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Measurement Learning Activities – Grade 6

Measurement at the Track Meet

Strand: Measurement, Grade 6

Big Idea: Attributes, Units, and Measurement Sense

Overview

In this learning activity, students explore estimated and precise measurements in the context of a school track meet. Students participate in a "mini track meet" as athletes and officials and plan two events: the 100 m dash and the long jump. They rotate through each of the 2 events. They record time results to the nearest hundredth of a second, which will require prior experience in working with decimal numbers. Students also need to be familiar with a variety of measurement tools, including stopwatches, trundle wheels, and measuring tapes, and need to recognize the units related to these measurement tools.

Curriculum Expectations

Attributes, Units, and Measurement Sense

Overall expectation

- estimate, measure, and record quantities, using the metric measurement system

Specific Expectations

- demonstrate an understanding of the relationship between estimated and precise measurements, and determine and justify when each kind is appropriate;
- estimate, measure, and record length, area, mass, capacity, and volume, using the metric measurement system.

Measurement Relationships

Specific Expectation

- select and justify the appropriate metric unit to measure length or distance in a given real-life situation

About the Learning Activity

Time: 2 hours

This learning activity is divided into three stages:

- Planning the mini track meet – 40 minutes
- Collecting track meet data – 40 minutes
- Analysing and reflecting on data to make recommendations – 40 minutes

Materials

- **M.BLM6a.1: Recording and Reflection Sheet**
- **M.BLM6a.2: Home Connections**
- chart paper, markers, measurement tools (e.g., metre sticks, measuring tapes, trundle wheel, stopwatch)
- track meet equipment (pylons, whistles or coloured paper or flags to mark start of races, finish line tape/string, jumping pit, rake, clipboards)

Mathematics Language

- elapsed time, measures of length (metres, centimetres), measures of time (minutes, seconds, fractions of seconds), measurement tools (stopwatch, trundle wheel, measuring tapes)

Instructional Grouping: small groups of 4-6

About the Math

Degree of accuracy of track and field events

The 100 m dash is measured in seconds and hundredths of a second. As of 2006:

- The 100 m record for men is 9.77 seconds and is held by Asafa Powell, of Jamaica (2006).
- The 100 m record for women is 10.49 seconds and is held by Florence Griffith Joyner, USA (1988).

The long jump is measured in metres and centimetres. As of 2006:

- The long jump record for men is 8.95 m and is held by Mike Powell, USA (1991).
- The world record for women is 7.52 m and is held by Galina Chistyakova, of the former Soviet Union (1988).

Getting Started

Introduction to students

Describe the following scenario to the class:

"Our class has been asked to assume a leadership role in the Junior Division Track and Field Meet this year. We will be "measurement mentors", helping to plan and execute this year's meet. We will have to advise the teachers who are working on the schedule how much time to allow for the entire track meet, as well as how much time will be required for each of the individual events. We will also need to determine when estimated or precise measurements should be used.

To gather our information, we will plan a two-event track and field meet for our class. We will communicate our findings, and provide a map suggesting locations for each event, to the teachers planning the larger school meet.

First, we will identify all the measurable attributes of the track meet events. Using a brainstorming web, we will record our ideas. The web will be available for your reference as you work through the task. We will have to determine the following:

- When will precise measurements be needed and when will estimates be appropriate?
- How can we justify our decisions?
- How will estimating some of the measurements make our planning more efficient?"

Note to Teacher: While creating the brainstorming web, draw students' attention to the wide range of measurement opportunities at a track meet (pre-event measurement of distances and designation of event space, measuring transition time between events, measuring time required to compete an event, measuring a jump or the time of a run).

Note to the Teacher: Throughout this task, students will be measuring using various tools and competing using athletic equipment. It will be important to review safety routines with the students prior to the track meet.

Working on It

Collecting data

Divide the class into four groups. Explain that each group is responsible for planning and running one event. Half of the students will participate as athletes; therefore, each event will be run twice. Each athlete group will be paired with a track-official group for the first event. At the conclusion of the event, the groups will switch roles and rotate to another event, to work with a new group.

	First Event	**Second Event**
Group A	Long Jump – Recorders	100 Metre – Athletes
Group B	Long Jump – Athletes	100 Metre – Recorders
Group C	100 Metre – Recorders	Long Jump – Athletes
Group D	100 Metre – Athletes	Long Jump – Recorders

Provide students with **M.BLM6a.1** and allow time to collect the tools and materials that will be needed for each event.

Analysing data

Explain that once data collection has been completed, students will form two event expert groups to analyse the data collected for each event. The following key questions (from **M.BLM6a.1: Event Recording Sheet**) will assist students to focus their discussions and record their data analysis:

- What similarities and differences are evident in the data collected by each group? How can we account for the differences?
- What is the average amount of time required for one person to complete your event? Why would this information be important for planning the junior division track meet?
- How might we expect our data to change with greater numbers of students or with younger or less-experienced students participating in the event?

Reflecting and Connecting

Following expert group discussion and analysis, reconvene the class to share findings and determine final recommendations. In preparation for this discussion, divide a piece of chart paper in half, one half per event. The chart will be used to collate the class data and recommendations. Within each half, insert subtitles such as “Measurement tools required”, “Total time required for the event”, “Number of event officials required to run the event”, and add other considerations generated by your class.

Tiered Instruction

Supports and extensions can be beneficial for all students. For any given activity, there will always be some students who require more or less support, or for whom extensions will increase interest and deepen understanding.

Supports for student learning

- Thoughtful attention to student partnering will embed support within the task.
- Provide recording sheets to help students organize data.
- While students progress through the analysis stage of the task, circulate and assess student needs, give feedback, and scaffold instruction.

Extensions

Precision over time. There are certain sports events in which the recording of world record times has become increasingly precise. Have students select a specific sports event and research the historical world records related to that event. Ask them to investigate how the precision of timing has changed and how that precision has affected the number of people holding the world record in the chosen event.

Record Book. Following the completion of the Junior Division Track Meet, have students create a Junior Division Record book based on data collected at each event.

Home Connection

See **M.BLM6a.2**

Assessment

Opportunities for assessment are embedded in this learning task, with many occasions to observe students as they measure and record lengths and discuss the relationship between estimated and precise measurement. Ask: "In our 100 m dash we used precision to hundredths of a second. Why is this precision necessary?"

Rubric

Assessment category	Level 1	Level 2	Level 3	Level 4
Knowledge and understanding				
– estimates, collects, measures, and records data	☐ limited	☐ some	☐ considerable	☐ thorough
– estimates and determines elapsed time	☐ limited	☐ some	☐ considerable	☐ thorough
– organizes and displays measurement data	☐ limited	☐ some	☐ considerable	☐ thorough
– reads, interprets, and draws conclusions from data	☐ limited	☐ some	☐ considerable	☐ thorough
Thinking				
– creates plan of action for collecting data	☐ limited	☐ some	☐ considerable	☐ high degree
– identifies and uses patterns in measurement data	☐ limited	☐ some	☐ considerable	☐ high degree
– makes predictions for patterns in measurement data	☐ limited	☐ some	☐ considerable	☐ high degree
– explores alternative solutions	☐ limited	☐ some	☐ considerable	☐ high degree
Communication				
– explains mathematical thinking	☐ limited	☐ some	☐ considerable	☐ high degree
– communicates using a variety of modes (short answers, lengthy explanations, verbal and written reports)	☐ limited	☐ some	☐ considerable	☐ high degree
– uses appropriate vocabulary and terminology	☐ limited	☐ some	☐ considerable	☐ high degree
Application				
– applies measurement skills in familiar contexts	☐ limited	☐ some	☐ considerable	☐ high degree
– transfers knowledge and skills to new contexts	☐ limited	☐ some	☐ considerable	☐ high degree
– makes connections among concepts	☐ limited	☐ some	☐ considerable	☐ high degree

M.BLM6a.1: Recording and Reflection Sheet

Name of Event: Long Jump (2 jumps per jumper)

What needs to be measured for this event?

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Attribute to be measured: __________

Unit of measurement to be used: _______________

Rationale: ____

Tools selected: ____

Estimated time to complete your event: __________________

Justify your estimate.

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Actual start time for your event: ____________

Actual finish time for your event: ___________

Total elapsed time for your event: __________

How close was your estimate to the total elapsed time?

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Expert Group Discussion Questions:

1. What similarities and differences are evident in the data collected by each group? How can we account for the differences?
2. What is the average amount of time required for one person to complete your event? Why would this information be important for planning the junior division track meet?
3. How might we expect our data to change with greater numbers of students or with younger or less-experienced students participating in the event?
4. What is our final recommendation for the junior division track meet?

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Name of Event: 100 metre dash (2-3 heats [2 runners per heat] and 1 final)

What needs to be measured for this event?

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Attribute to be measured:___________

Unit of measurement to be used: _______________

Rationale: ____________________

Tools selected: ______________

Estimated time to complete your event: _________________

Justify your estimate.

____

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Actual total times for individual heats: ______________________________

While the race itself may be very short, the time involved in setting up the runners, beginning the race, and recording the times will all need to be considered in the length of time needed to run this event. Use this chart to record the actual timing of this event.

Heat	Start Time (watch)	Finish Time (watch)	Elapsed Time
1			
2			
3			
Final			

Actual start time for your event: ___________

Actual finish time for your event: __________

Total elapsed time for your event: __________

1. How close was your estimate to the total elapsed time? ____________________

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2. What was the average heat time (not including final)?

____

Expert Group Discussion Questions:

1. What similarities and differences are evident in the data collected by each group? How can we account for the differences?
2. What is the average amount of time required for one person to complete your event? Why would this information be important for planning the junior division track meet?
3. How might we expect our data to change with greater numbers of students or with younger or less-experienced students participating in the event?
4. What is our final recommendation?

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M.BLM6a.2 Home Connections

Home Connection 1

Dear Parent/Guardian,

Our class has been exploring the relationships between estimated and precise measurements. Sporting events provide one context for examining the need for precision. Help your child to locate sports statistics involving length or time, using a newspaper, sports magazine, or other resource. Ask your child to discuss the degree of precision used in these measurements.

Sincerely,

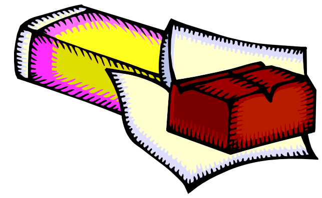
Home Connection 2

Dear Parent/Guardian,

Our class has just held a mini track and field meet for the purpose of investigating measurement concepts. Part of the task involved the analysis of data in order to make recommendations to the staff for the Junior Division Track and Field Meet. Please ask your child to share what he or she learned about the relationship between estimated and precise measurement.

Sincerely,

Packaging the Chocolongo Bar



Strand: Measurement, Grade 6

Big Idea: Measurement Relationships

Overview

In this learning activity students explore measurement relationships between the dimensions and the surface area of rectangular prisms. The purpose of the activity is to identify the chocolate bar format that requires the least amount of packaging. Working with a defined volume, students determine possible chocolate bar dimensions. They use manipulatives to represent possible solutions and communicate their findings. Once they have identified the ideal chocolate bar format, they begin to explore possible packaging formats for Chocolongo bars, using specific dimensions of store shelving displays.

Students need to have an understanding of the relationships between the length and width of a rectangle and its area and perimeter.

Curriculum Expectations

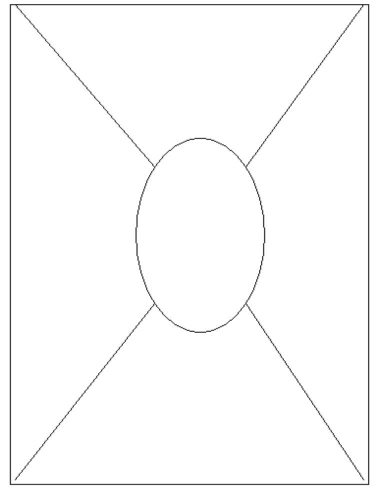
Overall Expectation

- determine the relationships among units and measurable attributes, including the area of a parallelogram, the area of a triangle, and the volume of a triangular prism

Specific Expectations

- determine through investigation using a variety of tools and strategies, the surface area of rectangular and triangular prisms;
- solve problems involving the estimation and calculation of the surface area and volume of triangular and rectangular prisms.

About the Learning Activity



Time

Stage 1 – 80 minutes; Stage 2 – 40 minutes

Materials

- 36 linking cubes per student, markers
- **M.BLM6b.1: Investor Fact Sheet**
- **M.BLM6b.2: Home Connections**
- placemat recording charts (image shown on the right), one per team. Have students reproduce the placemat on chart paper.

Mathematics Language

- area of base, height, surface area, volume

Instructional Grouping: Groups of 4

About the Math

See **Packaging: What 3D Shape Reduces Packaging Waste?**

Getting Started: Stage 1 – Packaging the Chocolongo Bar

Introducing the problem

Describe the following scenario to the class:

"Since the public is becoming increasingly concerned about the impact that food packaging is having on the environment, the president of Chocolate Company X has called a crisis management meeting of her strategy team. Sales of the company's signature chocolate bar, the Chocolongo, have plummeted since a recent article named the company as the largest producer of packaging waste in the chocolate bar industry. This is very distressing news for the company. Before the appearance of the article, the Chocolongo bar had always met with rave reviews because of its unique long, thin shape.

*	*	*	*	*	*	*	*	c	*	h	*	o	*	c	*	o	*	l	*	o	*	n	*	g	*	o	*	*	*	*	*	*	*	*	*

The president wants to continue providing her loyal customers with the same volume of chocolate, while reducing the amount of packaging used. Therefore, her strategy team must determine a different format for the bar. To preserve some similarity between the original Chocolongo bar and the new one, the team leader requires that the new bar have only a single wrapping. No additional sleeve is to be used. The team must provide proof that the selected format will result in the least amount of packaging. A member of the strategy team has asked our class for assistance with this challenging dilemma.

You have 36 linking cubes which represent the total volume of a Chocolongo bar. Your task is to work with the 36 linking cubes to find all other possible formats for the new and improved bar. For shipping and storage purposes, the final product must be in the form of a rectangular prism.

Prompts: How many possible formats do you think will be found for the Chocolongo chocolate bars? What makes you think that?

Place mat

You will be working in teams of four. As a first step, you will each work independently to complete a section of a placemat, noting every possible format and identifying the total surface area. During sharing, you will compare your possibilities with those of your team members and determine which format best meets requirements. Record this solution in the centre of your placemat. You will use your placemat as a reference as you present your work to the other strategy teams and justify your selection.”

Teacher Note: The placemat organizer provides students with a structure for recording individual thinking, and for group consensus built through sharing. If students are unfamiliar with this organizer, it is model this approach before introducing the task.

Working on It: Stage 1 – Packaging the Chocolongo Bar

While students work with their linking cubes and record their individual findings, circulate and encourage mathematical talk. The following questions may be helpful when assessing and promoting purposeful talk:

- How has your group decided to measure the surface area?
- Are there other methods?
- How will your group organize the data?

Teacher Note: As students create models and work to complete individual sections of the placemat, encourage them to engage in purposeful talk. Such talk is essential, as it allows students to express, clarify, and expand on their ideas while they work to solve problems.

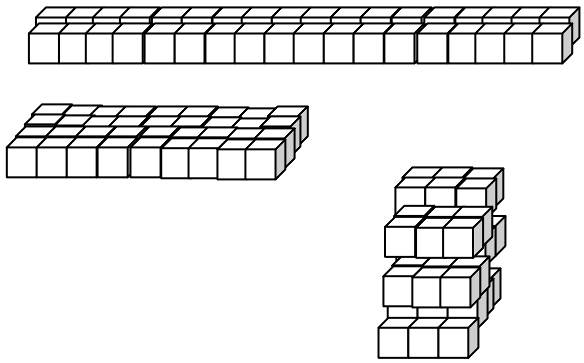
As groups work through the problem, encourage generalizations related to determining surface area for rectangular prisms by asking the following questions or using the prompts:

- How did your group decide which prism used the least packaging?
- Describe the steps your group used to determine how much packaging each prism needed.
- How could you prove that your strategy would apply to any prism?
- If you were given the specific dimensions of a very large prism, such as a rectangular-shaped building, how would you determine the surface area of that prism?
- How many sides of your prisms had the same area? Explain any patterns you noticed in your data.
- Is it possible, using your 36 cubes, to find a prism whose sides all have the same area? Explain your thinking.
- Given a prism where the area of all six sides is equal, how would you calculate total surface area?

STRATEGIES STUDENTS MIGHT USE

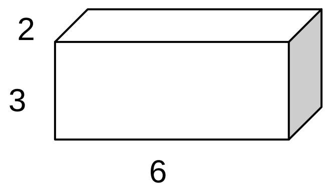
Make a model with concrete materials

Students use 36 linking cubes to concretely represent the Chocolongo bar.



Draw a diagram

They could draw diagrams like the one below and label the dimensions.



Use the guess-and-check method

Once students have generated two or three possible formats, they might guess and check to direct their thinking about possible dimensions.

Make a table

Students could create a table to record dimensions of possible chocolate bars and the areas of each face of the rectangular prism.

	Length	Width	Height	Area of face 1	Area of face 2	Area of face 3	Area of face 4	Area of face 5	Area of face 6	Total Surface Area
Bar 1	4 units	9 units	1 unit	36 units²	4 units²	36 units²	4 units²	9 units²	9 units²	98 units²
Bar 2										
Bar 3										

Teacher Note: As students experiment with three-dimensional figures, they notice that the more cube-like the package (with the same volume), the more efficient the packaging. This realization should lead them to conjecture that although they cannot construct a cube with the materials provided, a cube would be the most efficient shape. It is beneficial to encourage this type of thinking. One way to proceed is to use technology. A spreadsheet can be prepared on which students can enter different dimensions, after which the volume and surface area are calculated automatically. Another way would be to try a problem with a volume that is a perfect cube – such as 64 $cm^{3,}$ where it is possible for students to create a cube without using decimals ($4 \times 4 \times 4 = 64$).

Teacher Note: Prompt students to consider whether the name Chocolongo is still appropriate for the new design of the chocolate bar.

Reflecting and Connecting: Stage 1 – Packaging the Chocolongo Bar

Following group-work time, reconvene the class for a whole-group discussion. Have students post their placemats around the classroom. Invite them to participate in a “2 Stay 2 Stray Gallery Walk”, in which teams designate two people to stay with the placemat to explain their solution and strategy to other teams while the other two members view other placemats and listen to the solutions and strategies explained by other teams. Allow time for home-group discussion following the “Gallery Walk”. Team members who “strayed” are responsible for explaining other group strategies to those who “stayed”. Teams may decide to amend their solution based on this additional information. Invite the class to consider all the solutions to the problem and identify which solution best meets the criteria. Discuss what can be generalized regarding the relationship between surface area and volume. You might ask students to reflect on their learning by writing in their mathematics journal.

Journal Prompts:

- When volume remains constant, what is the impact on the surface area of a rectangular prism when the dimensions change?
- Why would it be important for companies that sell packaged products to know about these relationships?

Getting Started: Stage 2 – Shelf Space

Explain the following scenario to the class:

"Boxes of Chocolongo bars are located on shelves in grocery stores, corner stores, gas stations, and big chain stores all over Ontario. Chocolongo bar displays are allotted space measuring 10 units deep x 5 units high x 36 units across.

The original Chocolongo bars were sent in packets of 50. There were 10 Chocolongo bars in each layer and 5 layers in each box. This format made restocking shelves a manageable task. The sales associates are asking for an estimate of how many Chocolongo bars will now be in one packet. Estimate how many new Chocolongo bars can be displayed using the same volume of space.

- Do you think it will be possible to use all the space with the new Chocolongo format? Justify your thinking.

The president will need exact information for her report to investors. Record your estimate for the president on the formal fact sheet **M.BLM6b.1**."

Working on It: Stage 2 – Shelf Space

Have students use a model of their solution as a reference for determining how Chocolongo bars will be displayed in stores. The challenge is to find a way to display the greatest number of Chocolongo bars within the constraints of the existing display space (10 units deep x 5 units high x 36 units across). Ask:

Teacher Note: Students can draw a rectangle to represent the width and length of the shelf, and can use their blocks to explore how the chocolate bars might fit on the shelf.

- How will you represent the existing shelf space?
- How does the placement of the Chocolongo bars on the shelf affect how much of the space is used?
- How many possible placements would there be for the chocolate bar format our class has selected?

Teacher Note: Students may attempt to answer this question by determining the total volume available for display (10 units x 5 units x 36 units) and dividing that by the volume of the Chocolongo (36 units^3). Ask prompting questions that will guide them to recognize that while there might be available volume, it may not be useable. The Chocolongo bar is a solid and has to remain intact.

Strategies Students Might Use

Make a model with concrete materials

In order to visualize this problem some students may need to delineate a space equal to that of the shelving volume available and use concrete materials to fill that space. Students choosing this strategy will require additional manipulatives.

Draw a diagram

Students may choose to draw the shelf and layers of chocolate bars. Prompt them to consider all the possible ways of placing the Chocolongo bar in the space.

Teacher Note: The base the student chooses, and its position on the shelf, will influence how many Chocolongo bars will fit on the shelf and how much space will be unusable.

Reflecting and Connecting: Stage 2 – Shelf Space

Observe students as they work. Identify groups you will ask to share their solutions and strategies with the class. Include a variety of solutions and formats. Sharing opportunities that reflect a wide range of efficiency, strategy use, and solutions allow students to focus on process. Reflecting on less-efficient strategies or partial solutions allows students to identify gaps in reasoning, thereby gaining a deeper understanding of the problem.

Tiered Instruction

Supports and extensions can be beneficial for all students. For any given activity, there will always be some students who require more or less support, or for whom extensions will increase interest and deepen understanding.

Supports for student learning

This learning task provides many opportunities for differentiated instruction; it requires students to make choices and it promotes cooperative learning. Students are able to select personally meaningful strategies and materials and to represent their ideas in a variety of formats. Instructional groupings promote purposeful mathematics talk as students share their problem-solving approaches and solutions and justify their reasoning. As students progress through this task, you have opportunities to circulate and assess student needs, provide feedback, and scaffold instruction. Encourage journalling by providing sentence starters, checklists, and prompts or picture cues. You may also scaffold this task by giving careful consideration to the creation of student groupings. Consider "chunking" this task, providing time accommodations, and giving guiding instruction as needed.

Extensions

Shipping container. Extend this problem by having students consider what size container would be required to ship a large quantity of boxes. For example, ask:

- What size container would be required to ship 64 boxes of the best design of Chocolongo bars?
- Working with the same best design, can you think of other possible dimensions for a container of this size?

Ratio of dimensions. Bring various packages to the classroom and challenge students to determine the ratio between the height and width of the packages' dimensions. Direct them to look for patterns in the data.

Home Connection

See **M.BLM6b.2**.

Assessment

While students are working on this task, you can effectively observe and assess math talk and strategy use. Ensure that students are given the opportunity to reason and to record their work in personally meaningful ways.

Focus your observations in order to assess how effectively students:

- determine surface area of rectangular prisms;
- estimate and calculate surface area and volume of rectangular prisms.

Using probing questions, assess the depth and breadth of understanding that students bring to the task, and invite students to explain and justify their thinking. Ask:

- Do you have a strategy for identifying all the possible chocolate bar formats?
- How will you know when you have found all the possibilities?
- How are you planning to record your work?
- How will you know that you have included the area of all surfaces in your calculation of total surface area?
- What strategy are you using to ensure that your measurements of surface area are accurate?
- What patterns are evident in your data?
- Based on the formats that you have created and the surface area measurements that you have recorded, can you predict the shape of chocolate bar that the president will likely want to use? What is leading you to this prediction?

Once students have completed their work, use the following assessment prompts:

- We solved the problem by…
- The steps we followed were…
- We've shown our thinking by…
- Our strategy was successful because…
- The most important thing we learned about the relationship between volume and surface area is…

Rubric

Assessment category	Level 1	Level 2	Level 3	Level 4
Knowledge and understanding				
– makes use of relationships among units	☐ limited	☐ some	☐ considerable	☐ thorough
– calculates surface area and volume of rectangular prisms	☐ limited	☐ some	☐ considerable	☐ thorough
– constructs tables, graphs, and diagrams to represent measurement data	☐ limited	☐ some	☐ considerable	☐ thorough
Thinking				
– creates plan of action for analysing measurement data	☐ limited	☐ some	☐ considerable	☐ high degree
– identifies and uses patterns in problem solving	☐ limited	☐ some	☐ considerable	☐ high degree
– explores alternative solutions	☐ limited	☐ some	☐ considerable	☐ high degree
Communication				
– explains mathematical thinking	☐ limited	☐ some	☐ considerable	☐ high degree
– communicates using a variety of modes (short answers, lengthy explanations, verbal and written reports)	☐ limited	☐ some	☐ considerable	☐ high degree
– uses appropriate vocabulary and terminology	☐ limited	☐ some	☐ considerable	☐ high degree
Application				
– applies measurement skills in familiar contexts	☐ limited	☐ some	☐ considerable	☐ high degree
– transfers knowledge and skills to new contexts	☐ limited	☐ some	☐ considerable	☐ high degree
– makes connections among concepts	☐ limited	☐ some	☐ considerable	☐ high degree

M.BLM6b.1 Investor Fact Sheet

Important Considerations	Original Chocolongo Bar	New and Improved Chocolongo Bar
Dimensions		
Surface Area		
Volume		
Number per shelving display		

Based on the charted data, how much will the packaging be reduced with the new and improved Chocolongo Bar?

Qualities of our new Chocolongo Bar that we intend to highlight in our advertising campaign:

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M.BLM6b.2 Home Connections

Dear Parent/Guardian,

Our class has been learning about the relationship between surface area and volume.

Home Connection 1:

Have your child demonstrate how to calculate the volume and surface area of a rectangular package in your home. Work with your child to list the different dimensions possible for a package of this volume.

Ask:

- Which dimensions result in the least amount of surface area?
- Is there a pattern?

Home Connection 2:

Using the list of possible dimensions from Home Connection 1, help your child investigate other packages in your home.

Ask your child:

- Do companies generally use efficient packaging shapes?
- If a cube is the most efficient rectangular prism, why do you think companies sell their products (e.g., cereals or pancake mix) in other shaped boxes?

Sincerely,