist them in anything they may need. **Evaluation** By the end of this day, students should have finished painting the entire art design and programming all the movements. The experts and the teacher will meet with each team to check on their progress and determine what needs to be done the following day.
Teacher Tips	***To be added after implementation***	
Week 4	**Day 1**	**Day 2**
Finalizing the Artwork and Preparing for Presentation	**Objective (s):** **Students will be able to finalize their artwork with experts' guidance.** **Process** • Students will put the entire artwork together. • The programmers and painters will work together to connect the artwork to the Arduino motors. • The teams will spend the entire period finalizing their artwork. They will also test all the motors to make sure they are working properly **Evaluation** By the end of this day, the teams should have a completed their entire geometric moving art. The teacher will visit each of the teams to verify that everything is working properly	**Objective (s):** **Students will be able to develop a presentation plan, assign roles, and rehearse for the actual presentation.** **Process** • Students will determine what part of the presentation each member will take over. • The teacher will make sure students are taking into account what is expected of them to discuss during the presentation (outlined in the Presentation Day section). • Once roles have been assigned, students will rehearse their presentation. • Students will spend the remainder of the class period rehearsing or working on any details their artwork might need. **Evaluation**

		The teacher will meet with each team to go over their presentation and verify that they are ready to present.
Teacher Tips	***To be added after implementation***	
Presentation Day	**Objective (s):** **Students will be able to present their gardens to their parents, teachers, experts, administrators, and community members. They will be able to explain the following:** • Their roles in their teams and their contributions. • The process of exploration, brainstorming ideas, developing a plan, building, redesigning, rebuilding, editing, and finalizing. • How they applied STEAM knowledge, skills, and practices throughout the creation of their 3D models. • Why their final product best meets the goals of the project	
Teacher Tips	***To be added after implementation***	

The Geometric Moving Art Overview Calendar		
Week 1	**Monday (Selecting a design)**	**Thursday (Editing and Finalizing Design)**
	Students will meet with the experts to discuss the project. They will develop three different designs and select the one they believe is best for this project. Experts and teacher will facilitate.	Students will adjust their design and or scale drawing if necessary. Experts and teacher will serve as guidance.
	Concepts: **M.7RP/1, M.7G, M.7G1** **MS-ETS1.1-4** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**	Concepts: **M.7RP/1, M.7G, M.7G1** **MS-ETS1.1-4** Practices: **P1.b/c, P2.a/b, P3.a-c, P4.a, P5.a/b**
Week 2	**Monday (Programming with Arduinos)**	**Thursday (Painting)**
	Students will be introduced to the Arduino kit and software. They will learn the basics of coding and programming and begin to test their movements. Experts will lead and teacher will facilitate.	Students will learn how to use basic art tools and begin painting on pre-constructed models. Experts will lead and teacher will facilitate.
	Concepts: **T.1a/d, T.2c, T.3a/d, T.4a-d, T.5c/d, T6.a-d, T.7a-d** **MS-ETS1-4** Practices: **P1.b-e, P2.a/b, P3.c, P4a-c, P5.a/b**	Concepts: **A.1.1-4, A.2-2-7, A.5.1-4** Practices: **P1.b-e, P2.a/b, P3.a-c, P4.a-c, P5.a/b**

Week 3	Monday (Programming with Arduinos and Painting)	Thursday (Finalizing Programming and Painting)
	Students will determine if they will program and paint as a team or assign roles and split the work. Teacher will facilitate.	Students will finish programming all of their movements and painting all the pieces of their final design. Teacher will facilitate.
	Concepts: **A.1.1-4, A.2-2-7, A.5.1-4** **M.7RP/1, M.7G, M.7G1** **T.1a/d, T.2c, T.3a/d, T.4a-d, T.5c/d, T6.a-d, T.7a-d** **MS-ETS1.1-4** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**	Concepts: **A.1.1-4, A.2-2-7, A.5.1-4** **M.7RP/1, M.7G, M.7G1** **T.1a/d, T.2c, T.3a/d, T.4a-d, T.5c/d, T6.a-d, T.7a-d** **MS-ETS1.1-4** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**
Week 4	**Monday (Finalizing the Artwork)**	**Thursday (Preparing for Presentation)**
	Students will finalize their artwork. They will spend the entire class period working on final details. Teacher will facilitate.	Students will prepare for presentation. They will assign roles, parts to cover, and rehearse their entire presentation. Teacher will facilitate.
	Concepts: **A.1.1-4, A.2-2-7, A.5.1-4** **M.7RP/1, M.7G, M.7G1** **T.1a/d, T.2c, T.3a/d, T.4a-d, T.5c/d, T6.a-d, T.7a-d** **MS-ETS1.1-4** Practices: **P1.b/c, P2.a/b, P3.a-c, P4.a, P5.a/b**	Concepts: Practices:
	Presentation	
	Inauguration of students' geometric moving art will take place. Parents, teachers, admins, and the community will be invited.	

Practices and Concepts

Practices	Overarching Concepts	Project-Specific Concepts	
Math, Science, and Engineering Practices **P1.** Make sense of problems and persevere in solving them (CCSS) / Asking questions (for science) and defining problems (for engineering) (NGSS) **P2.** Construct viable arguments and critique the reasoning of others (CCSS) / Constructing explanations (for science) and designing solutions (for engineering) (NGSS) **P3.** Model with mathematics (CCSS) / Developing and using models (NGSS) **P4.** Use appropriate tools strategically (CCSS) **P5.** Attend to precision (CCSS) **See "Practices" section in the Appendix for detailed descriptions of practices.**	**PROJECT-SPECIFIC AND OVERARCHING CONCEPTS** **CCSS MATHEMATICS:** **M7.RP** Analyze proportional relationships and use them to solve real-world and mathematical problems. **M7.RP1** Compute unit rates associated with ratios or fractions, including ratios of lengths, areas and other measured in like or different units. **M7.G** Draw, construct, and describe geometrical figures and describe the relationships between them. **M7.G1** Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. **NGSS ENGINEERING:** **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 such that an optimal design can be achieved.	**CALIFORNIA VISUAL ARTS CONTENT STANDARDS:** **A1.0 ARTISTIC PERCEPTION** Processing, Analyzing, and Responding to Sensory Information Through the Language and Skills Unique to the Visual Arts Students perceive and respond to works of art, objects in nature, events, and the environment. They also use the vocabulary of the visual arts to express their observations. Develop Perceptual Skills and Visual Arts Vocabulary Analyze Art Elements and Principles of Design **A2.0 CREATIVE EXPRESSION** Creating, Performing, and Participating in the Visual Arts Students apply artistic processes and skills, using a variety of media to communicate meaning and intent in original works of art. **A5.0 CONNECTIONS, RELATIONSHIPS, APPLICATIONS** Connecting and Applying What Is Learned in the Visual Arts to Other Art Forms and Subject Areas and to Careers Students apply what they learn in the visual arts across subject areas. They develop competencies and creative skills in problem solving, communication, and management of time and resources that contribute to lifelong learning and career skills. They also learn about careers in and related to the visual arts. **See "Standards" in the Appendix section for detailed descriptions of standards.**	**INTERNATIONAL SOCIETY FOR TECHNOLOGY IN EDUCATION (ISTE)** **T1. Empowered Learner** Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences. **T2. Digital Citizen** Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical. **T3. Knowledge Constructor** Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others. **T4. Innovative Designer** Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions. **T5. Computational Thinker** Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions. **T6. Creative Communicator** Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals. **T7. Global Collaborator** Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally. **See "Standards" in the Appendix section for detailed descriptions of standards.**

Project 3: The Geometric Garden

Project 3: The Geometric Garden - Lesson Plan

Overview:

The Geometric Garden project is designed to cover geometry and measurement concepts (composite figures), proportionality (scale drawings and scale factor), horticultural science (development and maintenance of plants), and principles of engineering (designing an irrigation system). The project asks students to design and plant a garden using only geometric shapes and plants that are native to the local environment, and to build an irrigation system to maintain the garden once completed. The geometry, measurement, and proportionality concepts are embedded in a similar manner in all four projects of the iTEAMS curriculum; students need to apply their understanding of geometry to create their designs, using realistic measurements, and proportionality to create scale drawings or models that accurately represent the actual measurements of the final product. The science concepts become salient when students investigate which plants are best for their designs and have the best chances of surviving in the local environment. The engineering concepts appear in the third stage, when students develop an irrigation system that will benefit all the plants selected for the garden as well as the geometric design.

The decisions regarding the design of the garden, the plants selected, and the irrigation system will depend on each other. Students will need to develop several options and determine which combination of the three main components of the garden work best together. In this process, their understanding of geometry, science, and engineering will need to be simultaneously applied to develop viable solutions for the garden. Additionally, students will have to work within the constraints of cost (plants available for purchase) and space for the garden (a 5ft by 5ft space in the green area).

This project allows students to collaborate on a set of hands-on activities that explicitly require them to apply their knowledge of math, science, and engineering concepts. At the same time, the project is presented as an opportunity for students to "leave a mark" at their school by planting a permanent garden, designed and maintained by them. This introductory approach allows students to engage in the tasks more meaningfully since the final product will be a representation of their work, their creativity, and their presence at the school.

Project Duration: 4-5 Weeks

Tools and Materials	Sketching tools (paper, pencil, rulers) Various types of plants Planting tools and materials Various types of PVC pipes or heavy duty hoses (irrigation system) Cutting tools (jigsaw, scissors)
Math, Science, and Engineering Practices	*q.* Make sense of problems and persevere in solving them (CCSS) / Asking questions (for science) and defining problems (for engineering) (NGSS) *r.* Construct viable arguments and critique the reasoning of others (CCSS) / Constructing explanations (for science) and designing solutions (for engineering) (NGSS) *s.* Model with mathematics (CCSS) / Developing and using models (NGSS) *t.* Use appropriate tools strategically (CCSS) *u.* Attend to precision (CCSS)

	v. Using mathematics and computational thinking (NGSS)
STEAM Content	**Project-Specific and Overarching Concepts** **CCSS Mathematics:** M7.RP Analyze proportional relationships and use them to solve real-world and mathematical problems. M7.RP1 Compute unit rates associated with ratios or fractions, including ratios of lengths, areas and other measured in like or different units. M7.G Draw, construct, and describe geometrical figures and describe the relationships between them. M7.G1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. **NGSS Engineering:** 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 such that an optimal design can be achieved. **Project-Specific Concepts** **NGSS SCIENCE:** 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.

Project Goal: Design and plant a garden using only geometric shapes and plants that are native to the local environment, and to build an irrigation system to maintain the garden once completed.

Week 1	**Day 1**	**Day 2**
Designing and Editing	**Objective (s):** **Students will be able to create several designs for a geometric garden that is limited to regular figures, and determine which one is the best for this project. Once a design has been selected, students will create a scaled model to represent the garden.** **Process** • The class will begin with the teacher providing an overview of the project, a brief explanation of each step, a description	**Objective (s):** **Students will be able to determine the feasibility of their designs and make adjustments to their scaled model where necessary.** **Process** • Students will return to work on their scaled models, but this time, they will be working with the experts to determine the feasibility of their designs,

	of the tools and materials that will be needed, and what is expected as a final product.
	• After the overview, the teacher will introduce the experts who will guide the students throughout this project.
	  ○ Each of the experts will introduce themselves to the class, and describe:
	    ▪ What they do for a living
	    ▪ What type of education they completed to obtain their current job
	    ▪ The average salary in those professions
	    ▪ How they normally begin a project such as the one the students will be working on (what things does an expert think about before starting such a project?)
	    ▪ How they plan to assist the teams in this project
	• Following the expert introductions, students will form teams and begin to work on their designs. The math teacher will explain the constraints regarding the geometry, measurement, and scale that needs to be present in their designs.
	• Once each team has created at least three designs, they will select the one they believe to the best one for this project and begin working on a scaled model for the garden.
	
	Evaluation
	Students will write a brief paragraph explaining why they chose their specific design from the selections they had, what makes it the best, the geometry involved, and the scale ratio for their final model.
		considering the plants that will be used and the maintenance constraints.
		• The experts will meet with each team to go over their final design and offer any input they can in terms of feasibility. They will find ways to improve their designs if necessary.
		• Students will use the entire period to finalize their scaled models, make adjustments, or redesign if necessary.
		• The teacher will assist in revisiting any geometry, measurement, or scale ratio with those teams that may need it.
		
		Evaluation
		Once students have finalized their scaled models, and verified their feasibility with the experts, the teacher will lead a discussion where each team will present their final models to the class.

Teacher Tips	***To be added after implementation***	
Week 2	**Day 1**	**Day 2**
Plant Selection, Irrigation System and Maintenance Schedule Development	**Objective (s):** **Students will be able to research the types of plants that are native to Florida and determine which ones will be most appropriate for their designs. They will also begin to develop an irrigation system model for the garden.** **Process** • The teacher will begin class by reviewing what students worked on the previous week. The teacher will then	**Objective (s):** **Students will be able to develop an irrigation system model and a maintenance schedule for the plants they selected, and create a purchase order for the plants, tools, and materials.** **Process** • For the first hour, students will work on finalizing their irrigations system models.

	introduce and explain today's objectives and what is expected to be completed by the end of the day. • The teacher will guide students to an internet site where they can find several different plants that are native to Florida. The teacher will then have students select which ones are most appropriate for their designs, considering size, maintenance, cost, and other criteria. • As students work on their plant selections, experts will be meet with each team to assist them in any specific knowledge they may need. • Once the plants have been selected, and approved by the experts, students will begin to develop an irrigation system model for their garden. **Evaluation** Students will create a list of the plants they selected and briefly explain their reasoning for their selections. The teacher will also check each team's progress on the irrigation system model.	• The second hour will be dedicated to work on developing a maintenance schedule for the garden (who is responsible, when will it happen, how often?). • Experts will meet with each team to go over, once again, the plant selection, and provide their expertise on maintenance. • The science teacher will elaborate on general understanding of plant growth, what they need to stay alive, and how Florida plans differ from plants in other regions. • Once the maintenance schedule has been finalized, students will create a purchase order for the plants they selected and other tools and materials for the irrigation systems. They will have the names of each item, quantity, price, and size. **Evaluation** By the end of the day, students should have completed the irrigation system model, the maintenance schedule in calendar form, and a purchase order for the plants, tools, and materials, both approved by the experts and the teacher.
Teacher Tips	***To be added after implementation***	
Week 3	**Day 1**	**Day 2**
Planting the Garden	**Objective (s):** **Students will be able to begin planting the garden with experts' guidance.** **Process** • Once the plants and all the tools and materials have been received, students will meet with the experts to go over the planting process. • The experts will model the planting process and while they are doing that, they will explain each step in detail. • The teacher will ask students from each team to rephrase what the experts explain after each step to check for understanding.	**Objective (s):** **Students will be able to finish planting the remaining parts of the garden with experts' and teacher's guidance.** **Process** • Students will continue planting the garden. • The experts and the teacher will assist the teams with any problems they may encounters and/or provide guidance when needed. • At this point, students should be able to continue planting on their own, without any assistance. • Today's goal is for the teams to finish planting. **Evaluation**

	• A member from each team will go through the planting process with the experts to make sure they understand what to do in each step and make any corrections if needed. • Once the team representatives and the experts have successfully gone over the planting process, the representatives will go back to their teams and teach them what they have learned. • The teams will then use the scaled models they created the first week to begin planting different parts of the garden at the same time. **Evaluation** By the end of this day, students should have completed at least one-third of the garden. The experts and the teacher will meet with each team to check on their progress and determine what needs to be done the following day.	By the end of this day, students should have completed the entire garden. The experts and the teacher will meet with each team to check on their progress and determine what needs to be done the following day.
Teacher Tips	***To be added after implementation***	
Week 4	**Day 1**	**Day 2**
Finalizing the Garden and Installing the Irrigation System	**Objective (s):** **Students will be able to finalize their gardens with experts' guidance.** **Process** • Students will continue planting the garden. • The experts and the teacher will assist the teams with any problems they may encounters and/or provide guidance when needed. • At this point, students should be able to continue planting on their own, without any assistance. • Today's goal is for the teams to finalize their gardens. **Evaluation** By the end of this day, the teams should have a completed garden, ready for the irrigation system to be installed.	**Objective (s):** **Students will be able to install the irrigation systems for their gardens.** **Process** • Students will use their irrigation system model to create a "real-size" irrigation system for the garden. • The experts will assist the teams start the installation of the irrigation system. • Once the installation is started, students should be able to continue working on their own, without any assistance. • The teams will finish installing the irrigation system for the garden. **Evaluation** The teacher and experts will test each teams' systems to make sure they work as intended.
Presentation Day	**O Objective (s):**	

	Students will be able to present their gardens to their parents, teachers, experts, administrators, and community members. They will be able to explain the following: • Their roles in their teams and their contributions. • The process of exploration, brainstorming ideas, developing a plan, building, redesigning, rebuilding, editing, and finalizing. • How they applied STEAM knowledge, skills, and practices throughout the creation of their 3D models. • Why their final product best meets the goals of the project	
Teacher Tips	***To be added after implementation***	

Overview Calendar and STEAM Practices and Concepts

The Geometric Garden Overview Calendar		
Week 1	**Monday (Designing the Garden)**	**Thursday (Editing and Finalizing Design)**
	Students will work on several geometric designs and select the one they believe works best for this project. Experts and science teachers will facilitate.	Students will meet with experts to discuss feasibility of design. Students will adjust their design or scale drawing if necessary. Experts and teacher will facilitate.
	Concepts: **M.7RP/1, M.7G, M.7G1 MS-ETS1.1-4** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**	Concepts: **M.7RP/1, M.7G, M.7G1 MS-ETS1.1-4** Practices: **P1.b/c, P2.a/b, P3.a-c, P4.a, P5.a/b**
Week 2	**Monday (Plant Selection and Irrigation System Model Development)**	**Thursday (Finalizing Irrigation System Model, Developing a Maintenance Schedule, and Purchase of Plants)**
	Students will meet with experts to discuss the types of plants that would be appropriate for their designs and select the best. They will also begin to work on developing a model of the irrigation system. Experts and teacher will assist.	Students will finalize the irrigation system model, develop a maintenance schedule for the garden, and create a purchase order for all the plants and materials. Experts and teacher will assist.
	Concepts: **M.7RP/1, M.7G, M.7G1 MS-ETS1.1-4** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**	Concepts: **M.7RP/1, M.7G, M.7G1 MS-ETS1.1-4** Practices: **P1.b/c, P2.a/b, P3.a-c, P4.a, P5.a/b**

Week 3	Monday (Planting)	Thursday (Planting)
	Students will begin to work on the garden. Experts will teach and supervise the students' work. Teacher will facilitate.	Students will continue planting with the experts' supervision. Teacher will facilitate.
	Concepts: **M.7RP/1, M.7G, M.7G1** **MS-ETS1.1-4** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**	Concepts: **M.7RP/1, M.7G, M.7G1** **MS-ETS1.1-4** Practices: **P1.b/c, P2.a/b, P3.a-c, P4.a, P5.a/b**
Week 4	**Monday (Finalizing Garden and Installing Irrigation System)**	**Thursday (Finalizing Irrigation System)**
	Students will finalize planting with experts' supervision and guidance. They will also begin to install the irrigation system, using the scale model created. Teacher will facilitate.	Students will finalize the irrigation system with the experts' supervision and guidance. Teacher will facilitate.
	Concepts: **M.7RP/1, M.7G, M.7G1** **MS-ETS1.1-4** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**	Concepts: **M.7RP/1, M.7G, M.7G1** **MS-ETS1.1-4** Practices: **P1.b/c, P2.a/b, P3.a-c, P4.a, P5.a/b**
	Presentation	
	Inauguration of newly student-made Geometric Garden will take place. Parents, teachers, administrators, and the community will be invited.	

Practices and Concepts

Practices	Overarching Concepts	Project-Specific Concepts
Math, Science, and Engineering Practices **P1.** Make sense of problems and persevere in solving them (CCSS) / Asking questions (for science) and defining problems (for engineering) (NGSS) **P2.** Construct viable arguments and critique the reasoning of others (CCSS) / Constructing explanations (for science) and designing solutions (for engineering) (NGSS) **P3.** Model with mathematics (CCSS) / Developing and using models (NGSS) **P4.** Use appropriate tools strategically (CCSS) **P5.** Attend to precision (CCSS) **See "Practices" in the Appendix section for detailed descriptions of practices.**	**PROJECT-SPECIFIC AND OVERARCHING CONCEPTS** **CCSS MATHEMATICS:** **M7.RP** Analyze proportional relationships and use them to solve real-world and mathematical problems. **M7.RP1** Compute unit rates associated with ratios or fractions, including ratios of lengths, areas and other measured in like or different units. **M7.G** Draw, construct, and describe geometrical figures and describe the relationships between them. **M7.G1** Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. **NGSS ENGINEERING:** **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 such that an optimal design can be achieved.	**NGSS SCIENCE:** **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.


Project 4: The Ideal Classroom
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Project 4: The Ideal Classroom - Lesson Plan

Overview:

The Ideal Classroom project is designed to cover most of the STEAM concepts embedded in projects 1-3. This project asks students to design, build, and present a physical model of their version of an ideal classroom. To accomplish this, students will need to develop a scale drawing, model the drawing on a 3D software, 3D print several parts for the physical model, construct and paint the model to look like a classroom, and present it at a STEAM conference as a proposal for new school classrooms. The project is highly personalized, as their designs will be based on what they consider ideal in terms of classroom size and design, furniture, student materials, and overall inside and outside physical environment. The initial tasks will require students to utilize the knowledge and skills they applied in the previous three projects (scale drawings, 3D modeling, constructing and painting, presenting a final work to a large audience). The progression in the four stages of the project is meant to be student-directed, meaning teacher, expert, and research team assistance will be as minimal as possible. By the time this project is introduced, students will have worked in three similar projects where assistance was gradually removed.

The designing stage of this project is the same as in the previous projects. Students will need to define what is an ideal classroom to them, develop several feasible designs, create a scale drawing of it, and model the design on a 3D modeling software. The application of geometry, measurement, and proportionality concepts are exactly the same as in the Dream Home and very similar to the Geometric Garden and the Geometric Moving Art. The mathematics, science, and engineering practices involved are also the same, although in a different context. The main difference in the design stage happens in the 3D modeling part. Instead of using the online software used in the Dream Home, which automatically creates a 3D model based on the blueprint, students will need to use SketchUp or another 3D modeling software that allows for 3D printing. This part of the project will be facilitated by experts who will provide basic training on the program. Students will only need to 3D print the walls and the roof of the classroom, therefore, the focus of the training will be on those areas instead of everything the software offers.

The constructing and painting stages are very similar to the Geometric Moving Art project. In these stages, students will need to piece together the 3D printed parts of the classroom, paint them, and construct 3D parts for the inside and outside of the classroom. If the construction of the pieces becomes too difficult or time consuming, students will have the option to use the pieces in the gallery within the 3D modeling software, print out a top view of them, and add them to their physical model. The focus in this stage is not on student' ability to physically construct models, but on their ability to scale each of them proportionally to the 3D printed classroom.

The last stage of the project is focused on preparing students to present their work at a STEAM conference. By this stage, students will have presented three times in the previous three projects, therefore, they are expected to be able to orchestrate their presentation mostly on their own. The requirements for the presentation are the same for all projects: They will be able to explain their roles in their teams and their individual contributions; the process of exploration, brainstorming ideas, developing a plan, building, redesigning, rebuilding, editing, and finalizing; how they applied STEAM knowledge, skills, and practices throughout the creation of the final product; and why their final product best meets the goals of the project.

Project Duration: 4-5 Weeks	
Tools and Materials	Sketching tools (paper, pencil, rulers) Computers with 3D modeling and printing software installed Various arts and crafts materials (e.g., paints and brushes, construction paper, scissors, glue, colored pencils) 3D printer Presenting materials (e.g., tri-fold board)
Math, Science, and Engineering Practices	*w.* Make sense of problems and persevere in solving them (CCSS) / Asking questions (for science) and defining problems (for engineering) (NGSS) *x.* Construct viable arguments and critique the reasoning of others (CCSS) / Constructing explanations (for science) and designing solutions (for engineering) (NGSS) *y.* Model with mathematics (CCSS) / Developing and using models (NGSS) *z.* Use appropriate tools strategically (CCSS) *aa.* Attend to precision (CCSS) *bb.* Using mathematics and computational thinking (NGSS)
STEAM Content	**Project-specific and Overarching Concepts** **CCSS Mathematics:** M7.RP Analyze proportional relationships and use them to solve real-world and mathematical problems. M7.RP1 Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. M7.G Draw, construct, and describe geometrical figures and describe the relationships between them. M7.G1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. M7.G Solve real-life and mathematical problems involving angle measure, area, surface area, and volume. M7.G6 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. **NGSS Engineering:** 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 such that an optimal design can be achieved. **Project-Specific Concepts** **California Visual Arts Content Standards:** **A1.0 Artistic Perception**

	Students perceive and respond to works of art, objects in nature, events, and the environment. They also use the vocabulary of the visual arts to express their observations. Develop Perceptual Skills and Visual Arts Vocabulary A1.2 Identify and describe scale (proportion) as applied to two-dimensional and three-dimensional works of art. A2.0 CREATIVE EXPRESSION A2.2 Use different forms of perspective to show the illusion of depth on a two-dimensional surface. A2.4 Develop skill in mixing paints and showing color relationships. A2.5 Interpret reality and fantasy in original two-dimensional and three-dimensional works of art. A5.0 CONNECTIONS, RELATIONSHIPS, APPLICATIONS A5.3 Examine art, photography, and other two and three-dimensional images, comparing how different visual representations of the same object lead to different interpretations of its meaning, and describe or illustrate the results. **International Society for Technology in Education (ISTE)** T1. Empowered Learner Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences. d) Understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies. T3. Knowledge Constructor Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others. a) plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits. c) curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions. d) build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions. T4. Innovative Designer Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions. a) know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems. b) select and use digital tools to plan and manage a design process that considers design constraints and calculated risks. of steps to create and test automated solutions. T6. Creative Communicator Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals. a) choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication. b) create original works or responsibly repurpose or remix digital resources into new creations. c) communicate complex ideas clearly and effectively by creating or using a variety of digital object T7. Global Collaborator Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally.

<table>
<tr><td></td><td colspan="2">b) use collaborative technologies to work with others, including peers, experts or community members, to examine issues and problems from multiple viewpoints.
c) contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal.</td></tr>
<tr><td colspan="3">Project Goal: Design, build, and present a physical model of your version of an ideal classroom</td></tr>
<tr><td>Week 1</td><td>Day1</td><td>Day2</td></tr>
<tr><td>Planning and Sketching</td><td>Objective (s):
Students will be able to develop a plan to design their ideal classroom. They will develop steps to take, assign roles, and determine what materials will be needed.

Process

The class will begin with the teacher providing an overview of the project, a brief explanation of each step, a description of the tools and materials that will be needed, and what is expected as a final product.

The teacher will begin a discussion, in a brainstorm format, about what possible changes could be made to convert the classroom into a perfect classroom.
Students will share their ideas and explain why they think those changes are ideal.
The teacher will show models on SketchUp of several classrooms to give the students an idea of what can be done to a classroom to make it ideal, and to show an expectation of what the project's final product needs to look like.

After the overview, the teacher will introduce the experts who will guide the students throughout this project.

Each of the experts will introduce themselves to the class, and describe:

What they do for a living
What type of education they completed to obtain their current job
The average salary in those professions
How they normally begin a project such as the one the students will be working on (what things does an expert think about before starting such a project?)

</td><td>Objective (s):
Students will discuss in group what kind of classroom they want to design, and develop a scale drawing (blueprint) of their ideal classroom

Process

Students will go over the expectations and goals of the project, discuss the size, scale, and shape of classroom, what it will look like inside, how many desks, chairs, and other relevant furniture that will be needed, and overall architectural style.
The teacher will provide examples of several scale drawings of classrooms other students have created, discuss the advantage and disadvantage of designing similar classrooms, and encourage students to create something original and that represents their vision of an ideal classroom.
If necessary, teacher will revisit area and perimeter of composite figures as well as scale drawings to strengthen the skills that will be needed today. This will help retrieve the prior knowledge necessary to complete the scale drawing of the floor plan.
Students will use the remainder of the class period to work on the blueprint of their ideal classroom.
Experts will also visit each group and assist in any way possible.

Evaluation
The teams will have a completed scale drawing (blueprint) of their ideal classroom. The experts and teacher will verify the feasibility of the design as well as accuracy in terms of measurement and scaling.</td></tr>
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How they plan to assist the teams in this project
Following the expert introductions, students will form teams and begin to work on their projects.
Students will navigate the software to see other models and find the “cool” stuff on their own, rather than the teacher showing them everything. The teacher will then show the students a 3D printed model of a classroom to show them what their final model could look like once printed.
The teacher will explain the details and process of the project and what needs to be accomplished at every stage as well as what is expected of each participant.
The teacher will also show an example of previous work from other students on a similar project and expand on what each student had to do to complete it as well as what was presented.
Evaluation
Students will explain to the class what the project is, what each student needs to do, and what materials will be needed complete it.
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<tr><td>Teacher Tips</td><td>To be added after implementation</td><td></td></tr>
<tr><td>Week 2</td><td>Day1</td><td>Day2</td></tr>
<tr><td>Modeling Using 3D Software</td><td>
Objective (s):
Students will explore several 3D modeling software and select one they believe is most appropriate for this project. They will also become familiar with the selected software and gain the necessary knowledge for the completion of the 3D model.

Process
The experts will present several 3D modeling software (e.g. Google SketchUp, Seamless 3D, ZEDit Pro or sweethome3d.com), and demonstrate some of the tools and features offered in each.
Students will determine which software is most appropriate for their designs.
After expert introduction, students will do a quick research those 3D software, the type of
</td><td>
Objective (s):
Students will begin working on their 3D model of their ideal classroom.

Process
The teacher will begin the class by going over the overall goal of creating a 3D model of their ideal classroom, and how that model must be based on the scaled drawing (blueprint) students created the previous week.
Students will use the entire class period to work on their 3D model. They will use their scale drawing as a starting point for their models. They will aim to complete at least one-third of their model by the end of the day.
The teacher will continue to meet with each group and assist them in anything they may need.
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	technological prior knowledge is necessary in order to use them effectively, and determine the advantages and disadvantages of using each program. ○ Students will decide on which software to use and explain their reasoning for selecting a particular 3D software program. • Once students have selected a 3D modeling software program, they will begin to familiarize themselves with the basic tools and relevant features that will be necessary for their ideal classroom 3D model. **Evaluation** Students will discuss with the teacher the 3D modeling program they decide to use and their reasoning for their selection. A pros and cons list will be delivered to the teacher in writing.	**Evaluation** Students will go over their progress with the teacher and determine what needs to be completed in the following days.
Teacher Tips	***To be added after implementation***	
Week 3	**Day1**	**Day2**
Finalizing and Modeling 3d-Printable Parts	**Objective (s):** **Students will be able to complete the 3D models of their ideal classroom.** **Process** • Students will use the entire period to finalize their 3D models • The teacher will continue to meet with each team to go over the overall goal and the details in each model. • Experts will also meet with each team to verify that their models are accurate in terms of proportionality and scaling. **Evaluation** The teacher will meet with each team to verify that their models are complete. If teams are not finished, then the teacher and the teams will develop a plan for completion.	**Objective (s):** **Students will design 3D-printable parts for the "shell" of the classroom.** **Process** • An expert in 3D printing will begin the class by going over the basics of 3D printing. The expert will discuss the requirements a design needs to meet to be 3D printable, constraints the 3D printer poses, and the process of designing to 3D printing. • The teacher will go over the goal of this day: to design a 3D printable "shell" of the classroom, in parts. • Students will spend the remainder of the class period completing their design and 3D printing them. **Evaluation** Students will have a completed 3D printed shell of their ideal classroom model.
Teacher Tips	***To be added after implementation***	
Week 4	**Day1**	**Day2**

Putting Pieces Of 3D Printing Together and Decorating the Inside	**Objective(s):**
	Students will begin to put together their 3D-printed parts of their classroom and decorate the inside of the classroom.
	
	Process
	• Students will put the pieces of 3Dprinting together to create an overall frame of classroom and will consider:
	  ○ The right proportion and scale of walls
	  ○ The match between walls, floors and roof
	  ○ The firmness of the overall frame
	• Students will discuss in groups to develop a plan to decorate the inside of the classroom, and begin work on it.
	  ○ Students will decide the number, type, location, and proportion of furniture
	  ○ If some furniture, such as tables and chairs, are too small to print, students will use some miniature models to replace (provided by teachers).
	  ○ Students will paint the walls and roof of the classroom, and they will consider color assortment and harmony.
	  ○ Students will decide what they will put on the walls and choose the appropriate ornamentation inside the classroom.
	• Students will discuss the factors that will affect the decoration of the outside (e.g., their expectation, match with inside, the shape of the classroom), and develop a plan to complete the outside of the classroom.
	
	Evaluation
	The teacher will verify that students have completed the inside of the classroom and developed a plan for the completion of the outside.
		Objective(s):
		Students will finalize the inside of the classroom and begin to work on the outside.
		
		Process
		• Both teachers and experts will evaluate their decoration inside of the classroom to make sure the proportion and location of furniture, the color of walls and roof match with each other. If necessary, students will make some adjustments.
		• Students will begin to decorate the outside of the classroom based the plan made in the previous day. They will decide whether they will put the following things outside the classroom.
		  ○ Furniture
		  ○ Plants or paintings
		  ○ Slogan or signpost of the class
		  ○ Color of outside walls and roof
		• Students can also create something with their own style.
		
		Evaluation
		Students will have finalized the inside of the classroom and completed most of the outside.

Teacher Tips	***To be added after implementation***	
Week 5	**Day1**	**Day2**
Decorating the Outside and	**Objective(s):** **Students will finalize the outside of the classroom and develop a plan for presentation.**	**Objective(s):** **Students will assign their roles and rehearse the presentation with their teams.**

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<td>Rehearsing the Presentation</td>
<td>Process
• Students will finalize the outside of the classroom and work on any details left to complete.
• Both students and teachers will evaluate and analyze the final product and make some suggestions for improvement if necessary.
• The teacher will expand on the importance of using mathematical language and other details in the presentation when explaining the 3D model
• Students will work in groups to develop a plan for presentation and will be focus on:
    ○ The initial plan of the project
    ○ The actions and measures to follow the plan
    ○ The function of the plan in the whole process
    ○ The extent of realizing their goal and expectation
    ○ The roles in their team and their contributions
    ○ The most difficult parts in the whole process, the solutions to solve them
    ○ The final product

Evaluation
The teacher will meet with each team to make sure their models are completed and that they started a plan for presentation.</td>
<td>Process
• Teachers will explain the specific requirements of oral parts and state that a good presentation should be simple, specific, clear, and engaging.
• Based on the presentation plan and role arrangement, students will rehearse the presentation in their groups
    ○ The expositor will expand their completed plan and why they made such a plan
    ○ The presenter will show their final product and explain their specific design
    ○ The other students will conclude with the problems they have encountered in the whole process and their solutions to solve them
• The teacher will make sure that every group member knows their role assignment in the presentation

Evaluation
The teacher will meet with each team to verify that they are ready to present.</td>
</tr>
<tr>
<td>Presentation Day</td>
<td colspan="2">Objective (s)
Students will be able to present their projects to their parents, teachers, experts, administrators, and community members. They will be able to explain the following:
• Their roles in their teams and their contributions.
• The process of exploration, brainstorming ideas, developing a plan, building, redesigning, rebuilding, editing, and finalizing.
• How they applied STEAM knowledge, skills, and practices throughout the creation of their 3D models.
• Why their final product best meets the goals of the project</td>
</tr>
<tr>
<td>Teacher Tips</td>
<td>To be added after implementation</td>
<td></td>
</tr>
</table>

Overview Calendar and STEAM Practices and Concepts

The Ideal Classroom Overview Calendar		
Week 1	**Monday (Developing a plan)**	**Tuesday (Designing the 2D sketch of classroom)**
	Students will be able to develop a plan to design their ideal classroom. They will develop steps to take, assign roles, and determine what materials will be needed. Experts will introduce themselves and teachers will serve as guidance.	Students will discuss in groups the types of classrooms they want to design and develop a scale drawing (blueprint) of their ideal classroom. Experts and teacher will facilitate.
	Concepts: **M.7RP/1, M.7G, M.7G1** **MS-ETS1.1-4** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**	Concepts: **M.7RP/1, M.7G, M.7G1, MS-ETS1-1, MS-ETS1-4** **A1.0, A1.2, A2.2, A2.5, A5.3, T4-a/b** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**
Week 2	**Monday (Selecting the 3D modeling software)**	**Thursday (Creating 3D modeling)**
	Students will explore several 3D modeling software and select one they believe is most appropriate for this project. They will also become familiar with the selected software and gain the necessary knowledge for the completion of the 3D model. Experts will lead and teacher will facilitate.	Students will use the entire class period to work on their 3D model. They will use their scale drawing as a starting point for their models. They will aim to complete at least one-third of their model by the end of the day. Teacher will facilitate.
	Concepts: **T1-d,T3a-d, T6a-c,T7b/c** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**	Concepts: **M.7RP/1, M.7G, M.7G1, MS-ETS1-4** **A1.2, A2.5, A5.3** **T1d, T3a-d, T6a-c, T7b/c** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**

Week 3	Monday (Completing the 3D models)	Thursday (Designing 3D-printable parts)
	Students will use the entire period to finalize their 3D models. Experts and teachers will meet with each team to verify that their models are accurate in terms of proportionality and scaling.	Students will design 3D-printable parts for the “shell” of the classroom. Experts and teacher will serve as guidance.
	Concepts: **M.7RP/1, M.7G, M.7G1, MS-ETS1-1, MS-ETS1-4** **A1.0, A1.2, A2.2, A2.5, A5.3** **T4-a/b** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**	Concepts: **M.7RP/1, M.7G, M.7G1, MS-ETS1-1, MS-ETS1-4** **A1.0, A1.2, A2.2, A2.5, A5.3** **T4-a/b** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**
Week 4	Monday (Putting pieces of 3D printing together and decorating the inside)	Thursday (Decorating the outside of classroom)
	Students will put the pieces of 3D printing parts together to create an overall frame of the classroom. Students will discuss in groups to develop a plan to decorate the inside of the classroom and begin work on it. Teacher will facilitate.	Both experts and teachers will evaluate the decoration of the inside of the classroom for improvement, and students will proceed according to the suggestions received. Once finished, students will begin to decorate the outside. Experts and teacher will serve as guidance.
	Concepts: **M.7RP/1, M.7G, M.7G1, M7.G6, MS-ETS1-4** **A1.0, A2.4, A5.0, A5.3** **T6a-c, T7b/c** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**	Concepts: **M7.RP, M7.RP1, M7.G, M7.G, M7.G6** **A1.0, A2.4, A5.0, A5.3** **T6a-c, T7b/c** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**
Week 5	Monday (Finalizing the outside and developing a plan for presentation)	Thursday (Rehearsing the presentation)

Students will finalize the outside of the classroom and complete the whole design of the project. Students will work in groups to develop a plan for presentation. Teacher will facilitate.	Teacher will explain the specific requirements of the oral part for the presentation. Based on the presentation plan and role arrangement, students will rehearse the presentation in their groups.
Concepts: **M7.RP, M7.RP1, M7.G, M7.G, M7.G6** **MS-ETS1-1, MS-ETS1-4** **A1.0, A2.4, A5.0, A5.3** **T6a-c, T7b/c** Practices: **P1.a-c, P2.a/b, P3.a-c, P4.a, P5.a/b**	Concepts: Practices:
Presentation	
Students will be able to present their projects at a STEAM conference.	

Practices and Concepts

Practices	Overarching Concepts	Project-Specific Concepts
Math, Science, and Engineering Practices **P1.** Make sense of problems and persevere in solving them (CCSS) / Asking questions (for science) and defining problems (for engineering) (NGSS) **P2.** Construct viable arguments and critique the reasoning of others (CCSS) / Constructing explanations (for science) and designing solutions (for engineering) (NGSS) **P3.** Model with mathematics (CCSS) / Developing and using models (NGSS) **P4.** Use appropriate tools strategically (CCSS) **P5.** Attend to precision (CCSS) **See "Practices" in the Appendix section for detailed descriptions of practices**.	**PROJECT-SPECIFIC AND OVERARCHING CONCEPTS** **CCSS MATHEMATICS**: M7.RP Analyze proportional relationships and use them to solve real-world and mathematical problems. M7.RP1 Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. M7.G Draw, construct, and describe geometrical figures and describe the relationships between them. M7.G1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. M7.G Solve real-life and mathematical problems involving angle measure, area, surface area, and volume. M7.G6 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. **NGSS ENGINEERING:** 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 such that an optimal design can be achieved.	**CALIFORNIA VISUAL ARTS CONTENT STANDARDS:** A1.0 ARTISTIC PERCEPTION Students perceive and respond to works of art, objects in nature, events, and the environment. They also use the vocabulary of the visual arts to express their observations. Develop Perceptual Skills and Visual Arts Vocabulary A1.2 Identify and describe scale (proportion) as applied to two-dimensional and three-dimensional works of art. A2.0 CREATIVE EXPRESSION A2.2 Use different forms of perspective to show the illusion of depth on a two-dimensional surface. A2.4 Develop skill in mixing paints and showing color relationships. A2.5 Interpret reality and fantasy in original two-dimensional and three-dimensional works of art. A5.0 CONNECTIONS, RELATIONSHIPS, APPLICATIONS A5.3 Examine art, photography, and other two and three-dimensional images, comparing how different visual representations of the same object lead to different interpretations of its meaning, and describe or illustrate the results. **INTERNATIONAL SOCIETY FOR TECHNOLOGY IN EDUCATION (ISTE)** T1. Empowered Learner Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences. d) Understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies. T3. Knowledge Constructor Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others. a) plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits. c) curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions. d) build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions. T4. Innovative Designer Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions. a) know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems. b) select and use digital tools to plan and manage a design process that considers design constraints and calculated risks. of steps to create and test automated solutions. T6. Creative Communicator Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals. a) choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication. b) create original works or responsibly repurpose or remix digital resources into new creations. c) communicate complex ideas clearly and effectively by creating or using a variety of digital object T7. Global Collaborator Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally. b) use collaborative technologies to work with others, including peers, experts or community members, to examine issues and problems from multiple viewpoints. c) contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal.

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APPENDIX - Practices

Common Core State Standards (CCSS) Math Practices
http://www.nationalartsstandards.org

1. Make sense of problems and persevere in solving them.
Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on
their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

2. Reason abstractly and quantitatively.
Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved.
Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

3. Construct viable arguments and critique the reasoning of others.
Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there

is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

4. Model with mathematics.
Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

5. Use appropriate tools strategically.
Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper, concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

6. Attend to precision.
Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

APPENDIX – Practices

Next Generation Science Standards (NGSS) Science and Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world(s) works and which can be empirically tested.

Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify ideas.

2. Developing and using models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.

3. Planning and carrying out investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions.

4. Analyzing and interpreting data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria—that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.

5. Using mathematics and computational thinking
In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; solving equations exactly or approximately; and recognizing, expressing, and applying quantitative relationships.
Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions.

6. Constructing explanations (for science) and designing solutions (for engineering)
The end-products of science are explanations and the end-products of engineering are solutions.
The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories.
The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

7. Engaging in argument from evidence
Argumentation is the process by which evidence-based conclusions and solutions are reached.
In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits.
Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to evaluate claims.

8. Obtaining, evaluating, and communicating information
Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.
Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to obtain information that is used to evaluate the merit and validity of claims, methods, and designs.

APPENDIX – Standards

Common Core State Standards (CCSS) for Mathematics

http://www.corestandards.org/Math/Content/7/EE/

M7.G Draw, construct, and describe geometrical figures and describe the relationships between them.

7.G.A1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale

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.

M7.RP Analyze proportional relationships and use them to solve real-world and mathematical problems.

7.RP1 Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units.

7.RP.A2 Recognize and represent proportional relationships between quantities.

M7.NS.A3 Solve real-world and mathematical problems involving the four operations with rational numbers.

M7.EE.B3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies.

Texas Essential Knowledge and Skill (TEKS) for Mathematics

http://ritter.tea.state.tx.us/rules/tac/chapter111/ch111b.html

Personal and Financial Literacy

7.13A Calculate income tax for earned wages

7.13E Calculate and compare simple and compound interest

7.13F Analyze and compare monetary incentives including sales, rebates, and coupons

7.13B Identify the components of a personal budget including income, planned savings for college, retirement, and emergencies, taxes, and fixed and variable expenses, and calculate what percentage each category comprises of the total budget.

APPENDIX - Standards

International Society for Technology in Education (ISTE)

https://www.cde.ca.gov/BE/st/ss/

1. Empowered Learner

Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences. Students:

a) Articulate and set personal learning goals, develop strategies leveraging technology to achieve them and reflect on the learning process itself to improve learning outcomes.

b) Build networks and customize their learning environments in ways that support the learning process.

c) Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.

d) Understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies.

2. Digital Citizen

Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical. Students:

a) cultivate and manage their digital identity and reputation and are aware of the permanence of their actions in the digital world.

b) engage in positive, safe, legal and ethical behavior when using technology, including social interactions online or when using networked devices.

c) demonstrate an understanding of and respect for the rights and obligations of using and sharing intellectual property.

d) manage their personal data to maintain digital privacy and security and are aware of data-collection technology used to track their navigation online.

3. Knowledge Constructor

Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others. Students:

a) plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits.

b) evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources.

c) curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions.

d) build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.

4. Innovative Designer

Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions. Students:

a) know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.

b) select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.

c) develop, test and re ne prototypes as part of a cyclical design process.

d) exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.

5. Computational Thinker

Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions. Students:

a) formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.

b) collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.

c) break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.

d) Understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.

6. Creative Communicator

Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals. Students:

a) choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.

b) create original works or responsibly repurpose or remix digital resources into new creations.

c) communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.

d) publish or present content that customizes the message and medium for their intended audiences.

7. Global Collaborator

Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally. Students:

a) use digital tools to connect with learners from a variety of backgrounds and cultures, engaging with them in ways that broaden mutual understanding and learning.

b) use collaborative technologies to work with others, including peers, experts or community members, to examine issues and problems from multiple viewpoints.

c) contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal.

d) explore local and global issues and use collaborative technologies to work with others to investigate solutions.

APPENDIX – Engineering

APPENDIX – Standards

Next Generation Science Standards (NGSS) for Engineering Design
https://www.nextgenscience.org/dci-arrangement/ms-ets1-engineering-design

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 such that an optimal design can be achieved.

Next Generation Science Standards (NGSS) for Science
https://www.nextgenscience.org/pe/ms-ls2-1-ecosystems-interactions-energy-and-dynamics

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.

APPENDIX – Standards

California Visual Arts Content Standards (CVACS)

http://www.nationalartsstandards.org

1.0 Artistic Perception

Processing, Analyzing, and Responding to Sensory Information Through the Language and Skills Unique to the Visual Arts

Students perceive and respond to works of art, objects in nature, events, and the environment. They also use the vocabulary of the visual arts to express their observations.

Develop Perceptual Skills and Visual Arts Vocabulary

- 1.1 Describe the environment and selected works of art, using the elements of art and the principles of design.
- 1.2 Identify and describe scale (proportion) as applied to two-dimensional and three-dimensional works of art.

Analyze Art Elements and Principles of Design

- 1.3 Identify and describe the ways in which artists convey the illusion of space (e.g., placement, overlapping, relative size, atmospheric perspective, and linear perspective).
- 1.4 Analyze and describe how the elements of art and the principles of design contribute to the expressive qualities of their own works of art.

2.0 Creative Expression

Creating, Performing, and Participating in the Visual Arts

Students apply artistic processes and skills, using a variety of media to communicate meaning and intent in original works of art.

Skills, Processes, Materials, and Tools

- 2.1 Develop increasing skill in the use of at least three different media.
- 2.2 Use different forms of perspective to show the illusion of depth on a two-dimensional surface.
- 2.3 Develop skill in using mixed media while guided by a selected principle of design.
- 2.4 Develop skill in mixing paints and showing color relationships.

Communication and Expression Through Original Works of Art

- 2.5 Interpret reality and fantasy in original two-dimensional and three-dimensional works of art.
- 2.6 Create an original work of art, using film, photography, computer graphics, or video.
- 2.7 Create a series of works of art that express a personal statement demonstrating skill in applying the elements of art and the principles of design.

5.0 Connections, Relationships, Applications

Connecting and Applying What Is Learned in the Visual Arts to Other Art Forms and Subject Areas and to Careers

Students apply what they learn in the visual arts across subject areas. They develop competencies and creative skills in problem solving, communication, and management of time and resources that contribute to lifelong learning and career skills. They also learn about careers in and related to the visual arts.

Connections and Applications

- 5.1 Study the music and art of a selected historical era and create a multimedia presentation that reflects that time and culture.
- 5.2 Use various drawing skills and techniques to depict lifestyles and scenes from selected civilizations.

Visual Literacy

- 5.3 Examine art, photography, and other two and three-dimensional images, comparing how different visual representations of the same object lead to different interpretations of its meaning, and describe or illustrate the results.

Careers and Career-Related Skills

- 5.4 Identify professions in or related to the visual arts and some of the specific skills needed for those professions.

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