Math Integrated STEM Lesson Plan
Measure and Compare the Travel Distance of Balloon Rockets

Chloe Zuo

Endeavor STEM Teaching Certificate Program

Targeted Grade Level: Preschool and Kindergarten

Time Needed: 6-8 Days; 45 minutes in each lesson

Subject Integration: Engineer, Math and Arts

Justification: This is a project developed from Simple Rocket Project on NASA JPL website. Rocket ship is an interesting topic that draws the students' attention. In this project, students will use balloons to make rockets and measure the travel distance of each balloon rocket filled with different amount of air on the string. From each measurement, each student will record the measured Data on the Table and compare them. It is an activity incorporating Math, Engineer and Arts with the essential math questions of "How far can a air-filled balloon rocket travel? How can we make the balloon rocket travel further?" Throughout the activity, students will practice math skills in number counting between 1-100 and develop new math skill in double-digit number writing, using reference objects to measure the measurable attributes and comparing the attributes. At the end of the activity, students will use the data collected from the experiments to determine the correlation between amount of air in the balloon and distances the rockets can travel, thus to answer the questions of the essential questions. To extend the activity further, I would also like to challenge students to utilize the air filled balloon (theory of action and reaction) to create something else to solve a real life problem, and use the number and data measurement to verify their creation.

Material Needed:

. Standard size Oval Shape balloon x 20

. Paper straws x 2 pieces

. A4 paper x 20 plus

. 6-8 meters of Fishing Lines x 2

. Small binder clips x 20

. Scotch tapes x 5 rolls

. Manual Balloon Pump x 1

. Markers and Crayons x 5 sets

. Masking Tape x 2 rolls

. 2 chairs with same height

. Equal size and shape of Duplo blocks x 50

Standards:

Common Core Math Standard

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*.

CCSS.MATH.CONTENT.K.CC.A.1

Count to 100 by ones and 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).

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.

CCSS.MATH.CONTENT.K.CC.C.7

Compare two numbers between 1 and 10 presented as written numerals.

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.

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*.

CCSS.MATH.CONTENT.1.MD.C.4

Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.

NGSS standard

K-PS2-1 Motion and Stability: Forces and Interactions

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.

K-PS2-2 Motion and Stability: Forces and Interactions

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.

K-2-ETS1-1 Engineering Design

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.

National Arts Standards

PreK VA: Cr2.3.pka

Create and tell about art that communicates a story about a familiar place or object.

Measurable Student Learning Objectives: (Webb's Depth of Knowledge 1-3)

1. Students will be able to identify different shapes in a rocket ship.
2. Students will be able to use different shapes to construct a rocket ship with drawing.
3. Students will be able to use number to represent measurable attributes.
4. Students will be able use the reference objects to make measurements.
5. Students will be able to make comparison between two or three number measurements.
6. Students will be able to understand the simple relationship between action and reaction and achieve the change in reaction by making the change in action.
7. Students will be able to use "action and reaction" from an air filled balloon to move different object.

Engaging Context:

Students will need to understand the simple concept of how Rocket ship works. I would first use the Youtube video from National Geography to give students a brief overview about Rocket ship (Appendix C). After viewing the video, I would present students the fact sheet of SLS evolution fact sheet (Appendix A) from NASA website. With each SLS system, students need to identify the shapes that they could find in it, which will help them later to design and draw their own rocket ships.

Data Integration

During the experiments of the balloon rocket ships, students will record data to compare which balloon rocket travels further. After completion of the experiments, I will sort and organize the data together with the students and guide the students to use the data to determine their answers to the essential questions.

Diagnostic Assessment:

Prior the activity, students will need to have a basic or good understanding for following math standard

1. Number counting by one between 1-50
2. Number writing between 1-10
3. Number comparison under 10
4. 2D shapes recognition (Circle, triangle, rectangle, square and trapezoid)

Differentiation of Instruction

During the process of measurement, I will provide jumbo cardboard blocks as a reference objects for measurement if students' counting ability remains between 1-50

There are usually two teachers in one classroom. If there is only one teacher who can guide the lesson procedure, the competition mode during the Exploration can be changed to one by one test mode. Then teacher can skip using the Table in Appendix B and use the Table in Appendix D instead.

There will be student(s) who refuses to participate the activity. Instead of forcing the participation from certain students, teacher can prepare activity in a different station for students to choose.

Lesson Procedures

Day 1: Engage

Introduction and Motivation

Procedure: Part of engaging context of this lesson is visual arts. Before beginning the Arts component, I would like to use a video from a National Geography film on Youtube channel (See Appendix C) to give students a simple overview about Rocket Ship. In this video, students will obtain simple concepts about the structure of a rocket ship, as well as the launching process. This video will connect students to the arts creation process later, as well as the engineer process in the Elaboration section.

Visual Arts Lesson

- Review all the 2D shapes learnt from last month
- Print out Space Launch System (SLS) Evolution facts sheet from NASA website
- Ask students to find 2D shapes in each rocket ship on SLS fact sheet.
- Students start designing and drawing the rocket ship on their own
- Ask students to share with others about the shapes in the rocket ships they design and draw
- Guide students to describe the relative positions of the shapes on the rocket ship drawing
- Make one photocopy of each students drawing and put them aside

Modifications

- Enlarge the scale and print out the SLS Evolution Fact Sheet in Appendix A
- Laminate SLS Evolution print out

- Demonstrate how to find different shapes on a rocket ship by using black marker to draw lines on one rocket ship to make close shapes
- Describe the relative positions of these shapes on the rocket ship to familiarize students with the terms
- Ask students to use similar approach to find the shapes on the rest of rocket ship on the picture

Standard Addressed

Common Core Math Standard

•*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.

Visual Arts Standard

PreK VA: Cr2.3.pka

Create and tell about art that communicates a story about a familiar place or object.

Formative/Summative Assessment

Informal assessment will take place as students find different shapes in the rest of rocket ship on SLS picture, also when students describe the shapes in their own design and drawing. With the description on the relative position of each shapes, I will take anecdotal notes and work with the students as needed.

Resources

- SLS Evolution Fact Sheet (Appendix A)
- Black Markers

- A4 papers
- Printer
- Color markers

Day 2 and 3: Explore

Process of Making

Background:

1. Play the video of Rocket ship launch and ask students how rocket ship lifts off from the ground.
2. Talk about the word of “Propel” with students (Means push and move forward)
3. To understand the word of “propel” better, teacher can ask students do a simple experiment by standing in front of the classroom wall and using their hands to push the wall and see which direction their body will move to
4. Explain to the students when a rocket expels fuel or propellant out of its engine, the rocket moves in the opposite direction. The rocket pushes the propellant out, and the propellant then pushes the rocket upward. The propellant comes out of the engine. This is the “Action”. The rocket lifts off the launch pad in the opposite direction. This is the “Reaction”. In the following experiment, the rocket is a balloon propelled by the escaping air.
5. Demonstrate how balloon can be propelled by air by releasing the nozzle of an inflated balloon
6. Ask students to imagine the air pumped in the balloon would like to “push themselves out” from the balloon, thus they propel the balloon to an opposite direction

7. Explain to them that they will be conducting a simple demonstration or science experiment to show how a rocket lifts off the launch pad. Students, just like the astronauts in space and scientists on Earth, will conduct an experiment to gather information.

Procedure:

1. Set up the experiment by threading the fishing line through the paper straw, then attach each end of the line to the back of two classroom chairs. Pull the chairs apart to stretch the line tightly. Make two of the experiment stations like this with one meter distance in between.
2. Separate classroom of 16 students into two groups. One group of six students will have their balloons inflated with 15 full pumps of air; another group of six students will have their balloons filled with 25 full pumps of air.
3. Two groups of students will line up in front of each station and set to compete with each other and see whose balloon rocket travel further in distance.
4. Print out Table I and distribute it to each group of competitors.
5. Explain Table I to the students briefly.
6. Inflate a balloon and keep it tightly closed with a binder clip while carefully taping the balloon to the straw.
7. Slide the balloon-straw assembly to the middle of the fishing line span.
8. Show students the position of the balloon on the fishing line and ask students which direction the balloon will move towards.
9. Release the balloon and based on the direction of where balloon moves, ask students to determine the starting point.

10. Line up each group of students behind the starting point at the designated experiment station
11. Return the rocket ship drawing to each student and ask them to hold on the drawing while waiting for their turns for the experiment.
12. Have one student from each group stand by for the competition. Teacher will inflate their balloons with pumps of air based on their group and use binder clip to keep the nozzle closed.
13. Each student will stick their rocket drawings on each side of the inflated balloon.
14. Group countdown and students release the balloon, ideally together.
15. After both balloons completely stop, ask students to make physical comparison in the distance the balloons travel.
16. Ask students how we can find out the distance each balloon travels and collect their answers.
17. Ask students to experiment on their answers.
18. If no feasible method proposed by students, teacher can suggest using Duplo blocks as a reference object to make the measurements.
19. One student from the group will hold on one end of the Duplo blocks; another student will keep extending the length by adding more Duplo blocks on the other end until it reaches the point where the balloon rocket stops.
20. Students count on the number of blocks used for the measurements and write down the numbers on the Table created earlier.
21. Students will put a star under the student's name that wins the race.

Modifications:

1. Depending on the distance, teacher may provide students bigger cardboard building blocks to make the measurement to avoid complexity in counting
2. Work with some students individually to connect the balloon to the straw
3. Help students with double digit writing when recording the distance measurement on the Table
4. Use smaller blocks when the remaining distance is shorter than the regular block, and record it differently on the Table

Standard Addressed

Common Core Math Standard

CCSS.MATH.CONTENT.K.CC.A.1

Count to 100 by ones and 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).

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.

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.

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.

NGSS standard

K-PS2-1 Motion and Stability: Forces and Interactions

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.

Formative/Summative Assessments

Informal assessments will take place as I help students during the measurement process. I anticipate some students will need help with the number recording and some will need with the number counting when it is over 20. I will take anecdotal notes and work with students as needed.

Resources

- NASA JPL Simple rocket science procedure (Appendix B)
- NASA Launching Video (Appendix B)
- Measurement Data Recording Table I (Appendix C)
- Standard size Oval Shape balloon
- Paper straws
- 6-8 meters of Fishing Lines
- Small binder clips
- Scotch tapes
- Manual Balloon Pump
- Big Cardboard blocks

- Masking Tape
- 2 chairs with same height
- Same shape but two different size of Duplo blocks

Day 4: Explain

Use Data collected to answer the essential questions.

Procedure:

1. Review the Data recorded on the measurement Table I
2. Draw Table II on the white board. (See Appendix D)
3. Together with students, sort the measurement Data from Table I and transfer the Data to Table II to give students an overview about the measurement recorded from the whole competition
4. Ask students one of the essential questions “How far did your balloon rocket travel?”
5. Refer to Table II, ask students which balloon rockets travelled further? The ones with 15 pumps of air or the ones with 25 pumps of air?
6. Encourage students to draw their conclusion about what we should do to makes the balloon rocket travel even further

Modification:

1. Each student will input his/her number measurement to Table II on the white board
2. Each students will have an opportunity to talk about the distance that their own rocket travelled using the number measurement

3. Each student is encouraged to make comparison by using the number measurement on the Table II
4. Encourage students to reason their answers with numbers
5. Encourage students to use the word of “Propel” when answering questions

Standard Addressed

Common Core Math Standard

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).

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.

CCSS.MATH.CONTENT.K.CC.C.7

Compare two numbers between 1 and 10 presented as written numerals.

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.

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.

CCSS.MATH.CONTENT.1.MD.C.4

Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.

Resources

1. White Board
2. Blake Markers
3. Table II (Appendix D)

Formative/Summative Assessment

When students write the Data on Table II, I will take notes on their writing in double-digit numbers.

When students are describing the distance their rockets travelled, I will take a note on how they relate the number on Table II to the travelling distance of the balloon rocket and use the number in their answers.

When students make comparison, I will take a note about how they use the number to make comparison and how they use comparative adjectives in their answers.

When students draw their conclusion about what makes the rocket travel further, I will take a note on their understanding about the relationship between air and reaction.

Day 5-6: Elaborate

Test our conclusion.

Procedure:

1. Ask students the second essential question: How can we make the balloon rocket travel even further?
2. Collect answers from the students from the question

3. Do another experiment with only one station
4. Students make the measurement on the distance and record on a new Table
5. Verify the measurement Data and compare with the Data from last experiment
6. Ask students to draw their conclusions
7. Encourage student to think what else can be driven (propelled) by the “Balloon”

Modifications

1. Collect answers from all students and allow enough time for each student to verify their answers by doing the experiment
2. Teacher should encourage the students to lead the experiment to verify their answers
3. Collect ideas from students what else can be driven by balloon and provide them the material to work with

Standards Addressed:

NGSS

K-PS2-1 Motion and Stability: Forces and Interactions

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.

K-PS2-2 Motion and Stability: Forces and Interactions

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.

K-2-ETS1-1 Engineering Design

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.

Common Core Math Standard

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).

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.

CCSS.MATH.CONTENT.K.CC.C.7

Compare two numbers between 1 and 10 presented as written numerals.

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.

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.

CCSS.MATH.CONTENT.1.MD.C.4

Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.

Formative/Summative Assessments

I will let students to lead the experiment in this process and collect and record the Data. I will take anecdotal notes and provide assistant only when needed.

Evaluate:

Reflect on all the formative/Summative assessment recorded in the previous 4E and compare to the project objectives set in the beginning.

Procedure:

There are several components to this lesson. Throughout the activities, the teacher will be assisting students and to assess student learning. Anecdotal records will be taken during the other Math and Engineer component. There will be a rubric used to evaluate student work in Math learning and other rubrics for the engineering component.

Standard Addressed

Since there will be both formative and summative assessment, all the standards previously mentioned will be addressed as part of the evaluation

Formative/Summative Assessments

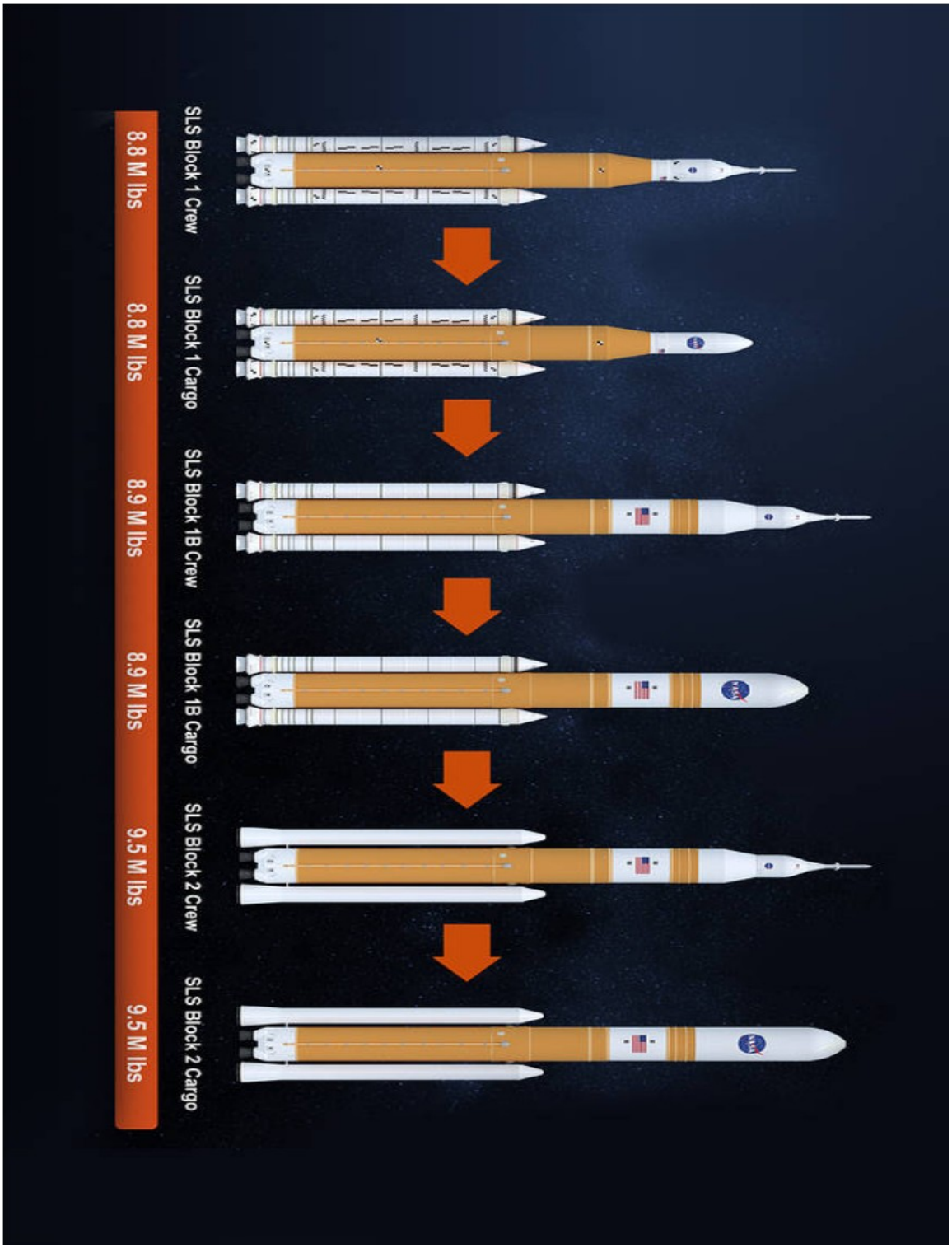
Formative assessments will take place throughout the activities to provide differentiated and ongoing support as needed. Summative assessment will include Math Rubrics and Engineer Rubrics.

Resources

- Math Rubrics (Appendix E)
- Engineer Rubrics (Appendix F)

Appendix A

Source https://www.nasa.gov/exploration/systems/sls/factsheets.html



Appendix B

Table I

Name / **Number of Pumps**	15	25
(exp) Jayden		*(exp)* 60 Duplo Blocks 
(*exp)* Lucy	*(exp)* 40 Duplo Blocks	

Appendix C

Simple Rocket Science *NASA Jet Propulsion Laboratory*
https://www.jpl.nasa.gov/edu/teach/activity/simple-rocket-science/
Video of Rocket Launch
https://www.youtube.com/watch?v=Qm-t0DgBVUs
Rocket 101 from National Geography
https://www.youtube.com/watch?v=1yBwWLunlOM

Appendix D

Table II

Group A (15 Pumps of Air)	**Group B** (25 Pumps of Air)
Travel Distance	Travel Distance

Appendix E

Math Rubric	**1**	**2**	**3**
Counting By One (1-100)	Have difficulty counting the numbers pass 20.	Continue counting forward in the right sequence; only needs reminder and help occasionally.	Can count from 1 to 100 with no interruption.
Number Writing	Write single digit number correctly.	Can write double digit number but confuse with the order of the numbers.	Can write double digit numbers with minimum help from teachers.
Measurement	Understand the concept of using tool to make measurement.	Able to use tool suggested to make measurement on the correct attributes.	Able to make their own approach to make the number measurement on the correct attribute.
Number Comparison	Understand the correlation between physical comparison and number comparison.	Able to make number comparison within 10 and use correct comparative adjectives when describing the comparing result.	Able to make number comparison beyond 10 and use correct comparative adjectives when describing comparing result.
Shapes	Able to find multiple shapes in one object with help from teacher.	Able to draw out the shapes in one object.	Able to use shape to compose their drawing and explain to others.

Appendix F

STEAM Rubrics	1	2	3
Critical Thinking	Not involve in problem solving; getting preoccupied with different activities or subjects.	Engage with the problem and try to improvise the solution copied from others.	Actively looks for ways to solve problems while addressing the criteria and constraints.
Risk Taking	Reserves to try new activities and ideas.	Uses ideas seen before and make few refinements and modifications in the activity.	Takes risks to design something different or unique. May use the materials or apply the criteria and constraints in unexpected ways.
Functionality	Design or solution is irrelevant to the problem.	Design or solution is conventional but solve some of the problems.	Design or solution is conventional but able to make refinement or adjustment on the design alone the process when it is needed.
Persistence in problem solving	Refuse to involve because of being afraid of failing.	Engage with the problem solving process but lost interests when encounters difficulties. Can proceed with the process with teachers' help.	Proceed with the problem solving process despite the difficulties with or without teachers' help.