Science Unit: *Matter*

Lesson 12: *Combining solids and liquids: Free experimentation*

School Year:	2012/2013
Developed for:	Sir Wilfrid Laurier Elementary School, Vancouver School District
Developed by:	Ingrid Sulston (scientist); Patricia Ellis and Barbara Duncan (teachers)
Grade level:	Presented to grades 1-3; appropriate for grades K – 4 with age appropriate modifications
Duration of lesson:	1 hour and 30 minutes (minimum)

Objectives

1. Experience free, unguided investigations of a collection of materials, to independently discover patterns and phenomena.
2. Practice group reporting of observations, and uncritical discussions of similar and differing results.
3. Practice group problem solving and critical thinking to design further experiments.
4. Gain a deeper understanding of mixtures, solutions, floating and sinking, and other ways that solids and liquids combine.

Background Information

Free experimentation is an often overlooked method of science teaching. Championed by Selma Wasserman and George Ivany in their “Play, Debrief, Replay” format (ref. 1 and summarized below), it promotes exploration, inquiry, self confidence, curiosity and excitement of science. Students often naturally make predictions, set up controls and develop hypotheses, as they realise their need in their investigations, even if they do not know their terminology. With some encouragement to record results and to focus in on one problem, students can rapidly become quite sophisticated investigators.

Unfortunately, free experimentation is not often done in classrooms, perhaps because it can be messy, the results are unknown or the students get quite loud with excitement. These of course can all be overcome, and I have found myself relaxing as I try this method more often.

A collection of common solids and liquids (many from the kitchen) provide a complex and fruitful topic to explore by free experimentation.

Summary of Play-Debrief-Replay model of science teaching

Adapted from refs. 1 and 2.

Set-up

Set up enough stations so that students will not be crowded while working. Tell the students how much time you will give them for a particular centre (often 15-20 minutes, longer if the students are engaged). You can direct the students to investigating a particular aspect of the materials, or leave it wide open to any (reasonable and safe) investigations. In this lesson students were directed to mix materials together in Activity 1, and investigate sinking and floating in Activity 2.

Stage 1: Play

This is the time when the students freely experiment (or “play”) with the materials. Students can work together if they are all engaged in problem solving. The teacher circulates and is responsive to questions but does not make evaluative comments or direct the the students’ investigations in any way. If students are “stuck” and want help through a problem, the teacher can respond with open ended questions based

on good scientific method: maybe suggestions to try other materials, repeat with different amounts, or to look at it from another direction.

I generally encourage note taking (including drawings) of what students put together and what they find. It is easy to forget what is done without them, and tempting to (often incorrectly) make up what happened. It is a good habit to take notes while experimenting and students do indeed refer to their notes often while reporting on what they found.

Stage 2: Debrief

Call the students away from the materials, bringing their notes with them. This is a time to report to others on what has been discovered, and to discuss (without judgement) similarities and differences in results.

Debriefing may spontaneously start, as students gather and then start to talk with their peers about what they found. Teacher management is likely needed after a while to make sure every student has contributed, or to point out similarities between students' investigations that have gone unnoticed.

Towards the end of debriefing, I like to focus on one aspect of students' investigations, and ask them to think about how they can delve deeper and solve one problem or answer one question they have. By the end of debriefing most students have a specific question to answer and a specific way to test it. Students might be grouped with others that are asking similar questions to work on something together. Additional materials might be needed for some investigations, or questions to pursue can be limited to those that use the materials already available.

Stage 3: Replay

Students return to the materials, focusing on their question/problem identified during Debrief. This is a time to stress use of controls, repeating experiments, and rigorous experimentation to obtain solid results (positive or negative). Students that did not come up with a problem to focus on are not put down in any way, but encouraged to continue free exploration of the materials. Students again take notes on what they set up and the results they get.

An optional additional Debrief can follow, or students could write a report on their focused investigation.

Vocabulary

Solid:	A state of matter. The molecules in a solid are packed tightly together. Solids keep their shape. (Even in a granular solid, the individual grains keep their shape.)
Liquid:	A state of matter. The molecules in liquids are free to move but remain close to each other. Liquids can change shape, but always take up the same amount of space.
Gas:	A state of matter. The molecules in gases are free to move apart from each other. gases spread out to fill the container they are in. Gases formed in a liquid make bubbles that rise to the top of the liquid.
Float:	When one material remains on the surface of another. The ability to float depends on the object's weight and shape.
Sink:	When one material falls to the bottom of another. When a solid sinks in a liquid some of the liquid will be displaced.
Dissolve:	A solid "disappears" into a liquid as it dissolves in it. As the the solid dissolves, its component chemicals separate and interact with the chemicals of the liquid.
Chemical reaction:	A chemical reaction occurs when chemicals break apart and rearrange to form new chemicals. Sometimes chemicals with a different state of matter are formed e.g. a chemical reaction between baking soda (solid) and vinegar (liquid) form carbon dioxide (gas, seen as bubbles in the liquid) and water.
Absorb:	Some solids absorb, or soak up, liquids.

Materials

- Little plastic cups e.g. dollar store shot glasses, 4 or more per student
- Liquids in labelled squeeze bottles e.g. water, vinegar
- Toothpicks
- Granular solids in labelled cups each with a small scoop/coffee stirrer e.g. baking soda, table salt, sugar, flour, sand, rice
- Paper and pencil for students to report their results, marked into boxes for younger students (see example of a student's worksheet following this lesson)
- Wide trays filled with water
- A variety of objects that sink and float in water, some of which can change shape e.g. modeling clay, tinfoil, paper towel, sponge, ping pong balls, golf balls, straws, wooden sticks, styrofoam, coins, paper cups, marbles.
- Many towels for spill management.

In the Classroom

Introductory Discussion

Inform students that they will be doing their own investigations on solids and liquids, to find out what happens when different solids and liquids are combined together. There are no rules about how materials are combined and mixed, but the materials do need to remain at their own activity station. Students will be trying things that have not been tried before, so they should use the paper to take notes on what is combined together and what is found - they should write or draw what they do and see. The class will experiment for about 15 minutes before switching activity stations. Then after everyone has done both activities, students bring their notes to a class discussion on the discoveries made.

Brief description of science activities:

- Free experimentation on mixing various solids and liquids (activity 1).
- Free experimentation on how various solids float or sink in a tray of water (activity 2).

Brief description of the processes of science that the students will focus on: careful manipulation of materials, accurate observation and recording of results, verbally summarizing and reporting results, comparing and classifying results, making inferences, predicting, designing experiments, curiosity.

Science Activities

(1) Activity Title: Free experimentation: mixing solids and liquids

Purpose of Activity: For students to freely investigate and discover how some common solids and liquids interact when they are mixed together.

Methods and Instructions:
Set-up prior to experiment: lay out the materials in their labelled pots, about one set for four students. If there are limited materials, half the class can work at Activity 1, and half at Activity 2, then they can switch.
Students work in groups of four or less around one group of materials. They work individually on their investigations, though they may share their discoveries.

1. Tell students that this station is for experimenting with mixing different solids and liquids. Show the students the little empty plastic pots that they will mix the materials in. Show them the scoops in each solid, and tell them that the scoop needs to go back in the container once they have used it to move some solid to the little plastic pot. Show them how to use the squeeze bottles if necessary. Show them the toothpicks that they can use to mix the materials together thoroughly in the little plastic pot if they want, and to use a new toothpick each time to avoid contamination of their experiment.
2. Remind students to take notes on each mixture they try and the results they get (see an example of a student's worksheet following this lesson).

3. Leave students to play, with the guidance outlined above (under “Summary of Play-Debrief-Replay model of science teaching”). Students are likely to try mixing everything together in one pot. Try and leave enough time for them to move on from this and to be more selective about what they are mixing. Alternatively, during Debrief encourage discussion about what can be found out by mixing fewer materials at a time, compared to mixing them all together (the results of an experiment can be attributed to one material combination when fewer materials are used).
4. Debrief, maybe after doing both activities. Students are likely to be very excited about their results so allow time for them to talk together before starting a more formal class discussion. Encourage students to refer to their notes to remember exactly what they added and what happened.
5. Replay if there is time (we did not have time, partly because I let the students Debrief together for a while before we discussed their results as a group - a worthwhile trade).

(2) Activity Title: Free experimentation: sinking and floating

Purpose of Activity: For students to freely investigate and discover what materials sink and float in water, individually and in combination.

Methods and Instructions:
Set-up prior to experiment: lay out trays filled with water, and a collection of materials to test beside them. Students work in groups of four or less around one group of materials. They work individually on their investigations, though may well discuss results together.

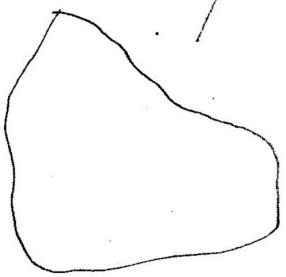
1. Tell students this station is for experimenting with how solids sink and float in water. They can combine the materials in anyway they like.
2. Remind students to take notes on each mixture they try and the results they get (see an example of a student’s worksheet following this lesson).
3. Leave students to play, with the guidance outlined above (under “Summary of Play-Debrief-Replay model of science teaching”).
4. Debrief, maybe after doing both activities. Students are likely to be very excited about their results so give them time to talk together before starting a class discussion. Encourage students to refer to their notes to remember exactly what they added and what happened.
5. Replay if there is time (we did not have time, partly because I let the students Debrief together for a while before we discussed their results as a group - a worthwhile trade).

References

1. Wassermann, Selma and Ivany, J.W. George. 1996. The New Teaching Elementary Science: Who’s Afraid of Spiders? Teachers College Press.
2. <http://www.usask.ca/education/coursework/mcvittiej/methods/play.html> Summary of the Play-Debrief-Replay teaching method, part of a University of Saskatchewan Education class, taught by Janet McVittle. Accessed May 26, 2013.

We put everything in a container and it floated

clay



it sank into the water

P.S. I didn't know that

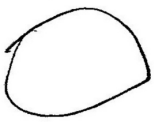
sponge

it floats

foam

floats

Golf ball



Sinks into the water

Name: Kelly

MY THINK TANK

I put 3 spoons of Flour and 1 scoop of sugar. I also put in baking soda and water The smell smelled like dough. Then it turn hard and I con'det get it out!

I put some flour, sand and salt. Then I put 2 scoops of sugur. Now I added vinegar and water. It turned the colour brown!

I added some baking soda and water. Now mine is over flowing. I can see little babbles coming up. It smells stinky