Lesson Research Proposal for Chicago Lesson Study Conference, 5th Grade, Unit Conversions

For the lesson on May 11, 2017

Helen C. Peirce School of International Studies, Vivian Leventis’ class

Instructor: Lori Zaimi

Lesson Research Proposal developed by: Lisa Lambro, Vivian Leventis, Haneefa Muhammad, Katherine Nigh, Michael Richie and Lori Zaimi

# Title of the Lesson: Measuring & Expressing Capacity with Liters and Milliliters.

# Brief description of the lesson

Students will measure a predetermined amount of water using Liter and Milliliter graduated cylinders, and express the amount in just liters. Students may use a proportional number line (also known as double number line) to determine how to express the amount of water in just liters. Students will use the base ten decimal system to express the amount to 3 decimal places.

# Research Theme

As a Primary Years Programme (PYP) International Baccalaureate (IB) Candidate school, Peirce teachers are investigating best practices and strategies to implement inquiry-based learning in the mathematics program. We are at the very beginning stages of implementing the teaching through problem solving process to help increase student inquiry in the math classroom – we want students to discover mathematics without a direct instruction/top down approach. In this particular unit, we want students to explore unit conversions without directly telling students to use a conversion chart.

# Goals of the Unit

1. Students will understand how to choose an appropriate measurement tool (graduated cylinder, yard or meter stick, ruler, etc) when working in different measurement contexts (weight, capacity, distance).
2. Students will determine when larger/smaller measurement units are appropriate to use when expressing values for measurement (gram vs kilogram, milliliter vs liter, meter vs kilometer, etc).
3. Students will understand the proportional relationship between units (ex: 1L=1,000mL) and be able to work within conversion systems using proportional reasoning.

# Goal of the Lesson

Students understand that a quantity measured in L and a quantity measured in mL can be combined by considering mL as thousandths of a L and expressing the mL quantity as a decimal. E.g. 1L and 138 mL = 1L + 0.138L = 1.138L

# Relationship of the Unit to the Standards

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| 1. **Related prior learning standards** | 1. **Learning standards for this unit** | 1. **Related later learning standards** |
| 1. 4.MD.5 Express a fraction with denominator 10 as an equivalent fraction with denominator 100, and use this technique to add two fractions with representative denominators 10 and 100. (e.g. express 3/10 as 30/100 and add 3/10 + 4/100 = 34/100 2. 4.MD.6 Use decimal notation for fractions with denominators 10 or 100. For example, rewrite 0.62 as 62/100; describe a length as 0.62 meters; locate 0.62 on a number line diagram. | 1. 5.MD.1: Convert like measurement units within a given measurement system. Convert among different-sized standard measurement units within a given measurement system (e.g. convert 5 cm to 0.05 m) and use these conversions in solving multi-step, real world problems. 2. 5.NBT.3a: Read, write, and compare decimals to thousandths. | 1. 6.NS.1 Apply and extend previous understandings of multiplication and division to divide fractions by fractions. Interpret and compute quotients of fractions, and solve word problems involving division of fractions by fractions, e.g., by using visual fractions models and equations to represent the problem. *For example, create a story context for (⅔ divided by ¾) and use a visual fraction model to show the quotient.* |

# Background and Rationale

The 5th grade classroom has 31 students; 2 students have a 504 plan which addresses allergies and extra time on tests. There are no students with an IEP, no English Language Learners as identified by state identification, 3 students score below the 21st percentile, 3 between 21st and 40th percentile, 4 students are between 41st and 60th percentile, 13 students between the 61st and 80th percentile and 8 students above the 80th percentile. This classroom is an example of a “high scoring” classroom on standardized tests; however, students still have difficulty with understanding unit conversions in both the Metric and US Customary systems of measurement. We originally discussed a lack of knowing how to convert within the customary and metric systems appropriately. Through further discussion and research, we determined that many of the U.S. curricula (at Peirce we use *Go Math* but we also looked at *EngageNY*) use conversion tables as the place to begin teaching about measurement, and standardized tests typically provide a conversion table that students are able to use. This led us to determine that there was a greater underlying issue rather than the lack of basic recall knowledge of the customary system. For this reason, we decided to focus our unit on a hands-on, inquiry based approach to develop student understanding of the values of measures and how they relate proportionally.

It is our belief that students have not had enough experiences to ensure a conceptual understanding of the various attributes of measuring – using a scale to measure mass, a graduated cylinder to measure capacity and other real applications of measurement – learning by doing, not just by reading about conversions and trying to apply. Because of the lack of a familiar context in measuring, students have difficulty choosing the appropriate unit of measure in addition to finding the actual measure. Throughout this unit, we will provide students with a hands-on approach with the goal of creating memorable real world connections which we hope will lead to stronger retention and application of the proportional relationships between measurements as opposed to a memorization-based approach, *i.e*. conversion tables.

When developing the unit, we ran into many questions which pushed us in thinking about the units that we teach leading up to this unit. The Japanese texts do not teach measurement in isolation, measurement is embedded in multiple content areas, which is vastly different than the Go Math Curriculum. In planning, we were faced with the challenges of students needing to understand decimals, base 10, proportional reasoning, choosing measurement tools and using them to measure and write numbers. Given that this research lesson is taking place during the later half of the final quarter of school, we struggled with how much do we go back and review before moving forward in this unit. Do we review proportional reasoning, decimal writing, base 10, etc? We know that there will still be gaps in students understanding even after this unit – we are aware that we need to revisit the order of topics that are taught and the depth of knowledge that students gain as we work to restructure our math program.

During our planning process, we decided to focus on two Standards for Math Practice: “Reason Abstractly and Quantitatively” and “Look for and express regularity in repeated reasoning”. We want students to have a stronger understanding of the proportional relationships in measurement units.

# Research and Kyozaikenkyu

Our current mathematics series, Go Math (Houghton Mifflin Harcourt, 2012) uses a very direct table approach to teaching measurement, focusing on conversions without context.

From Van De Walle, Karp and Bay-Williams, we deemed the following findings relevant:

* Attributes (weight, volume, length, area) should be understood first
* Needs based measurement is helpful to understand
* Measurement should be integrated as opposed to teaching in isolation
* Front load the teaching of the concepts to applied throughout the math curriculum
* Connecting measurement processes through the use of tools
* Measurement is a number that indicates a comparison between the attribute of an object and the same attribute of a given unit.
* Knowing basic conversions is typically only useful when standardized testing.

The Sansu Math Curriculum integrates the teaching of measurement throughout the curriculum and measurement is not taught in isolation nor are conversion tables used as a primary source of teaching.

# Unit Plan

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| **Lesson** | **Learning Goals and Tasks** |
| Pre-Unit | Several lessons with double number lines, focus on proportional reasoning, see page 26 in 4th grade PDF Japanese Text |
| 1  2 days | Goal: Students are able to identify which unit would be the most appropriate to measure various objects (liquid in a bottle, length of a board, weight of a chromebook)  Students are able to read measurements on objects (ex: bubbles = 118mL, 1.25L bottle of pop)  Familiarize students with measuring using graduated cylinders and reading/writing the measurement. Understand that 1L=1,000mL |
| 2  Research Lesson | Students understand that a quantity measured in L and a quantity measured in mL can be combined by considering mL as thousandths of a L and expressing the mL quantity as a decimal. E.g. 1L and 138 mL = 1L + 0.138L = 1.138L  Task: Express the amount in the pitcher using L as the unit (1.138 L) |
| 3 | Goal: Students will learn how to read and write decimal numbers up to the 1/1000s place, and they will understand how to express decimal numbers.  Task: Let’s investigate the number 1.435. |
| 4 | Goal: Students understand the relationship between 1, 0.1, 0.01, and 0.001, as well as the structure of decimal numbers.    Task: What fraction is 1 of 0.1? Also, what fractions of 1 are 0.01 and 0.001? |
| 5 | Goal: Students understand the mechanism of determining the place values of decimal numbers.  Task: Let’s investigate the structure of 2.345? |
| 6 | Goal: Students understand the relative sizes of decimal numbers as well as their size relationship.  Task: How many 0.01s together make 2.45? |
| 7 | Goal: By viewing decimal numbers in a variety of ways, students acquire a rich sense of decimal numbers.  Task: Let’s investigate the number 2.45 |
| 8 | Goal: Students understand numbers that are 10 times a decimal number and 1/10 of a decimal number.  Task: There is 1.75 L of water in a water bottle and 2.64 L in a kettle. How much water is there altogether? |
| 9 | Goal: Students understand how to do subtraction calculations of decimal numbers involving the 1/100s place and 1/1000s place using the algorithm, and they can carry out such calculations.  Task: There was 3.64 L of water in a container. We used 2.76 L of it. How much water is left? |
| 10 | Goal: Students check and reinforce their understanding of the math content in this unit.  Task: Mastery Problems |

# Design of the Unit and Lesson

Students coming into this unit have struggled with multiplying and dividing by powers of 10, even though it is addressed at the beginning of every *Go Math* Chapter. Prior knowledge needed includes decimal place value (tenth, hundredth, thousandth). Students also need to work with different sizes of graduated cylinders so that they are familiar with the materials before the research lesson. Before this unit, teachers have introduced proportional number line diagrams (double number lines), and students have practiced working with those diagrams.

The beginning of the unit focuses on real world experiences – measuring smaller amounts of liquids in mL and then measuring amounts greater than a liter. It moves into other measurement systems – grams, meters, etc.

# Research lesson

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| Steps, Learning Activities  Teacher’s Questions and Expected Student Reactions | Teacher Support | Assessment |
| Introduction   1. What did we do in our last lesson together? | 2. Have an anchor chart from the lesson before and reference them there. 3. Have the bottle of water that was used to measure the day before. 4. Reference the responses from Altin and Piper: Decimals help with less than 1L (Piper) and 245mL is .245L (Altin) | 1. Do students remember that we used a graduated cylinder to measure the amount of liquid in mL in a small bottle? 2. Do students recall use of the proportional number line? 3. Do students remember that 1L=1,000mL? 4. Do students remember that 245mL was also written as .245L? |
| Posing the Task   1. Here is a different container of water – do you think that there will be more than or less than 1 Liter of water? How can we find out? 2. How much water is in the container? Write your answer in Liters. | 1. Students will have 1 pre-measured container of 1,138 mL of water with the amount to be discovered by students. 2. There will be a table of graduated cylinders in varying sizes available for students to choose from when measuring. 3. Students will be given a container of water, extra containers will be on hand in case of major spills. | 1. Do students understand the task? 2. Do students know how to choose and use the appropriate tools for measuring? 3. Are students able to accurately read the scale on the graduated cylinder? 4. Are students able to write the answer in Liters? |
| Anticipated Responses   1. There will be multiple variations of reading the numbers due to water loss, container holds 1.138mL of water, but we anticipate that some students may read numbers above/below that. 2. St1: uses incorrect units to describe the amount measured 3. St2: fills the graduated cylinder to the top and says that it is about 1000 mL or some variation of the unit 4. St3: Measures 1 liter and then measures the remaining amount in the mL graduated cylinder, says that it is 1 liter and 138 mL 5. St4: Measures correctly and is able to express in liters only – 1.138L 6. St5: Measures correctly and is able to express in mL only – 1,138ML 7. St6: Measures correctly and writes the measure as 1 and 138/1000 mL or L 8. St7: water levels are off when pouring water in, some students come up with a number slightly above or below 1.138L (ex: 1.134, 1.131, etc) 9. St8: measures accurately and writes 1L and .138L and then combines to write 1.138L |  |  |
| Comparing and Discussing   1. Ask each group what their answer is and write it on a post-it then place it on the board. 2. Which answer is correct? How do you know? What did our question ask us to do when writing the number? 3. Focus on these responses if class is unable to debate: 4. St3: Measures 1 liter and then measures the remaining amount in the mL graduated cylinder, says that it is 1 liter and 138 mL 5. St3/St5: Can we write that number using liters only? What part of a liter is 138 mL? | 1. What are the ideas to focus on during the discussion? 3. Why would we measure using L vs mL? Measuring in small amounts mL is appropriate but measuring in larger amounts L is more appropriate. 4. Focus on the difference of how they got from 1,138 mL to 1.138 L – proportional number line. 5. St1: Have student re-read the question and look at the container for the unit of measurement that is being used. 6. St2: How can we measure accurately, what tools do we have available to help us? 7. St4: How did you get your answer? 8. St6: Can we write that another way using decimals? | 1. Are students able to read the measurement tools correctly and defend why their answer is correct by using Liters or mL in their answer? 2. Do students connect that they are dividing by powers of 10 moving from mL to L. 3. Do students see the equivalency between 1.138L and 1,138mL? |
| Summing up   1. Sum up based on students discussion. 2. Focus on how we expressed the amount of water that was 1L and a little more. |  | 1. Does the summary accurately represent the students’ view of the lesson? 2. Do students understand that when we have small amounts of liquid, measuring in mL is appropriate but when we have larger amounts of liquid, L is appropriate. |
| Student Reflection/Exit Slip   1. What did you learn from today's lesson? 2. What is a question that you have after today’s lesson? 3. Write 3,586mL using only liters 4. Write 2.586L using only milliliters |  |  |

# Evaluation

* Did the lesson support student inquiry?
* Did students understand the proportional relationship between numbers and that they can write measurements using different units, ex: 1,138mL is the same thing as 1.138L?
* Was the proportional number line used by students? Was it needed?

# Board Plan & Seating Chart (TO BE COMPLETED)

**Prior Lesson**





