Unit Overview: Bottle Flipping

Inquiry Question:
What fraction of a bottle needs to be filled with water to be the best for bottle flipping?

Summary of learning goals

This unit in the Special Topic **Mathematical Inquiry into Authentic Problems** uses content in unit fractions and collection of categorical data to deepen students' understanding and confidence working with ways to collect and organise data as they determine the best water level to fill bottles so they will flip upright. The 4 lessons provide opportunities for students to apply their understanding of fractions as they mark them on a bottle. Fractions of height and of volume can be contrasted. Students identify issues for making a fair test and for collecting categorical data and organising it. They create and interpret simple column graphs to answer the inquiry question. Students record their mathematical thinking about the data they collect as they work through iterations to get good data. Students work systematically and record (e.g. photograph) their progress through each of the Phases. They will see the importance of planning methods of data collection and considering what to record. Students justify their solution to the inquiry question using evidence that shows the mathematical thinking and reasoning used to determine what fraction of their bottle should be filled.

Australian Curriculum: Mathematics (Year 3)

ACMNA058: Model and represent unit fractions including 1/2, 1/4, 1/3, 1/5 and their multiples to a complete whole.
ACMMG061: Measure, order and compare objects using familiar metric units of length, mass and capacity.
ACMSP068: Identify questions or issues for categorical variables. Identify data sources and plan methods of data collection and recording.
ACMSP069: Collect data, organise into categories and create displays using lists, tables, picture graphs and simple column graphs, with and without the use of digital technologies.
ACMSP070: Interpret and compare data displays.

Summary of lessons

Who is This Unit For?

This sequence of lessons is for students in Year 3 who are building an understanding of fractions. The set of fractions to be used can be determined by the teacher or the students, although these lesson plans are written around using unit fractions (1/2, 1/3, 1/4, 1/5, 1/8, 1/10). It builds on earlier experience in recognising and interpreting common uses of halves, quarters and eighths of shapes and collections. Students will need to be able to find a fraction of a quantity, either by physical division or by calculation. Knowledge of millilitres is used. The lessons build on earlier experiences of data collection and representation and focuses students on interpreting data displays and assessing their appropriateness in answering the Inquiry question.

We value your feedback after these lessons via https://www.surveymonkey.com/r/CV2TXTT

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Lesson 1: Discover Phase

Students are introduced to the context and the inquiry question: "What fraction of a bottle needs to be filled with water to be the best for bottle flipping?" They brainstorm what they know about bottle flipping and see it done. The mathematics of fractions is reviewed and students describe the amount of water in the bottles using fractions. Students experiment informally with flipping different bottles and various amounts of water.

Lesson 2: Devise Phase

Students begin recording a plan to answer the inquiry question. They determine what "best" means in the inquiry context, acknowledging that a fraction of water in the bottle is a key consideration. Students practice flipping bottles with various amounts of water, and in different size and shape bottles, before seeking feedback on their initial ideas for a fair test and for systematic recording of results.

Lesson 3: Develop Phase

Students use feedback to adjust and improve existing evidence before continuing their data collection and systematically organizing their evidence.

Lesson 4: Defend Phase

Students prepare their justified solution to the inquiry question and provide feedback on others' presentations, focusing on the mathematical evidence used. Students reflect on the feedback given to determine what they did well and what they could do to improve their results and presentation.

Reflection on this sequence

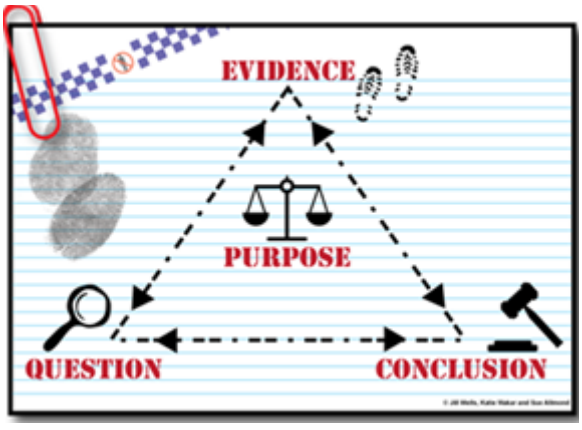
Rationale

This unit requires students to use a problem-solving approach to answer the inquiry question. The mathematical focus for students is in making connections with the fraction of water and the size of a bottle. To convince others, students will gather systematic evidence as they work towards a solution and communicate orally the thinking and strategies to justify their answer.

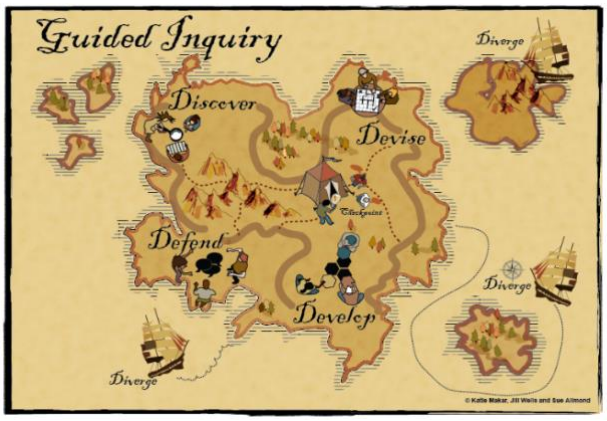
This unit offers a popular real-life game as a context for inquiry. To understand how to successfully flip bottles of water, students need to make connections between unit fractions and amounts of water in a chosen bottle and record their findings to convince others that their chosen data display is an appropriate representation to support the solution.

Throughout the inquiry, students use evidence they have gathered to support, justify and convince their peers that their solution answers the inquiry question. Lessons stress the need to gather mathematical evidence and the importance of explicitly connecting the inquiry question, the evidence and the conclusion, as shown in the Evidence Triangle (below, left). The unit is structured around the 4D Guided Inquiry model (below, right), which guides the teacher to support and scaffold students through each phase.

Further information is given in the *Mathematical Inquiry into Authentic Problems Teachers' Guide*.



The Evidence Triangle



4D Guided Inquiry Map

reSolve Mathematics is Purposeful

reSolve relies on the Mathematical Proficiencies of the Australian Curriculum: Mathematics to apply mathematical ideas and practices to everyday problems in authentic ways. This creates connections to deepen students' understanding.

Understanding: Students apply their understanding of fractions as they mark unit fractions on a bottle. They identify issues for data collection and representation to answer the inquiry question.

Fluency: Students accurately measure unit fractions on their bottles.

Problem Solving: Students use an inquiry approach to find the best fraction of a bottle to fill with water for it to flip successfully. The notion of a fair test can be highlighted.

Reasoning: Students provide sufficient, appropriate evidence to convince others that they have the best unit fraction of water in their bottle to successfully flip it so it lands upright. They analyse the reasoning of others, seek clarification where required and explain their thinking when challenging ideas or mathematics used.

reSolve Tasks are Challenging Yet Accessible

Using popular real-life game as a context for inquiry makes it attractive to a wide variety of students. This inquiry provides students with opportunities to work collaboratively in mixed ability groups, to make connections between the fraction of water and the size of a bottle using their existing knowledge of fractions. Regular class sharing allows groups to share their progress, any challenges they are facing and to see how others are working on the problem. Sharing presents groups with other ideas they could build on and guides them towards their next step. Teachers can use the opportunities presented in the sharing sessions to focus students on evidence, encourage further iterations to adjust the water level, question the mathematical thinking or to challenge groups to consider options that are more complex. As groups work towards a solution, teacher prompting, through open questioning, can support groups to embrace setbacks as challenges that can be overcome.

reSolve Classrooms Have a Knowledge Building Culture

The inquiry addresses a knowledge building culture through requiring students to take on many roles usually undertaken by the teacher. In their groups, students collaboratively plan the pathway they will use to answer the inquiry question and negotiate between their own ideas and understandings and those of others. During the Devise Phase, students acknowledge that all ideas, including those that are unformed and un-evidenced, can be improved on through the giving and receiving of constructive feedback. Expecting all students to be active listeners and contributors who share ideas, build on others' ideas, seek clarification where required, and question or challenge ideas respectfully, ensures all students contribute towards the advancement of knowledge in the classroom and provides opportunities for them to build, reconceptualise, recreate and extend mathematical concepts. The expectation that all group members will contribute in some way to preparing and sharing the solution, provides each student with an opportunity to demonstrate their ability to reason and justify and develop conceptual understanding.