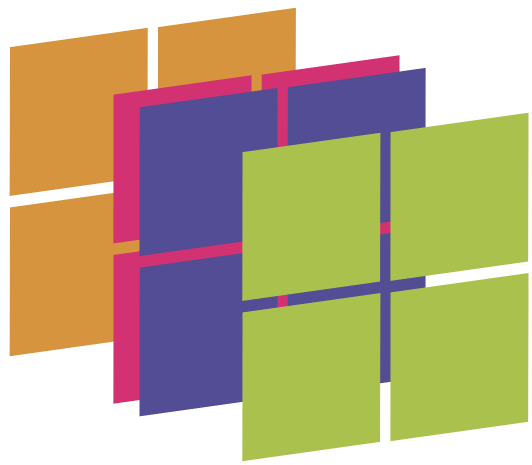
SmART SCHOOLS

Unit Planning Template



Unit Designer: Amy Leidtke Grade Level: G5 - 6

Title: Cascading Cube Constructions

Discipline(s): Arts, and Math

School: SmART Schools STEAM Mini-Institute, October 10, 2014 Time Frame: 8:00 – 11:00 AND 11:30 – 2:30

Location: School Library, Madeline English School, Everett, MA

Participants/Consulting Everett Educators: INSERT NAMES

STAGE ONE: Identify Desired Results What do we want students to know, understand, and be able to do?	
Unit Overview *What will be studied and why?* *How does this study ask fundamental questions about the content or discipline(s) being studied?*	**Unit Overview** Educators, roll up your sleeves, take off your shoes, and stretch – get ready to immerse yourselves in the full-body-and-mind experience of creating an interactive and tessellating geometric toy. During the Cascading Cube Constructions STEAM Mini-Institute, educators will investigate mathematical concepts of geometry, multiplication, and scale, as well as create and design a dynamic visual story, one that flexes, tumbles, and rotates in space. *"Cascading Cube Constructions",* a hands and minds on participatory educator's workshop, explores ways to promote core pedagogical ideas and practices in the Grade 5 - 6 context through the theme of geometrically-inspired design innovation. The session will illuminate how a geometry-inspired design challenge can appropriately integrate Science, Technology, Engineering, Art, and Math (STEAM) subject areas, meeting the latest education standards for grades five and six. Activities will focus on bringing design thinking into the classroom and assignments, with the objective of integrating arts with academics. In a mock studio setting, educators take the role of students, accepting an assigned geometry-themed design challenge. Working through a guided design process, participants will not only endeavor to solve the design challenge, but will simultaneously investigate methods for the following educational pursuits: Understand what students know through pre-assessment Address preconceived notions and misconceptions

	Define the design brief with clear project goals and objectives Scaffold the experience for different learners Develop an integrated rubric Stimulate curiosity through the act of asking "igniting questions" Coach students through guided discovery (research, observation, empathy, investigation, experimentation, and journaling) Document evidence of teaching and learning progression. During the experience, participants will be encouraged to identify key applicable competencies across a variety of disciplines, including but not limited to Science, Technology, Engineering, Arts, and Math. While educators will consider many subject areas, the workshop will specifically focus on Math and Visual Art skills. Based upon the studio investigation, participants will be encouraged to think about how they might take the project (or something similar) into their own classroom and how they might modify it to suit their students' needs and interests. While it will not be a major portion of the institute, educators will be asked to consider, given time to develop the unit for their own classroom, how they would determine a range of successful and/or acceptable project solutions. Further, how might they make minor adjustments to the experience in order to accommodate special needs (i.e.: scaffolding the learning experience). As the project develops, participants will be encouraged to consider the potential success indicators, applications across academic disciplines, and teaching prompts. Additionally, participants will be prompted to consider how teamwork, process, critique, reflection and product might factor into the expectations and assessment. *Below is an excerpt from Design Connections: Curriculum Tools for Design Education, a book authored by Amy Leidtke:* *Overview* *This project contains a sampling of useful curriculum tools for educators to use as inspiration for developing their own projects. The exercises reflect real-world visual arts studio experiences.* *The project promotes learning design-based skills, including brainstorming, mastering form and material, solving problems, working in groups, and thinking creatively and strategically.* *This project contains important elements of invention, discovery, and play.* *Core Design Principles* *This project is developed with the notion of inspiring design thinking. Guiding principles for the development of this project include the following:* *Sustainability – Utilize earth-friendly materials, those that are made from recycled content, and whenever possible those materials that have been temporarily removed from the recycling stream. Promote ideas of sustainability through not only practice, but also through discussion and example.* *Innovation – Encourage creativity and invention through open-ended exploration, be it through ideation, material investigation, and testing.* *Curiosity – Ignite curiosity through hands-on experiences.* *Curriculum-based – Encompass a wider curriculum connection, including science, math, language arts, social studies, and other subjects.* *Fun – Great fun factor is paramount to student engagement.* *Success – Offer accessible activities, ensuring students a high rate of success and a sense*

	of achievement. *Process-oriented – Embrace creative thinking and promote problem-solving skills, and know that experiencing the design process can be just as significant, if not more meaningful than successfully completing a project.* *Experiential – Provide highly interactive, meaningful, hands-on experiences that students can get excited about.* *Participatory – Involve students in projects on multiple levels, encouraging participation through inquiry, investigation, observation, interaction, experimentation, testing, and reflection.* *With these guiding principles, the purpose is to provide skill-based design exercises that excite the imagination and increase learning potential.* *Copyright owner, Amy Leidtke*
Enduring Understandings *What are the big ideas that give meaning and importance to the facts studied?* *What are the big understandings that reside at the heart of the study, that you want students to uncover and attempt to understand through this study?*	**Enduring Understandings** • 2-D and 3D mathematical designs are based upon unit systems. • Designers can look to geometric shapes and forms for inspiration, seeing patterns, structures and systems. • The process of innovating requires motivation, ingenuity, technology (materials and tools), visualization, trial and error, and perseverance. • The process of 'critical making' involves generating meaningful connections to content, being flexible, making abstractions, generating multiple solutions for comparison, experimentation, synthesizing knowledge, critique, reflection, revision, and refinement. Critical making bridges the gap between making concepts and arriving at a final solution. The process of critical making require one to think critically about their work.
Essential Questions *What are the relevant, meaningful questions that will encourage deep exploration of ideas?* *What universal, compelling question(s) will focus the study and the final performance of student learning?*	**Essential Questions** • How can we look to geometry for design inspiration? • Why do people use tools and technology? • What role does motivation play in the innovation process? • How can one best visualize and document different design iterations? Teaching prompts that can help increase student learning, as well as serve students with different learning styles. • In what ways does weight, balance, tension, compression, and symmetry factor in the design? • What are different ways to hold the object? • How many different ways might there be to work with the cube in conjunction with the grid? • What would be suitable materials for the object? How will those components be joined securely?

Cascading Cube Constructions

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Desired Outcomes for Student Learning/ Standards

What do I want students to know, understand, and be able to do?

What skills or insights do I expect them to gain?

How do these ideas align to state and/or national standards and/or graduation requirements? (Include all standards for all disciplines being assessed that align with desired outcomes)

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Desired Outcomes for Student Learning/ Standards

• Students will gain insight into the design process, learning research methods, problem solving techniques, and communication skills.

• Students will use the design process to develop and practice important 21st century skills for innovation. Design thinking skills include activities such as research, observation, empathy, teamwork, ideation, visual communication, modeling, testing, revision, testing, and modification.

• Students will engage in Science, Engineering, Technology, Visual Art, and Math disciplines.

• Students will experience the joy of making their own mathematical, story-telling toy, one they can keep for themselves, show to others, and use to reflect upon the learning experience.

VISUAL ARTS STRANDS AND STANDARDS
(BY GRADE 8 STUDENTS WILL BE ABLE TO DO THE FOLLOWING)
PreK–12 STANDARD 2 Elements and Principles of Design
Students will demonstrate knowledge of the elements and principles of design.
2.7 For color, use and be able to identify hues, values, intermediate shades, tints, tones, complementary, analogous, and monochromatic colors
Demonstrate awareness of color by painting objective studies from life and free- form abstractions that employ relative properties of color
2.8 For line, use and be able to identify various types of line, for example in contour drawings, calligraphy, freehand studies from observation, memory, and imagination, and schematic studies
2.10 For shape, form, and pattern, use and be able to identify an expanding and increasingly sophisticated array of shapes and forms, such as organic, geometric, positive and negative, or varieties of symmetry
Create complex patterns, for example, reversed shapes and tessellation

PreK–12 STANDARD 4 Drafting, Revising, and Exhibiting
Students will demonstrate knowledge of the processes of creating and exhibiting artwork: drafts, critique, self-assessment, refinement, and exhibit preparation.
4.4 Produce work that shows an understanding of the concept of craftsmanship
4.5 Demonstrate the ability to describe preliminary concepts verbally; to visualize concepts in clear schematic layouts; and to organize and complete projects
4.6 Demonstrate the ability to articulate criteria for artistic work, describe personal style, assess and reflect on work orally and in writing, and to revise work based on criteria developed in the classroom

STANDARDS FOR MATHEMATICAL PRACTICE G5-6

G5 STANDARDS FOR MATHEMATICAL PRACTICE
1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for an express regularity in repeated reasoning.

Geometry 5.G
Graph points on the coordinate plane to solve real-world and mathematical problems.

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	1. Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., x-axis and x-coordinate, y- axis and y-coordinate). 2. Represent real-world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. Classify two-dimensional figures into categories based on their properties. 3. 4. Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles. Classify two-dimensional figures in a hierarchy based on properties. G6 STANDARDS FOR MATHEMATICAL PRACTICE 1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for an express regularity in repeated reasoning. Geometry 6.G Solve real-world and mathematical problems involving area, surface area, and volume. 1. Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems. 2. Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas V = lwh and V = bh to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems. 3. Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems. 4. Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface areas of these figures. Apply these techniques in the context of solving real-world and mathematical problems.

<u>**Cascading Cube Constructions**</u>

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STAGE TWO: Determine Acceptable Evidence

How will we know if students have achieved the desired outcomes and met the standards?

What will we accept as evidence of student understanding and proficiency?

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Assessment

How will I know if students have achieved the desired outcomes and met the standards?

What will I accept as evidence of student understanding and proficiency? How will I communicate this to students?

How will I evaluate student evidence of learning the desired outcomes?

How will I offer students the opportunity to expand on and apply what they've learned?

How will students have an opportunity for self-evaluation and/or revision?

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Assessment

(see the Instructional Plan section of this unit for a sample list of success indicators)

• Through research, observation, thinking, making, and testing, students will demonstrate a depth of understanding in the topic area; they will engage in critical making, constructive critique, group and individual reflection, refinement, and documentation/exhibition. During the institute, educators will reflect on what factors will contribute to a successful project.

• As concepts from the desired learning standards are uncovered throughout the learning process, educators can subsequently generate a rubric of criteria that defines successful outcomes. For the purposes of this institute, we will not focus on the act of generating a rubric.

• Through object making, students will explore a range of materials, experimenting with different ideas, developing and testing iterative designs, ultimately realizing their final solution in a final working model.

• Through documentation and exhibition students demonstrate, illustrate, communicate, and disseminate not only the design process, but also project failures and successes.

• Students can use a combination of visual, verbal, and written narrative to describe the context and utilitarian function of the objects.

• Students can draw, label, and dimension a scaled drawing of the objects.

• Students assess their progress throughout the process, using the group rubric. Prior to creating their final work, students share their process and receive feedback. Reflections, such as checking a rubric or writing a brief progress report, aid students in thinking about how they engaged with the project.

• Students will present and defend their work in a group critique, describing their understanding of the various concepts outlined throughout the process, defined in the group created rubric. This is a positive form of assessment.

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STAGE THREE: Plan Learning Experiences and Instruction What teaching and learning experiences will equip students to demonstrate the targeted understandings?	
Develop the Instructional Plan *What is the scope and sequence of activities that lead to student success on the assessment(s) and academic rigor?* *Do activities require that students ask deep questions about their learning?* *Are there opportunities for students to develop language and conceptual understandings related to content?* *Are there opportunities for meaning-making and personal reflection on the part of students?* *Are students encouraged to revise and produce quality work?* *Do the activities provide multiple entry-points and accommodate for different learning styles?* *Is the teacher spending her time coaching, conferencing, leading, participating, and sharing responsibility for learning with the students?*	**Instructional Plan:** Classroom experience (this is how one could think about bringing this lesson into the classroom): Intro to design challenge: 'Create a unique geometric design for the cascading cube toy.' Review project constraints: 'Use only the materials provided. Develop at least three concepts before deciding on the final version.' Review vocabulary (i.e. face, vertex, edge, net, diagram, concept, cube, prism, tessellation, grid, polygon, volume, coordinates, plan, design, sketch, schematic, layout, hinge, craftsmanship, etc.) Share tools and materials (see next section). Set expectation and requirement for craftsmanship as well as project documentation. Conduct demonstrations of specific techniques (i.e. drawing and cutting out the pattern, forming a cube, assembling the cubes according to the specific instructions, and creating different design concepts). Construct the eight cubes. Assemble the toy according to the pattern. Play with the toy, becoming familiar with the rotation and faces. Create three different concepts. Compare, contrast, reflect, revise, and refine the design. Use post-it notes to transfer one design onto the model. Compare, contrast, reflect, revise, and refine the design. Finalize. Teaching Prompts: Begin by making eight cubes. Assemble the cubes according to the diagram. Make sure to tape each hinge securely on both sides. Play with the toy, rotating it in order to become familiar with the way it works. Think about all of the different faces of the toy – how many faces are there? Develop at least three possible design solutions for the cube before deciding on a final solution. And so on. Success Indicators: The cube toy is structural, well-constructed (i.e. clean hinges that are taped from edge to edge), and rotates according to the pattern. Each face has a unique geometric design. For an extra challenge, design each face in such a way that it is unique, but also relates to the connecting faces. For example, lines on the faces can connect at the vertices and/or the edges. References and Resources (see next section) More information: For those of you who are interested in deeper investigation, consider using Bloom's Taxonomy and Webb's Depth of Knowledge Levels (DOK). Below are some examples of how this unit ties to the DOK. • Define design process strategies and make connections to mathematically-inspired designs, both 2-D and 3-D. (DOK 1 & 2) • Construct a class rubric defining criteria for successful use of a geometrically inspired design challenge. (DOK 2 + 3) • Explore the images and model collections and participate in the discussions and design exercises. (DOK 1) • Apply concepts learned to create an artifact (a mathematical toy). (DOK 4) • Consider and discuss geometry as one approval to design innovation. (DOK 3) • In-process critique to allow for revised ideas and product. (DOK 3 + 4) • Exhibit and assess final work in a group critique using the class' rubric. (DOK 4)

Identify Materials and Resources *What materials and resources—including student handouts, books, periodicals, media, software, URLs—are required to implement this unit?* *Are the materials and resources sufficient for exploring the topic and directly related to the essential question?*	**Identify Materials and Resources** This is a list of materials of what you will need in order to bring the lesson into the classroom: Pencils, erasers, 3 ply Bristol board (or similar, such as cereal boxes, chip board, or tag board), scissors, rulers, triangles, compasses, protractors, circle guides, paper (grid paper is especially useful for this project), dry media (such as multiple colors of pencils or paper), glue sticks (or double stick tape), and masking tape. Students can also use Photoshop (or similar) in order to execute the layouts. Additional resources, those that educators may find helpful when planning and executing this unit: Visual references of M.C. Escher's tessellations <u>Art Forms in Nature</u>, Ernst Haeckel Museum of Math, NY www.mathisfun.com website www.korthalsaltes.com and Gijs Korthals Altes Biennial Design Science Symposium, on the campus of RISD Make Magazine Maker Faire Mary Everest Boole and the Curve-Stitch Isometric Cube Sol Lewitt, artist

STAGE FOUR: ALIGNMENT and REFLECTION	
Implementation Alignment and Reflection *How do the instructional activities support the achievement of the desired outcomes?* *How do the assessment methods demonstrate achievement of the desired outcomes?* *AFTER THE UNIT IS COMPLETE:* *What worked?* *What didn't work?* *What would another teacher need to know in order to enact this curriculum?*	**Implementation Alignment and Reflection** The instructional activities support the achievement of the desired outcomes by asking students to apply the concepts of geometric-inspired design innovation to their own project(s). The group critique, using the student generated assessment criteria, allows for consensus or allows for discussion as to the success of the design projects. When students participate in the act of generating a list of evaluation criteria, they are more likely to arrive at a common understanding of how the work will be evaluated and valued. Extended Study: This project is highly interdisciplinary and provides many opportunities for further investigation and inquiry. Natural Science: How might natural science collections aid in an integrated curriculum? Career Paths: What careers relate to math and nature? What are the pathways to those careers? Science: What are the ways in which we learn about the natural world? Technology: What are the different ways we observe, study and investigate nature? What tools we can employ to aid in this investigation? Engineering: What can we learn about nature's structures, patterns, and forms? Visual Arts: How does nature solve problems? How do we make meaning from nature? How can we use nature's problem solving method to solve our problems today? Math: How can we use nature to understand and visualize geometric structure?