LUX BLOX HANDS-ON ACTIVITIES

Aligned with Common Core MATH Standards and NGSS (Next Generation Science Standards) Grades K-8

STANDARD	DETAILS	LUX HANDS-ON ACTIVITIES
GRADE K - COUNTING & CARDINALITY		
CCSS.MATH.CONTENT.K.CC.A.1	Count to 100 by ones and by tens.	Students use individual Lux pieces as manipulatives to count by ones, and connect them into strips of ten to count by tens.
CCSS.MATH.CONTENT.K.CC.A.3	Write numbers from 0 to 20. Represent a number of objects with a written numeral 0-20 (with 0 representing a count of no objects).	Student connect strips or patterns of Lux to depict the number written. Students may use the Lux individually or they can connect them to represent any number above 1.
CCSS.MATH.CONTENT.K.CC.B.4.A	When counting objects, say the number names in the standard order, pairing each object with one and only one number name and each number name with one and only one object.	Students may use Lux as counting manipulatives in this activity. They can connect each LUX piece as they count them off into a strip or a shape.
CCSS.MATH.CONTENT.K.CC.B.4.B	Understand that the last number name said tells the number of objects counted. The number of objects is the same regardless of their arrangement or the order in which they were counted.	Students use a variety of single pieces and strips to count a total quantity, emphasizing that the last number counted represents the total number of Lux pieces.
CCSS.MATH.CONTENT.K.CC.B.4.C	Understand that each successive number name refers to a quantity that is one larger.	Students use Lux to explain and demonstrate that each successive number name refers to a quantity that is one larger than the last. This can be done in the activity of adding to a strip of LUX, or building a tessellation of any shape.
CCSS.MATH.CONTENT.K.CC.B.5	Count to answer "how many?" questions about as many as 20 things arranged in a line, a rectangular array, or a circle, or as many as 10 things in a scattered configuration; given a number from 1-20, count out that many objects.	Students use Lux to answer "How many?" questions. They count to answer how many Lux are arranged in various arrays such as circles, rectangles, and scattered configurations.
CCSS.MATH.CONTENT.K.CC.C.6	Identify whether the number of objects in one group is greater than, less than, or equal to the number of objects in another group, e.g., by using matching and counting strategies.[1]	Students will use both singular Lux and strips of Lux to identify whether the number of objects in one group is greater than, less than, or equal to the number of objects in another group. They will do this by using matching and counting strategies.
GRADE K - OPERATIONS & ALGEBRAIC THINKING		
CCSS.MATH.CONTENT.K.OA.A.1	Represent addition and subtraction with objects, fingers, mental images, drawings[1], sounds (e.g., claps), acting out situations, verbal explanations, expressions, or equations.	Students use Lux to represent addition and subtraction. Using linear counting strips, put them over and under each other to see and count out the difference between them and next to each other to add them.
CCSS.MATH.CONTENT.K.OA.A.2	Solve addition and subtraction word problems, and add and subtract within 10, e.g., by using objects or drawings to represent the problem.	Students use Lux to represent number quantities in addition and subtraction problems, using the method of overlapping the lesser strip over the greater strip and counting the difference.
CCSS.MATH.CONTENT.K.OA.A.3	Decompose numbers less than or equal to 10 into pairs in more than one way, e.g., by using objects or drawings, and record each decomposition by a drawing or equation (e.g., 5 = 2 + 3 and 5 = 4 + 1).	Students use a variety of Lux strips less than or equal to ten and record decomposition by drawing the equation represented.

CCSS.MATH.CONTENT.K.OA.A.4	For any number from 1 to 9, find the number that makes 10 when added to the given number, e.g., by using objects or drawings, and record the answer with a drawing or equation.	Students use Lux groupings of 1 to 9 and then find the combinations that add up to ten and record the answer with a drawing or equations.
CCSS.MATH.CONTENT.K.OA.A.5	Fluently add and subtract within 5.	Using Lux strips of one to four, students drill to build fluency of adding and subtracting within 5.
GRADE K - NUMBER & OPERATIONS IN BASE TEN		
CCSS.MATH.CONTENT.K.NBT.A.1	Compose and decompose numbers from 11 to 19 into ten ones and some further ones, e.g., by using objects or drawings, and record each composition or decomposition by a drawing or equation (such as 18 = 10 + 8); understand that these numbers are composed of ten ones and one, two, three, four, five, six, seven, eight, or nine ones.	Using Lux from one to strips of 19, students record each composition and decomposition by drawing or equation, and will demonstrate and understand that these numbers are composed of a strip of ten ones and strips of numbers less than ten. For instance, 18 = 10 + 8 can be expressed as a strip of ten plus a strip of eight or eight individual pieces of Lux.
GRADE K - MEASUREMENT & DATA		
CCSS.MATH.CONTENT.K.MD.A.1	Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.	Students use two and three dimensional Lux constructions to measure attributes such as their length, height, width, and weight.
CCSS.MATH.CONTENT.K.MD.A.2	Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. *For example, directly compare the heights of two children and describe one child as taller/shorter* .	Students compare Lux constructions with measurable attributes in common to measure and demonstrate which object has more or less of the attribute.
CCSS.MATH.CONTENT.K.MD.B.3	Classify objects into given categories; count the numbers of objects in each category and sort the categories by count.	Students use Lux to demonstrate and explain how to classify. Objects can be classified according to their various attributes such as shape, color, and size.
GRADE K - GEOMETRY		
CCSS.MATH.CONTENT.K.G.A.1	Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as *above* , *below* , *beside* , *in front of* , *behind* , and *next to* .	Students use Lux as objects to describe their relative position such as, "the red Lux is underneath the yellow Lux, next to the blue Lux, in front of the green Lux, and on top of the orange Lux."
CCSS.MATH.CONTENT.K.G.A.2	Correctly name shapes regardless of their orientations or overall size.	Students use Lux to identify and explain the correct names of shapes regardless of their orientations. Shapes to be identified will be squares. Rhombuses (diamonds), triangles, trapezoids, hexagons, pentagons, and rectangles.
CCSS.MATH.CONTENT.K.G.A.3	Identify shapes as two-dimensional (lying in a plane, "flat") or three-dimensional ("solid").	Students us Lux to distinguish and identify between two and three-dimensional shapes. Students can construct the various configurations, for instance have the children build a series of cubes and other prisms along with various flat tessellations. Then discuss the difference between two dimensional and three dimensional shapes, and then have the, distinguish the objects that they had created.
CCSS.MATH.CONTENT.K.G.B.4	Analyze and compare two- and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/"corners") and other attributes (e.g., having sides of equal length).	Students will use Lux to build and utilize two and three-dimensional objects to describe their similarities, differences, parts (number od sides, vertices, and corners). And other attributes.
CCSS.MATH.CONTENT.K.G.B.5	Model shapes in the world by building shapes from components (e.g., sticks and clay balls) and drawing shapes.	Students use Lux to model shapes in the world from components, such as prisms, pyramids, and polyhedra.
CCSS.MATH.CONTENT.K.G.B.6	Compose simple shapes to form larger shapes. For example, "Can you join these two triangles with full sides touching to make a rectangle?"	Students use Lux to compose simple shapes to form large shapes.
GRADE K- NGSS		

FORCES AND INTERACTION: PUSH AND PULL		
K-PS2-1	Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.	Using LUX, create objects that move by pushing and pulling. Test to see how the object responds to pushing and pulling in terms of the different directions it tends to travel when the forces are applied to it.
K-PS2-2	Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull	Have students redesign their objects to cause a change in the observed behaviors from the previous investigation and then conduct an investigation to see if their design changes had the desired effect in the motion of the object when pushed and pulled.
ENGINEERING AND DESIGN		
K-2-ETS1-1	Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.	After defining the problem and gathering information and ideas about what solutions can be considered, have students us LUX as the construction material to design a new or improved object or tool that will help to change a situation.
K-2-ETS1-2	Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.	Use LUX to illustrate how the shape of an object helps its function as needed to solve a problem. Explore with children tools that imitate the hand, like scoops, and shovels,
K-2-ETS1-3	Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.	Have students design and construct an object to solve a specific problem. Then have them analyze data from tests they conduct of the two objects to compare their strengths and weaknesses. Discuss the importance of fairness and impartiality in judging and how in science, just as in sports and the law , impartiality is an important quality to ascertain the truth.

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STANDARD	DETAILS	LUX HANDS-ON ACTIVITIES
GRADE 1 - OPERATIONS & ALGEBRAIC THINKING		
CCSS.MATH.CONTENT.1.OA.A.1	Use addition and subtraction within 20 to solve word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using objects, drawings, and equations with a symbol for the unknown number to represent the problem.1	Apply Lux in word problem involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns. This can be done by simply using assembled chains of Lux squares or triangles, linking them to represent a quantity. These assemblages can be put over and under each other illustrate differences, next to each other or combined to show
CCSS.MATH.CONTENT.1.OA.A.2	Solve word problems that call for addition of three whole numbers whose sum is less than or equal to 20, e.g., by using objects, drawings, and equations with a symbol for the unknown number to represent the problem.	Use chains of Lux squares or triangles to create quantities that can be used to represent whole numbers. Use these chains or patterned configurations (a square consisting of four LUX squares), in place of numerals.
GRADE 1 - NUMBER OPERATION IN BASE TEN		
CCSS.MATH.CONTENT.1.NBT.B.2.A	10 can be thought of as a bundle of ten ones — called a "ten."	Using chains of ten connected LUX squares or trigons, reinforce that these bundles of single pieces are called "ten".
CCSS.MATH.CONTENT.1.NBT.B.2.B	The numbers from 11 to 19 are composed of a ten and one, two, three, four, five, six, seven, eight, or nine ones.	Using a different color for the additional pieces after ten, have the students add pieces to the strip of ten, and use this to reinforce the numbers from 11 to 19.
CCSS.MATH.CONTENT.1.NBT.B.2.C	The numbers 10, 20, 30, 40, 50, 60, 70, 80, 90 refer to one, two, three, four, five, six, seven, eight, or nine tens (and 0 ones).	By using a colored piece to denote a ten, have the children make chains that represent the numbers of 10, 20, 30, 40, 50, 60, 70, 80, and 90,
GRADE 1 - MEASUREMENT & DATA		
CCSS.MATH.CONTENT.1.MD.A.1	Order three objects by length; compare the lengths of two objects indirectly by using a third object.	Using strips of LUX of various lengths, order them by length, and compare the lengths by counting the number of pieces and by using a third length or other object.
CCSS.MATH.CONTENT.1.MD.A.2	Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps. *Limit to contexts where the object being measured is spanned by a whole number of length units with no gaps or overlaps* .	Using a single Lux square as unit length one, create chains (or strips) of LUX. Express these lengths as a whole number with length units- :this red chain is twelve LUX long", for instance.
GRADE 1 - GEOMETRY		
CCSS.MATH.CONTENT.1.G.A.1	Distinguish between defining attributes (e.g., triangles are closed and three-sided) versus non-defining attributes (e.g., color, orientation, overall size); build and draw shapes to possess defining attributes.	Build shapes using LUX and then use then to distinguish defining attributes versus non-defining attributes.

CCSS.MATH.CONTENT.1.G.A.2	Compose two-dimensional shapes (rectangles, squares, trapezoids, triangles) or three-dimensional shapes (cubes, right rectangular prisms, right circular cones, and right circular cylinders) to create a composite shape, and compose new shapes from the composite shape.1	Using LUX, create two-dimensional representations of shapes. Do this either by make tessellations using LUX pieces flat on a table top, or use the LUX pieces on their sides and make bendable chains that can define shapes when looking down on them. Also create three dimensional shapes and make composite shapes, such as prisms, pyramids, cubes, and truncations and combinations of these.
CCSS.MATH.CONTENT.1.G.A.3	Partition rectangles into two and four equal shares, describe the shares using the words halves, fourths, and quarters, and use the phrases half of, fourth of, and quarter of. Describe the whole as two of, or four of the shares. Understand for these examples that decomposing into more equal shares creates smaller shares.	LUX squares are used in this exercise to partition rectangles into two and four equal shares so the words halves, fourths, and quarter of can be used.
GRADE 1 - NGSS		
WAVES LIGHT AND SOUND		
1-PS4-1.	Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.	Using LUX create devices that use vibrating materials such as rubber bands that can also generate sound.
STRUCTURE, FUNCTION, AND INFORMATION PROCESSING		
1-LS1-1.	Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.	LUX students can demonstrate how plant and animal design features can be used to solve a human problem and how these features meet the needs of these creatures to survive grow and meet their other needs.
1-PS4-4	Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance	Use LUX to build a communication device using light or sound that can communicate over a distance.
ENGINEERING AND DESIGN		
K-2-ETS1-1	Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.	After defining the problem and gathering information and ideas about what solutions can be considered, have students us LUX as the construction material to design a new or improved object or tool that will help to change a situation.
K-2-ETS1-2	Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.	Use LUX to illustrate how the shape of an object helps its function as needed to solve a problem. Explore with children tools that imitate the hand, like scoops, and shovels,
K-2-ETS1-3	Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.	Have students design and construct an object to solve a specific problem. Then have them analyze data from tests they conduct of the two objects to compare their strengths and weaknesses. Discuss the importance of fairness and impartiality in judging and how in science, just as in sports and the law , impartiality is an important quality to ascertain the truth.

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GRADE 2 - OPERATIONS & ALGEBRAIC THINKING		
CCSS.MATH.CONTENT.2.OA.C.3	Determine whether a group of objects (up to 20) has an odd or even number of members, e.g., by pairing objects or counting them by 2s; write an equation to express an even number as a sum of two equal addends.	Using LUX chains, the concept of symmetry can also be added to this discussion, as an odd number is always one more or less than its neighbor when using whole numbers. For instance, a chain of eight LUX will end and show it has a middle and four LUX on each side, making it even. A LUX chains of seven will not have a break in the middle ant the students will see that the
CCSS.MATH.CONTENT.2.OA.C.4	Use addition to find the total number of objects arranged in rectangular arrays with up to 5 rows and up to 5 columns; write an equation to express the total as a sum of equal addends.	Us LUX squares to have students create their own arrays to test each other and practice writing equations to express the total sum of equal addends.
GRADE 2 - NUMBER & OPERATIONS IN BASE TEN		
CCSS.MATH.CONTENT.2.NBT.A.1.A	100 can be thought of as a bundle of ten tens — called a "hundred."	The concept of 100 being a bundle of ten tens can be reinforced by having students fashion chains of ten LUX and then create squares of them ten long by ten wide, thus anticipating the idea of square numbers and multiplication.
GRADE 2 - MEASUREMENT & DATA		
CCSS.MATH.CONTENT.2.MD.B.6	Represent whole numbers as lengths from 0 on a number line diagram with equally spaced points corresponding to the numbers 0, 1, 2, ..., and represent whole-number sums and differences within 100 on a number line diagram.	Create a number line using LUX squares in a chain. Each hole in the each square represents the point corresponding to the numbers 0, 1,2, 2, …, and represent whole-number sums and differences within 100 on this line diagram made of LUX.
CCSS.MATH.CONTENT.2.MD.D.10	Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put-together, take-apart, and compare problems1 using information presented in a bar graph.	This graph can be constructed with LUX, having various colored chains of LUX representing the data sets in multiple categories.
GRADE 2 - GEOMETRY		
CCSS.MATH.CONTENT.2.G.A.2	Partition a rectangle into rows and columns of same-size squares and count to find the total number of them.	Use LUX to build a rectangle with rows and columns and count to find the total number of them.
CCSS.MATH.CONTENT.2.G.A.3	Partition rectangles into two, three, or four equal shares, describe the shares using the words halves, thirds, half of, a third of, etc., and describe the whole as two halves, three thirds, four fourths. Recognize that equal shares of identical wholes need not have the same shape.	Using multiple colors, students can partition rectangles into tow, three, and four equal shares and describe them using the words halves, thirds, half of, a third of, etc., and describe the whole as two halves, three thirds, four fourths.
GRADE 2 - NGSS		
STRUCTURE AND PROPERTIES OF MATTER		

2-PS1-3.	Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object	Using a set number of LUX pieces, document the process of using these pieces to construct a variety of different objects. The objects could be machines, tools, shelters, etc.
ENGINEERING AND DESIGN		
K-2-ETS1-1	Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.	After defining the problem and gathering information and ideas about what solutions can be considered, have students us LUX as the construction material to design a new or improved object or tool that will help to change a situation.
K-2-ETS1-2.	Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.	Use LUX to illustrate how the shape of an object helps its function as needed to solve a problem. Explore with children tools that imitate the hand, like scoops, and shovels,
K-2-ETS1-3.	Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.	Have students design and construct an object to solve a specific problem. Then have them analyze data from tests they conduct of the two objects to compare their strengths and weaknesses. Discuss the importance of fairness and impartiality in judging and how in science, just as in sports and the law , impartiality is an important quality to ascertain the truth.

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GRADE 3 - OPERATIONS & ALGEBRAIC THINKING		
CCSS.MATH.CONTENT.3.OA.A.1	Interpret products of whole numbers, e.g., interpret 5 × 7 as the total number of objects in 5 groups of 7 objects each. *For example, describe a context in which a total number of objects can be expressed as 5 × 7*.	Using Square LUX, create chains to interpret the product of whole numbers. For instance, create three chains four LUX long, to show that the total number of objects of a group of three chains four long is twelve. Create many such chains to interpret the products of many combinations of whole numbers.
GRADE 3 - NUMBER & OPERATIONS - FRACTIONS		
CCSS.MATH.CONTENT.3.NF.A.2	Understand a fraction as a number on the number line; represent fractions on a number line diagram.	Using LUX, create a number line that can show fractions. Using various colors, a whole length can be represent by a group representing a fraction of the whole number on the number line. For instance, to show the fractions of fourths, halves, thirds, sixths, and twelfths, create a chain of LUX that is twelve squares long. The first and the twelf square can be the same color, to show that they represent the whole number of one. Students can use the LUX chain to examine how fractions work on a number line.
CCSS.MATH.CONTENT.3.NF.A.3.B	Recognize and generate simple equivalent fractions, e.g., 1/2 = 2/4, 4/6 = 2/3. Explain why the fractions are equivalent, e.g., by using a visual fraction model.	Using the LUX number line, generate equivalent fractions such are 1/2 = 2/4 and 4/8,
GRADE 3 - MEASUREMENT & DATA		
CCSS.MATH.CONTENT.3.MD.C.5	Recognize area as an attribute of plane figures and understand concepts of area measurement.	Using LUX squares as units of area, demonstrate how area can be assigned to the surfaces of plane figures like rectilinear boxes.
CCSS.MATH.CONTENT.3.MD.C.5.A	A square with side length 1 unit, called "a unit square," is said to have "one square unit" of area, and can be used to measure area.	Reinforce the concept of a square with side length 1 unit with establishing LUX squares as a unit 1. Use these to measure the surface area of book covers, desk tops, to reinforce this concept.
CCSS.MATH.CONTENT.3.MD.C.5.B	A plane figure which can be covered without gaps or overlaps by *n* unit squares is said to have an area of *n* square units.	Enforce the saying "Square n units" by having students use LUX to create sheets of various flat configurations, count the squares (n unit squares), and then say out loud how many square units there are in the give area.
CCSS.MATH.CONTENT.3.MD.C.6	Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).	Measure area using LUX as improvised units.
CCSS.MATH.CONTENT.3.MD.C.7.C	Use tiling to show in a concrete case that the area of a rectangle with whole-number side lengths a and $b + c$ is the sum of $a \times b$ and $a \times c$. Use area models to represent the distributive property in mathematical reasoning.	Use LUX models to represent the distributive property in mathematical terms. Use LUX tiling to show that an area of a rectangle with whole-number side lengths a and b + c is the sum of a x b and a x c.
CCSS.MATH.CONTENT.3.MD.D.8	Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.	Make this a creative project by having students using chains of LUX squares on their sides to create perimeters of same length but differing shapes and areas. Use the LUX chains as a means of measuring perimeter with one LUX square being unit length 1.
GRADE 3 - GEOMETRY		

CCSS.MATH.CONTENT.3.G.A.1	Understand that shapes in different categories (e.g., rhombuses, rectangles, and others) may share attributes (e.g., having four sides), and that the shared attributes can define a larger category (e.g., quadrilaterals). Recognize rhombuses, rectangles, and squares as examples of quadrilaterals, and draw examples of quadrilaterals that do not belong to any of these subcategories.	Create with LUX in different categories and use these to demonstrate how they may share attributes and that these shared attributes can define a larger category.
CCSS.MATH.CONTENT.3.G.A.2	Partition shapes into parts with equal areas. Express the area of each part as a unit fraction of the whole. *For example, partition a shape into 4 parts with equal area, and describe the area of each part as 1/4 of the area of the shape* .	Use LUX squares to partition shapes into parts with equal areas. Express the area of each part as a unit fraction of the whole.
GRADE 3 - NGSS		
FORCES AND INTERACTION		
3-PS2-1.	Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object	Using LUX, create objects that have moving parts in which balance can effect motion of those parts. For example, a simple seesaw design is an ideal model to create in such and investigation.
3-PS2-2.	Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion	Make observations and/or measurements of the LUX object's motions to provide evidence the a pattern can be used to predict future motion.
ENGINEERING AND DESIGN		
3-5-ETS1-1.	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	Utilizing LUX pieces as a constraint on materials, define a simple design problem reflecting a need or a want that includes specified criteria for success. Have multiple teams participate so comparisons can be made.
3-5-ETS1-2.	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	Design and build multiple possible solutions to the same problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3.	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	Plan and carry out fair tests on the LUX designs in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

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GRADE 4 - OPERATIONS & ALGEBRAIC THINKING		
CCSS.MATH.CONTENT.4.OA.C.5	Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself. *For example, given the rule "Add 3" and the starting number 1, generate terms in the resulting sequence and observe that the terms appear to alternate between odd and even*	This is a way to generate a shape pattern that follows a mathematical rule. Identify apparent features of the pattern that were not explicit in the rule itself. The dragon curve is a fractal that can be created by folding paper over and over again and then unfolding and arranging it through a series of Left and Right orthogonal turns. The problem with creating many iterations through
GRADE 4 - NUMBER & OPERATIONS IN BASE TEN		
CCSS.MATH.CONTENT.4.NBT.B.5	Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.	Using LUX, illustrate and explain the calculation by using rectangular arrays and area models (linear chains and Lux squares made into tiled sheets).
CCSS.MATH.CONTENT.4.NBT.B.6	Find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.	Illustrate and explain whole number quotients and remainders and the properties between division and multiplication with rectangular arrays and area models.
GRADE 4 - GEOMETRY		
CCSS.MATH.CONTENT.4.G.A.2	Classify two-dimensional figures based on the presence or absence of parallel or perpendicular lines, or the presence or absence of angles of a specified size. Recognize right triangles as a category, and identify right triangles.	Connect the ends of strips of LUX , flat on a table, with axles, so that the vertices of the two strips can be adjusted like the fulcrum in a scissors. Create and classify a series of two-dimensional figures based on the presence or the absence of parallel or perpendicular lines, or the presence or absence of angles of a specified size.
CCSS.MATH.CONTENT.4.G.A.3	Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.	Create two-dimension figures with LUX and recognize a line of symmetry across the figure such that the figure can be folded along match parts. Identify line-symmetric figures and draw lines of symmetry,
GRADE 4 - NGSS		
ENERGY		
4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.	Using LUX, have students create a simple fan or windmill. Have the, apply scientific ideas to design, test, and refine the windmill and show how it converts energy from one form into another.
4-PS4-1.	Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.	Using LUX fabric (a flat sheet of LUX pieces), , show how the structure of waves has patterns of amplitude and wavelength and that waves and cause objects to move.
ENGINEERING AND DESIGN		
3-5-ETS1-1.	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	Utilizing LUX pieces as a constraint on materials, define a simple design problem reflecting a need or a want that includes specified criteria for success. Have multiple teams participate so comparisons can be made.
3-5-ETS1-2.	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	Design and build multiple possible solutions to the same problem based on how well each is likely to meet the criteria and constraints of the problem.

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

LUX BLOX HANDS-ON ACTIVITIES

Aligned with Common Core MATH Standards and NGSS (Next Generation Science Standards) Grades K-8

STANDARD	DETAILS	LUX HANDS-ON ACTIVITIES
GRADE 5 - OPERATIONS & ALGEBRAIC THINKING		
CCSS.MATH.CONTENT.5.NF.B.4.B	Find the area of a rectangle with fractional side lengths by tiling it with unit squares of the appropriate unit fraction side lengths, and show that the area is the same as would be found by multiplying the side lengths. Multiply fractional side lengths to find areas of rectangles, and represent fraction products as rectangular areas.	Using a length of twelve LUX squares being unit one, you can create fractions of halves, thirds, fourths, sixths, and twelves. Use the LUX to create rectangles with these with sides of lengths from 1 to 12 and then show the area is the same as would be found by multiplying the side lengths.
CCSS.MATH.CONTENT.5.MD.C.3.A	A cube with side length 1 unit, called a "unit cube," is said to have "one cubic unit" of volume, and can be used to measure volume.	Using six square LUX create unit cubes of volume. Stack them to demonstrate three dimensional figures and their volumes.
CCSS.MATH.CONTENT.5.MD.C.3.B	A solid figure which can be packed without gaps or overlaps using *n* unit cubes is said to have a volume of *n* cubic units.	Create various configurations using the same number of n-units of volume cubes.
CCSS.MATH.CONTENT.5.MD.C.4	Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units.	Measure volumes by counting unit cubes using LUX as improvised units.
CCSS.MATH.CONTENT.5.MD.C.5.A	Find the volume of a right rectangular prism with whole-number side lengths by packing it with unit cubes, and show that the volume is the same as would be found by multiplying the edge lengths, equivalently by multiplying the height by the area of the base. Represent threefold whole-number products as volumes, e.g., to represent the associative property of multiplication.	Create a right rectangular prism made entirely of LUX cubes and then show that the number of cubes, the volume, can be found by multiplying the edge lengths, equivalently by multiplying the height by the area of the base.
GRADE 5 - GEOMETRY		
CCSS.MATH.CONTENT.5.G.A.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).	Create using chains of square LUX a pair of perpendicular number lines to define a coordinate axis, with the intersection of the lines (the origin) arranged to coincide with 0 on each line. With LUX the flower shaped hole in the middle of the squares are the points of whole numbers on the lines. So from the center hole to the next hole on the x-axis in one from the origin, 0. etc.
CCSS.MATH.CONTENT.5.G.A.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.	Create the first quadrant of a graph using 100 LUX squares to demark the a vale 0f 10 on the vertical or Y-axis and 10 to the right on the horizontal or x-axis. Represent real world and mathematical problems by graphing point in the first quadrant and interpret coordinate values of points in the context of the situation.
CCSS.MATH.CONTENT.5.G.B.4	Classify two-dimensional figures in a hierarchy based on properties.	Using LUX construction of two dimensional figures, classify them in a hierarchy based on properties.
GRADE 5 - NGSS		
ENGINEERING AND DESIGN		

3-5-ETS1-1.	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	Utilizing LUX pieces as a constraint on materials, define a simple design problem reflecting a need or a want that includes specified criteria for success. Have multiple teams participate so comparisons can be made.
3-5-ETS1-2.	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.	Design and build multiple possible solutions to the same problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3.	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	Plan and carry out fair tests on the LUX designs in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

LUX BLOX HANDS-ON ACTIVITIES
Aligned with Common Core MATH Standards and NGSS (Next Generation Science Standards) Grades K-8

STANDARD	DETAILS	LUX HANDS-ON ACTIVITIES
GRADE 6 - THE NUMBER SYSTEM		
CCSS.MATH.CONTENT.6.NS.C.6.C	Find and position integers and other rational numbers on a horizontal or vertical number line diagram; find and position pairs of integers and other rational numbers on a coordinate plane.	Create a vertical and horizontal number lines out of a strip of LUX. Find and position integers and other rational numbers* on these number lines. Have the number lines intersect and create a coordinate plane out of a sheet of square LUX. Find and position pairs of integers and other rational numbers on this coordinate plane. *Rational numbers can be shown if you gauge the
CCSS.MATH.CONTENT.6.NS.C.8	Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.	Create a four quadrant xy coordinate plane from LUX. Graph points in all four quadrants of the plane using pegs, dowels, pencils, or axles, as markers. Use rubber bands to connect these coordinated to demark distances between points. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.
GRADE 6 - GEOMETRY		
CCSS.MATH.CONTENT.6.G.A.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 = l w h* and *V = b h* to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.	Create LUX cubes and with tape mark them as fractional unit cubes. First create a "whole unit cube" from them. If there are 1/3 length unit cubes it will take 27 1/3 unit cubes. If the are 1/4 unit cube it will take 64 cubes to make a unit 1 cube. Etc. Show with these fractional edge length cube what the volume would be of right rectangular prisms with fraction edge lengths by stacking the cubes into the prisms and counting the number of cubes used. Show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas V = l w
CCSS.MATH.CONTENT.6.G.A.4	Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.	Create nets of triangles and rectangles using trigons and squares and use them to represent three dimensional figures and determine theory surface area.
GRADE 6 - NGSS		
STRUCTURE AND PROPERTIES OF MATTER		
MS-PS1-1.	Develop models to describe the atomic composition of simple molecules and extended structures.	Using LUX, create models of atomic composition of simple molecules and extended structures. Models of carbon molecules, for instance, can be made by assembling LUX into tetrahedrons, and these tetrahedron can be assembled to model the extended structure of diamond molecules.
FORCES AND INTERACTION		
MS-PS2-1.	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.	Using LUX, create models that demonstrate two objects colliding with one another. These can be two balls swinging from separate strings colliding or two cars rolling on a ramp into each other. Apply Newton's Third Law to design a solution to the problem of the two colliding objects.
MS-PS2-5.	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.	Using LUX create a pendulum in which a magnet or series of magnets are placed in a way to demonstrate that fields exist between objects and exert forces on these objects.

LUX BLOX HANDS-ON ACTIVITIES
Aligned with Common Core MATH Standards and NGSS (Next Generation Science Standards) Grades K-8

STANDARD	DETAILS	LUX HANDS-ON ACTIVITIES
GRADE 7 - GEOMETRY		
CCSS.MATH.CONTENT.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.	Using trigons and square LUX create two and three dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms. Solve real-world and mathematical problems involving area, volume and surface area of these objects.
GRADE 7 - STATISTICS & PROBABILITY		
CCSS.MATH.CONTENT.7.SP.C.5	Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.	Students can create Dice out of LUX cubes with various colors to generate different probabilities of outcomes. If the want to demonstrate that there is a 1/2 one 1:2 chance of rolling red, create a dice that has three sides that are red. Then roll the dice and record how many time the rolled and make a ratio with how many times they rolled red. This ration ought to come closer and closer to 1:2 or a one in two chance.
CCSS.MATH.CONTENT.7.SP.C.6	Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability. *For example, when rolling a number cube 600 times, predict that a 3 or 6 would be rolled roughly 200 times, but probably not exactly 200 times* .	The LUX cubes colors can be varied to change the probability of certain rolls. Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability. For example, when rolling a number cube 600 times, predict that a 3 or 6 would be rolled roughly 200 times, but probably not exactly 200 times.
CCSS.MATH.CONTENT.7.SP.C.7	Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy.	Create a probability model using either LUX cubes, Dreidels (Teetotums) , or octaballs. Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy.
CCSS.MATH.CONTENT.7.SP.C.7.B	Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process. *For example, find the approximate probability that a spinning penny will land heads up or that a tossed paper cup will land open-end down. Do the outcomes for the spinning penny appear to be equally likely based on the observed frequencies?*	Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process. For example, find the approximate probability that either a LUX Cube, Teetotum, or Octoball, will land on a certain color. Do the outcomes for the of these landings appear to be equally likely based on the observed frequencies?
GRADE 7 - NGSS		
STRUCTURE AND PROPERTIES OF MATTER		
MS-PS1-1.	Develop models to describe the atomic composition of simple molecules and extended structures.	Using LUX, create models of atomic composition of simple molecules and extended structures. Models of carbon molecules, for instance, can be made by assembling LUX into tetrahedrons, and these tetrahedron can be assembled to model the extended structure of diamond molecules.
FORCES AND INTERACTION		
MS-PS2-1.	Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.	Using LUX, create models that demonstrate two objects colliding with one another. These can be two balls swinging from separate strings colliding or two cars rolling on a ramp into each other. Apply Newton's Third Law to design a solution to the problem of the two colliding objects.
MS-PS2-5.	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.	Using LUX create a pendulum in which a magnet or series of magnets are placed in a way to demonstrate that fields exist between objects and exert forces on these objects.

LUX BLOX HANDS-ON ACTIVITIES

Aligned with Common Core MATH Standards and NGSS (Next Generation Science Standards) Grades K-8

STANDARD	DETAILS	LUX HANDS-ON ACTIVITIES
GRADE 8 - GEOMETRY		
CCSS.MATH.CONTENT.8.G.A.2	Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.	Construct from LUX two identical two dimensional figures and then demonstrate that they are congruent through a sequence of rotations. Add to the mix some shapes that are close by not congruent and have students test one another by rotation sequences to see if whether or not they can determine which figures are congruent to one another.
CCSS.MATH.CONTENT.8.G.A.3	Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.	Have students construct two dimensional figures and demonstrate the effect of dilations, translations, rotations, and reflections, on them and by using coordinates on a grid.
CCSS.MATH.CONTENT.8.G.A.4	Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.	Using an assortment of congruent and similar but incongruent figures made of LUX , demonstrate that the two-dimensional figures are similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.
CCSS. MATH. CONTENT.8.G.A.6	Explain a proof of the Pythagorean Theorem and its converse.	Students can make squares from LUX with a variety of sides and demonstrate a visual proof of Pythagoras by creating right triangles and proving the equation. For instance, a 3,4,5 triangle can be illustrated with aligning sqaures that are 3 by 3, 4 by 4, and 5 by 5, into a right triangle. A squared, 9, plus B squared, 16, equals C squared, 25.
GRADE 8 - NGSS		
STRUCTURE AND PROPERTIES OF MATTER		
MS-PS1-1.	Develop models to describe the atomic composition of simple molecules and extended structures.	Using LUX, create models of atomic composition of simple molecules and extended structures. Models of carbon molecules, for instance, can be made by assembling LUX into tetrahedrons, and these tetrahedron can be assembled to model the extended structure of diamond molecules.
FORCES AND INTERACTION		
MS-PS2-1.	Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.	Using LUX, create models that demonstrate two objects colliding with one another. These can be two balls swinging from separate strings colliding or two cars rolling on a ramp into each other. Apply Newton's Third Law to design a solution to the problem of the two colliding objects.
MS-PS2-5.	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.	Using LUX create a pendulum in which a magnet or series of magnets are placed in a way to demonstrate that fields exist between objects and exert forces on these objects.

LUX BLOX HANDS-ON ACTIVITIES
Aligned with Common Core High School MATH Standards

STANDARD	DETAILS	LUX HANDS-ON ACTIVITIES
NUMBER & QUANTITY		
N-RN 1 (Real Number System)	Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. *For example, we define 5^(1/3) to be the cube root of 5 because we want (5^(1/3))3 = 5^((1/3)3) to*	
N-RN 2	Rewrite expressions involving radicals and rational exponents using the properties of exponents.	
N-RN 3	Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.	While irrational numbers may be difficult to represent using LUX, this rational number theorem can be represented by having students combine a LUX object with *n* pieces to another object with *m* pieces, where *m* and *n* are integers, showing that the result will always be an integer.
N-Q 1 (Quantities)	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.	
N-Q 2	Define appropriate quantities for the purpose of descriptive modeling.	
N-Q 3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.	
N-CN 1 (Complex Number System)	Know there is a complex number i such that i^2 = –1, and every complex number has the form a + bi with a and b real.	
N-CN 2	Use the relation i^2 = –1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.	
N-CN 3	Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.	
N-CN 4	Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.	
N-CN 5	Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. *For example, (–1 + √3 i)^3 = 8 because (–1 + √3 i) has modulus 2 and argument 120°.*	

N-CN 6	Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.	
N-CN 7	Solve quadratic equations with real coefficients that have complex solutions.	
N-CN 8	Extend polynomial identities to the complex numbers. *For example, rewrite* $x^2 + 4$ *as* $(x + 2i)(x – 2i)$.	
N-CN 9	Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.	
N-VM 1 (Vector and Matrix Quantities)	Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v).	
N-VM 2	Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.	
N-VM 3	Solve problems involving velocity and other quantities that can be represented by vectors.	
N-VM 4 a	Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.	
N-VM 4 b	Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum	
N-VM 4 c	Understand vector subtraction v – w as v + (–w), where –w is the additive inverse of w, with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.	
N-VM 5 a	Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as c(vx, vy) = (cvx, cvy).	
N-VM 5 b	Compute the magnitude of a scalar multiple cv using ||cv|| = |c|v. Compute the direction of cv knowing that when |c|v ≠ 0, the direction of cv is either along v (for c > 0) or against v (for c < 0).	
N-VM 6	Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.	
N-VM 7	Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.	
N-VM 8	Add, subtract, and multiply matrices of appropriate dimensions.	
N-VM 9	Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.	
N-VM 10	Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.	
N-VM 11	Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.	
N-VM 12	Work with 2 × 2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area	

LUX BLOX HANDS-ON ACTIVITIES
Aligned with Common Core High School MATH Standards

STANDARD	DETAILS	LUX HANDS-ON ACTIVITIES
ALGEBRA		
A-SSE 1 a (Seeing Structure in Expressions)	Interpret parts of an expression, such as terms, factors, and coefficients.	
A-SSE 1 b	Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret $P(1+r)^n$ as the product of P and a factor not depending on P.*	
A-SSE 2	Use the structure of an expression to identify ways to rewrite it. *For example, see $x^4 – y^4$ as $(x^2)^2 – (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 – y^2)(x^2 + y^2)$.*	***CONTINGENT ON TRIAL WITH LUX PIECES*** Factoring can be completed using different sizes, shapes, and colors of LUX pieces. For example, establish blue as positive and red as negative, then establish a square shape as x^2, a long strip (same length as x^2) as x, and a small pieces as 1. Then construct a quadratic using the approrpiate colors and pieces (starts with $1x^2$). Then disassemble the object and break it into factors in the form of $(x \pm a)(x \pm b)$. Expand to quadratics of the form of ax^2.
A-SSE 3 a	Factor a quadratic expression to reveal the zeros of the function it defines.	
A-SSE 3 b	Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.	
A-SSE 3 c	Use the properties of exponents to transform expressions for exponential functions. *For example the expression 1.15^t can be rewritten as $(1.151/12)^{(12t)} \approx 1.012^{(12t)}$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.*	
A-SSE 4	Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. *For example, calculate mortgage payments.*	
A-APR 1 (Arithmetic with Polynomials and Rational Expressions)	Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials	
A-APR 2	Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).	
A-APR 3	Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.	

A-APR 4	Prove polynomial identities and use them to describe numerical relationships. *For example, the polynomial identity $(x^2 + y^2)^2 = (x^2 – y^2)^2 + (2xy)^2$ can be used to generate Pythagorean triples.*	
A-APR 5	Know and apply the Binomial Theorem for the expansion of $(x + y)^n$ in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.	
A-APR 6	Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + (r(x)/b(x)), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.	
A-APR 7	Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.	
A-CED 1 (Creating Equations)	Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.	
A-CED 2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.	Construct a graph of an equation on a coordinate plane (both using LUX), and have students answer questions regarding its equation using the picture. For example, for a picture of f(x) = 2x, show that f(2) = 4 and the point (2, 4) is on the plane.
A-REI 10	Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).	
A-CED 3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*	
A-CED 4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*	
A-REI 1 (Reasoning with Equations and Inequalities)	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.	
A-REI 2	Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.	
A-REI 3	Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.	Recreate an equation/inequality using LUX pieces, defining one piece/color as a unit and another piece/color as a variable. Manipulate both sides of the equation/inequality equally until only one variable piece/color is alone.
A-REI 4 a	Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.	

A-REI 4 b	Solve quadratic equations by inspection (e.g., for x^2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b.	
A-REI 5	Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.	Students can construct a large coordinate plane using LUX, then make multiple functions using LUX based on a table of values. Points of intersection will be found as the solution to the system of equations, and can be represented by different color LUX. Additionally, these points/pieces can be compared to the algebraic solution, making connections between the two ways of solving.
A-REI 6	Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.	
A-REI 7	Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. *For example, find the points of intersection between the line y = –3x and the circle x^2 + y^2 = 3.*	
A-REI 8	Represent a system of linear equations as a single matrix equation in a vector variable.	
A-REI 9	Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3 × 3 or greater).	
A-REI 11	Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.	
A-REI 12	Graph the solutions to a linear inequality in two variables as a halfplane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.	

LUX BLOX HANDS-ON ACTIVITIES
Aligned with Common Core High School MATH Standards

STANDARD	DETAILS	LUX HANDS-ON ACTIVITIES
FUNCTIONS		
F-IF 1 (Interpreting Functions)	Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).	
F-IF 2	Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.	
F-IF 4	For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity	
F-IF 5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function*	
F-IF 6	Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph	
F-IF 7 a	Graph linear and quadratic functions and show intercepts, maxima, and minima.	Students can create a coordinate plane using LUX to create these functions. Creating a very large coordinate plane can allow for multiple graphs on the same plane for many types of comparisons. Each type of function can be represented in a different color, and intersections of graphs can be marked in a different color as well. For polynomial functions, use the x-intercepts to of the graphs to create factors.
F-IF 7 b	Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.	
F-IF 7 c	Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.	
F-IF 7 d	Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.	
F-IF 7 e	Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.	
F-IF 8 a	Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.	
F-IF 8 b	Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions such as y = (1.02)^t , y = (0.97)^t , y = (1.01)^12t, y = (1.2)^(t/10), and classify them as representing exponential growth or decay*	

F-IF 9	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum*	
F-BF 1 a (Building Functions)	Determine an explicit expression, a recursive process, or steps for calculation from a context.	
F-BF 1 b	Combine standard function types using arithmetic operations. *For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.*	
F-BF 1 c	Compose functions. *For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.*	Have students construct an object using LUX, stopping every x seconds. At each stopping point, count how many LUX pieces have been used at that point (y). After complete, create a function based on time (x) and pieces (y)
F-BF 2	Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms	Determine an arithmetic sequence by constructing an object, counting its pieces, then adding (or subtracting) a certain number of pieces (common difference) each time. Then, determine a geometric sequence by multiplying by a common ratio. This could be done by having multiple people combine pieces of the same size. The Fibonacci sequence can be demonstrated using a similar method.
F-IF 3	Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. *For example, the Fibonacci sequence is defined recursively by* $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ *for* $n \geq 1$.	
F-BF 3	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.	
F-BF 4 a	Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse. *For example,* $f(x) = 2x^3$ *or* $f(x) = (x+1)/(x-1)$ *for* $x \neq 1$.	
F-BF 4 b	Verify by composition that one function is the inverse of another.	Inverses can be represented graphically as reflections over the line y = x, and as switching (x,y) to (y,x). Students can use LUX to create a coordinate plane, construct an exponential (or other) function, use the pieces to create the inverse, and show that it results in a logarithmic function (or other, based on the original)
F-BF 4 c	Read values of an inverse function from a graph or a table, given that the function has an inverse.	
F-BF 4 d	Produce an invertible function from a non-invertible function by restricting the domain.	
F-BF 5	Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.	
F-LE 1 a (Linear, Quadratic, and Exponential Models)	Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.	Linear functions can be demonstrated in a similar fashion as arithmetic sequences, and exponential functins can be demonstrated in a similar fashion as geometric sequence (see above). Be sure to make the connection between the two concepts.
F-LE 1 b	Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.	
F-LE 1 c	Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.	
F-LE 2	Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).	
F-LE 3	Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.	

F-LE 4	For exponential models, express as a logarithm the solution to ab^(ct) = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.	
F-LE 5	Interpret the parameters in a linear or exponential function in terms of a context.	
F-TF 1 (Trigonometric Functions)	Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.	
F-TF 2	Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.	
F-TF 3	Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosine, and tangent for π–x, π+x, and 2π–x in terms of their values for x, where x is any real number.	
F-TF 4	Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.	
F-TF 5	Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline	
F-TF 6	Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.	
F-TF 7	Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.	
F-TF 8	Prove the Pythagorean identity sin2(θ) + cos2(θ) = 1 and use it to find sin(θ), cos(θ), or tan(θ) given sin(θ), cos(θ), or tan(θ) and the quadrant of the angle.	
F-TF 9	Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.	

LUX BLOX HANDS-ON ACTIVITIES
Aligned with Common Core High School MATH Standards

STANDARD	DETAILS	LUX HANDS-ON ACTIVITIES
GEOMETRY		
G-CO 1 (Congruence)	Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.	
G-CO 2	Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).	
G-CO 3	Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.	Use LUX to construct the given shapes, establish a line of symmetry (or an amount of rotation), and describe the changes from the original object. This activity can be maximized by: a) creating a 2-dimensional object with different colors, to establish points of reference; and b) placing objects on a Cartesian plane to determine changes to x- and y-coordinates after reflections and rotations.
G-CO 4	Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.	
G-CO 5	Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.	
G-CO 6	Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.	
G-CO 7	Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.	
G-CO 8	Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.	
G-CO 9	Prove theorems about lines and angles. *Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.*	Students can construct 2-D figures with parallel lines and transversals; then, students can measure angles and determine which angles are congruent.

G-CO 10	Prove theorems about triangles. *Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.*	Have students construct various 2-D triangles with LUX. Though this does not take the place of a column proof, students can measure sides and angles to show that these theorems are true. Different colors can represent midpoints, right angles, etc. Additionally, students can be challenged to create a triangle (or pair of triangles) contradictory to a theorem, which they will not be able to. For the Pythagorean Theorem, students can use LUX to construct squares with the side lengths of a right triangle, showing that the sum of the areas of the two smaller squares is equal to the area of the largest square.
G-SRT 4	Prove theorems about triangles. *Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.*	
G-CO 11	Prove theorems about parallelograms. *Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.*	Students can construct 2-D parallelograms and confirm theorems. Also, similar to triangles, students can be challenged to contradict a theorem as a reinforcement.
G-CO 12	Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). *Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.*	
G-CO 13	Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.	
G-SRT 1 a (Similarity, Right Triangles, and Trigonometry)	A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.	
G-SRT 1 b	The dilation of a line segment is longer or shorter in the ratio given by the scale factor.	
G-SRT 2	Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.	
G-SRT 3	Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.	Have students use LUX to construct many different triangles with different side lengths, angles, etc. (or create them beforehand). Then have students match triangles that are similar, congruent, etc.
G-SRT 5	Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.	
G-SRT 6	Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.	
G-SRT 7	Explain and use the relationship between the sine and cosine of complementary angles.	
G-SRT 8	Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.	
G-SRT 9	Derive the formula A = 1/2 ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.	
G-SRT 10	Prove the Laws of Sines and Cosines and use them to solve problems.	Students can use LUX to construct non-right triangles to measure the sides/angles and use the Law of Sines and Cosines
G-SRT 11	Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).	
G-C 1 (Circles)	Prove that all circles are similar	Have students use LUX to construct circles of various sizes, and compare them using circle formulas, showing that they are all similar.
G-C 2	Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.	

G-C 3	Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.	
G-C 4	Construct a tangent line from a point outside a given circle to the circle.	
G-C 5	Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector	
G-GPE 1 (Expression Geometric Properties with Equations)	Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.	
G-GPE 2	Derive the equation of a parabola given a focus and directrix.	
G-GPE 3	Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.	Have students construct ellipses using LUX and use measurements to derive equations and/or use formulas to calculate area, perimeter, etc.
G-GPE 4	Use coordinates to prove simple geometric theorems algebraically. *For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, √3) lies on the circle centered at the origin and containing the point (0, 2).*	A 4-quadrant coordinate plane can be created using LUX. Using pieces as points in the coordinate plane, have students derive and use the distance formula to determine the perimeter of objects. In the given rectangle example, place LUX pieces on given points, and determine if a rectangle can be created without moving the pieces.
G-GPE 7	Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.	
G-GPE 5	Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).	
G-GPE 6	Find the point on a directed line segment between two given points that partitions the segment in a given ratio.	
G-GMD 1 (Geometric Measurement and Dimension)	Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. *Use dissection arguments, Cavalieri's principle, and informal limit arguments.*	Many different 3-D objects can be created using LUX. Students can construct regular 3-D objects (cylinders, pyramids, etc.), measure them, and use formulas to calculate the volume. As a challenge, students can construct irregular 3-D objects, and attempt to determine the volume using cross-sections, compositions of various regular objects, etc.
G-GMD 2	Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.	
G-GMD 3	Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems	
G-GMD 4	Identify the shapes of two-dimensional cross-sections of threedimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.	
G-MG 1 (Modeling with Geometry)	Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder)	Have students attempt to recreate real world objects using LUX, and have them record what type of regular 3-D shapes they are using to make the object
G-MG 2	Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).	
G-MG 3	Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).	

LUX BLOX HANDS-ON ACTIVITIES
Aligned with Common Core High School MATH Standards

STANDARD	DETAILS	LUX HANDS-ON ACTIVITIES
STATISTICS AND PROBABILITY		
S-ID 1 (Interpreting Categorical and Quantitative Data)	Represent data with plots on the real number line (dot plots, histograms, and box plots).	Divide a pack of LUX randomly to multiple groups of students, and have students count the number of each color (or shape, etc.). Collect the data for each color (or shape), then have students create plots, calculate statistical measures, etc. for the data.
S-ID 2	Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.	
S-ID 3	Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).	
S-ID 4	Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.	
S-ID 5	Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.	
S-ID 6 a	Fit a function to the data; use functions fitted to data to solve problems in the context of the data. *Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.*	
S-ID 6 b	Informally assess the fit of a function by plotting and analyzing residuals.	
S-ID 6 c	Fit a linear function for a scatter plot that suggests a linear association.	
S-ID 7	Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.	
S-ID 8	Compute (using technology) and interpret the correlation coefficient of a linear fit.	
S-ID 9	Distinguish between correlation and causation.	
S-IC 1 (Making Inferences and Justifying Conclusions)	Understand statistics as a process for making inferences about population parameters based on a random sample from that population.	
S-IC 2	Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. *For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?*	

S-IC 3	Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.	
S-IC 4	Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.	
S-IC 5	Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.	
S-IC 6	Evaluate reports based on data	
S-CP 1 (Conditional Probability and the Rules of Probability)	Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (“or,” “and,” “not”).	
S-CP 2	Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.	Have students choose LUX pieces randomly under certain conditions. For example, if a red is chosen with replacement, choosing another red is independent of the previous choice. However, without replacement, choosing a red is conditional on what was previously chosen.
S-CP 3	Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.	
S-CP 6	Find the conditional probability of A given B as the fraction of B’s outcomes that also belong to A, and interpret the answer in terms of the model.	
S-CP 7	Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.	
S-CP 8	Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.	
S-CP 4	Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. *For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*	
S-CP 5	Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. *For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer*	
S-CP 9	Use permutations and combinations to compute probabilities of compound events and solve problems.	Given a certain number of LUX pieces, determine how many different permutations are possible if all are placed in a certain order. Repeat if all are used, only some are used, etc. Then, repeat for combinations (in which order does not matter).
S-MD 1 (Using Probability to Make Decisions)	Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.	
S-MD 2	Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.	

S-MD 3	Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. *For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.*	
S-MD 4	Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. *For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?*	
S-MD 5 a	Find the expected payoff for a game of chance. *For example, find the expected winnings from a state lottery ticket or a game at a fastfood restaurant*	
S-MD 5 b	Evaluate and compare strategies on the basis of expected values. *For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.*	
S-MD 6	Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).	
S-MD 7	Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).	