Matter and Density

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Trends in Assessment of Science Instruction

From:	To:
Primarily paper-and pencil tests	A variety of test formats including pictorial and lab performance tests
Primarily end-of-term summative assessment	A variety of diagnostic, formative, and summative assessments
Primarily measurement of low-level cognitive outcomes	The inclusion of higher-level cognitive outcomes, as well as the measurement of affective and psychomotor outcomes.
Primarily norm-referenced achievement testing	The inclusion of more criterion-referenced assessment, mastery testing, and self and peer evaluation.
Primarily measurement of facts and principles of science	The inclusion of objectives related to the processes of science, the nature of science, and the interrelationship of science, technology, and society.
Primarily a one-dimensional format of evaluation, e.g., a numerical or letter grade.	A multidimensional system of reporting student progress with respect to concepts, processes, lab procedures, classroom discussion, and problem-solving skills.

Adapted from: Doran, R. 1980. *Basic Measurement and Evaluation of Science Instruction*. Washington, D.C. National Science Teachers Association.

Name- ______________________________________

Essential Eight

The purpose of this "get acquainted" activity is to start thinking about the different areas of intelligence. Participants are to mix freely and try to get seven different people to sign the blanks (each participant may sign her/his own sheet once). In order to record a name in the blank, the person signing must actually perform the task (not just say that she/he can do it).

Find Someone Who Can:

______________________ recite a poem from memory.

______________________ finish this numerical sequence: 64, 1, 49, 4, 36, 9, 25, ____, and explain the logic behind it.

______________________ within 20 seconds name 6 ways to sort rocks into categories.

______________________ with hands on head stand on one foot with eyes closed for at least 7 seconds.

______________________ recall at least one dream from the last 3 weeks.

______________________ hum the first line of *Silent Night* on key.

______________________ honestly say that he/she has more strengths than weaknesses and name 6 strengths in less than 15 seconds.

______________________ name five very close friends in less than 8 seconds.

Checklists for Assessing "How Students Are Smart"
Adapted by Debbie Silver

Name of Student- ___________________________________
Check all the items that apply:

Linguistic Intelligence (Word Smart)
__1. Is a good reader.
__2. Enjoys word games.
__3. Is a good joke teller/ story teller.
__4. Has a good vocabulary for age.
__5. Enjoys listening activities.
__6. Likes to write stories and/or poems
__7. Communicates with others in a highly verbal way.
__8. Appreciates rhymes, puns, and/or nonsense words.
__9. Has a good memory for words, stories, details.

Other linguistic strengths:

Logical-Mathematical Intelligence (Number Smart)
__1. Asks a lot of questions about how things work.
__2. Has a good sense of cause and effect.
__3. Finds math games interesting.
__4. Can see and repeat patterns easily.
__5. Enjoys working puzzles and brainteasers.
__6. Understands computer programming.
__7. Is a logical thinker.
__8. Can estimate things involving numbers with relative ease.
__9. Can work math concepts in head.

Other logical-mathematical strengths:

Visual-Spatial Intelligence (Picture Smart)
__1. Reports clear, visual images (or dreams).
__2. Can envision objects from more than one perspective.
__3. Daydreams more than peers.
__4. Likes to draw and/or create art projects.
__5. Has a good eye for detail and color.
__6. Is good at spatial games like chess and Tetris.
__7. Likes movies, slides, or other visual presentations.
__8. Can move between 2-dimensional and 3 dimensional representations with ease.
__9. Can read and/or create maps.
Other visual-spatial strengths:

Bodily-Kinesthetic Intelligence (Body Smart)
__1. Is very coordinated.
__2. Exceptionally mobile: moves, twitches, fidgets, taps when seated for long.
__3. Enjoys working with clay, finger paint, and other tactile media.
__4. Can mimic others' gestures, posture, and movements
__5. Must touch anything new or interesting.
__6. Loves to take things apart and put them back together.
__7. Uses dramatic body movements for self-expression.
__8. Enjoys running, hopping, climbing, wrestling, or similar activities.
__9. Exhibits fine motor control (crafts, painting, etc.).
Other bodily-kinesthetic strengths:

Musical Intelligence (Music Smart)
__1. Can detect music that is off-key, off-beat, or disturbing in some way.
__2. Remembers melodies of songs.
__3. Taps rhythmically as he/she works or plays.
__4. Sensitive to environmental noise (rain on the windows, etc.).
__5. Plays a musical instrument and/or sings in a choir.
__6. Has a good singing voice.
__7. Responds favorably when music is played.
__8. Sings songs that he/she has learned.
__9. Unconsciously hums much of the time.
Other musical strengths:

Interpersonal Communications Intelligence (People Smart)
__1. Establishes meaningful peer relationships.
__2. Seems to be a natural leader.
__3. Empathizes with others.
__4. Likes to play with others.
__5. Shows good teamwork skills.
__6. Others seek this student's company.
__7. Has two or more close friends.
__8. Frequently acts as a mediator and/or peacemaker.
__9. Enjoys teaching others.
Other interpersonal communication strengths:

Intra-personal Awareness Intelligence (Self Smart)
__1. Displays a sense of strong will.
__2. Enjoys playing or working alone.
__3. Has high self-esteem.
__4. Has a good sense of self-direction.
__5. Does not mind being different from others.
__6. Has a realistic view of his/her strengths and weaknesses.
__7. Is able to deal effectively with successes and failures.
__8. Has an interest or talent that is not readily shared with others.
__9. Seems to "march to the beat of a different drummer."
Other intra-personal awareness strengths

Naturalistic Intelligence (Nature Smart)
__1. Likes to identify and classify living and nonliving things in nature.
__2. Cares for pets or animals.
__3. Understands repeating patterns in nature and the universe.
__4. Seems more "in tune with nature" than peers.
__5. Would rather be outside than inside.
__6. Has a demonstrated appreciation for a part of the natural world (i.e. dinosaurs, clouds, rocks, etc.)
__7. Likes to garden and/or appreciates plants.
__8. Understands and appreciates the environment.
__9. Loves to collect things from nature.
Other naturalistic strengths

--from *Drumming to the Beat of Different Marchers: Finding the Rhythm for Teaching Differentiated Learning* by Debbie Silver, 2005. Incentive Publications: Nashville, TN.

Creative Candle Demonstration

After you have discussed "going outside the lines" thinking with your students, tell them you want them to observe a common phenomena and write down the most accurate description of what they actually see happening. Stress that they are not to tell you what they expect the "right" answers to be. Pull out a "candle" made of potato, apple, pear, or whatever you choose; its wick is made of some kind of nut sliver (the oil in it will burn just like a string wick). Light it, turn out the classroom lights, and let it burn for about 4 minutes. Have the children write down their observations, and then share them aloud with the class. (I always use cooperative groups for this.) Accept all observations enthusiastically. Some will probably report seeing the wax melting, the sparks shooting out of the string, etc. Nod your head very attentively, thank them for their responses, then remind them that sometimes they need to think OUTSIDE the lines! Begin eating the "candle" as you explain. Leave as the bell rings.

M. I. And Your Science Classroom

(adapted from J. Abruscato's *Teaching Children Science*, 2001)

Logical-mathematical (Number/Puzzle Smart)

- Emphasize the underlying patterns children observe in science activities.
- Have students think about the steps involved in all deductions and activities.
- Stress numbers, measuring, and other mathematical concepts whenever possible.

Linguistic (Word Smart)

- Begin concept studies with popular children's books.
- Emphasize writing down predictions, observations, and writing in science journals.
- Encourage students to keep personal science dictionaries.
- Connect creative writing activities to science concepts.

Musical (Music Smart)

- Use songs, raps, and music selections to accompany the introduction of new concepts and/or to practice vocabulary.
- Encourage students to make up their own songs using science concepts.

Visual/Spatial (Picture Smart)

- Encourage students to use models and pictures to demonstrate understanding.
- Present new material through videos and pictures.
- Connect graphs to information whenever possible.

Bodily/Kinesthetic (Body Smart)

- Provide ample opportunities for students to use science materials and equipment.
- Whenever possible, have students demonstrate new learning through movement and dance. (i.e. acting out the metamorphosis of a butterfly).

Interpersonal (People Smart)

- When doing a cooperative activity help students "de-brief" not only their findings but also how well they worked together.
- Provide opportunities for students to share their findings, discoveries, and questions with their classmates.

Intrapersonal Awareness (Self Smart)

- Encourage the use of personal journals and reflective activities.
- Allow students to choose solitary, independent work occasionally.

Naturalist (Nature Smart)

- Use activities from programs such as Project Learning Tree, Project WILD/Aquatic, and Project WET that link science to the natural world.
- Use natural objects or media using natural objects to illustrate points.

Cartesian Diver

Introduction:

The Cartesian Diver was made popular in the 1800's by the philosopher René Descartes. It is commonly found in science classrooms or perhaps you have seen the Diving Tony toy distributed in boxes of Frosted Flakes. The Cartesian diver offers an eloquent demonstration of the most unique property of a gas, its compressibility.

Materials:

One 2-liter plastic bottle with cap
One glass eyedropper

Procedure:

1) Fill the bottle with water.
2) Fill a glass with water.
3) Draw water into the dropper until it is 2/3 full.
4) Place the dropper into the glass of water. If it sinks, adjust the water level until the dropper floats.
5) Place the dropper into the 2-liter bottle and screw the cap tightly in place.

Activity:

Hold the bottle in one hand and squeeze. What do you observe? Release the pressure with your hand and observe again.

Questions:

Why does the dropper sink when you apply pressure to the bottle?

As you squeeze the bottle the pressure inside increases. Liquids are not compressible but gases are. Therefore, the air in the dropper compresses and allows more water to flow into the dropper. This increases the weight of the dropper. As the weight increases, the density increases until it becomes greater than the density of water. Objects that have a density greater than water will sink.

Why are gases compressible and liquids not?

In gases the molecules are very far apart compared to their size. In other words, gases are mostly empty space. When put under increased pressure, the gas molecules can move closer together and the gas will occupy less volume.

On the other hands, in liquids the molecules are already crowded very close together. Since there is no empty space between the molecules, an increase in pressure can not cause a decrease in volume.

The Learning Cycle

The Learning Cycle's Three Phases

The **exploration phase** initiates students' interaction with information, materials, and each other in order to investigate an open-ended question. All class members are given common, concrete experiences that challenge them to gather and organize data and compare their answers. Lessons involving paradoxical or conflicting information capitalize on their natural curiosity.

The **concept development phase** builds on student curiosity, discoveries, and inquiries as the teacher assimilates data that students have organized, and clarifies terms and concepts they have developed. In this phase, students are far more receptive to vocabulary lists, direct instruction, and investigating other resources because their earlier explorations have shown them the relevance of the lesson. They also are far more likely to retain ideas and concepts because they begin to see patterns and connections to their knowledge of the world.

During the **concept application phase** the teacher challenges students to apply their knowledge to real-world situations and to explore broader applications of their discoveries. At this point, the teacher can pose new situations and questions to ensure deeper understanding.

(Silver, 1998, p. 64)

Why the Learning Cycle Works

Instructional specialists advocate this kind of student-centered, active learning because it gives learners tasks that relate to their concerns, allows them to pursue their own interests, offers links to the outside world, and stimulates curiosity by introducing unexpected or unique information. (Silver, 1998).

Learning is dependent on these factors:

1. The student's motivation.
2. The student's active involvement in the experience of learning.
3. Linking the new concepts with information that is familiar.
4. Being able to take new information and apply it to the real world.

Exploration Phase

Often the exploration phase of the learning cycle is launched with a situation or question designed to capture the interest of students. A problem can be posed in which new information that is introduced is inconsistent with knowledge previously thought to be true. During this motivational phase students are encouraged to manipulate materials and explore ideas without the specific outcomes designated by the teacher. Students use their skills to gather and organize data.

Most learning cycle advocates suggest that teachers use classroom activities to make sure that all students share the same experience. Students who have not achieved proficiency in English, who are mainstreamed into classes, or who have not had the same experiential background as their peers can find themselves at a disadvantage for learning in a traditional setting; the exploration phase helps build a common ground for all. Some subjects more easily lend themselves to active classroom activities than others, but no matter what the subject it is imperative that the lesson starts from a point shared by all.

Many teachers find that they can use a collective past experience (being scared at night, visiting a relative, eating a favorite food, solving a mystery) to illustrate a concept or begin a discussion. My advice regarding drawing on common experiences is to be sure that they are indeed shared by each student.

Why Discrepant Events?
Debbie Silver

Teaching is an active verb that requires the engagement of the learner. Because it has become harder and harder to capture the attention of students, discrepant events are a way to stimulate interest in a particular topic.

For instructional purposes discrepant events can be described as an investigation in which the new information that is introduced is inconsistent with information previously thought to be true (misconceptions). Piaget refers to this type of learning when he describes how learners can be motivated to learn if they experience a sense of "disequalibration." As long as the learner's environment is stable, mental activity is not necessary. But when an unfamiliar problem arises the learner must use prior experience, new insights, and/or peer interaction to solve the problem and reestablish *equilibration*. Equilibration can be restored through *accommodation* whereby the learner creates or restructures his/her thought patterns or through *assimilation* whereby the learner incorporates the new information into existing thought patterns.

A discrepant event can encompass all of the above. It arouses interest and allows for exploration, discovery, questioning, and discussion. This involvement and interaction between students and their environment will initiate linking and application. Discrepant events can be used to help students learn.

Concept Development

The concept development phase is, as it has always been, a time for the teacher to provide direct instruction if needed. It is an excellent time for teachers to use multi-sensory and multi-task choices for students to learn by capitalizing on their own strength areas. Students are involved as they are guided to create explanations, classifications, or hypotheses through discussions, mini-lectures, research, models, and so forth. With the advent of the Internet learners literally have at their fingertips links to all of the best research, models, and examples they would like to explore. The key idea in the learning cycle is that although this phase has traditionally been used to introduce lessons, research tells us that it is better placed *after* the exploration phase. This phase is greatly enhanced by the teacher's ability to utilize effective questioning techniques.

Questions can generally be regarded as three levels.

1. **First level (exploration phase)**- Students are asked to gather or recall information

2. **Second level (concept development phase)**- Students are asked to analyze, classify, compare, contrast, distinguish, explain, group, infer, make an analogy, organize, or synthesize.

3. **Third level (concept application phase)-** Students are encouraged to think intuitively, creatively, and hypothetically. They may be called on to apply a principle, build a model, evaluate, extrapolate, forecast, generalize, hypothesize, imagine, judge, predict, or speculate.

Questioning is an often overlooked strategic teaching tool. Effective questioning techniques can help the teacher discover student experiences, understandings, and misconceptions. They can also help guide student thinking and learning.

It is important to think deeply about what kinds of questions you are going to ask before you teach a lesson. Even experienced teachers and certainly novice teachers will want to write out questions they want to ask when they teach the lesson. Giving thought to the kinds of questions you want to ask can help you think about where you want the lesson to go and what it is you want students to know and to be able to do when they leave your room (your mission statement). Even hands-on, active learning experiences are not complete without a follow-up opportunity for students to clarify what they learned and extend their learning to new and novel situations. The questions you pose cue students to the level of thinking expected of them.

Concept Application

According to Newmann, Marks, & Gamoran, (1995) assessment strategies are moving beyond superficial levels of comprehension and towards deeper understandings such as:

- Construction of knowledge: Students should construct or produce knowledge, instead of merely reproducing or identifying understandings that others have created.

- Disciplined inquiry: Students should engage in cognitive work that requires them to rely on a field of knowledge, search for understanding, and communicate in "elaborate forms," their ideas and findings.

- Value beyond school: Students' accomplishments should have value — either aesthetic, utilitarian, or personal — beyond just documenting their competence. (p. 3)

If we truly want students to become autonomous, life-long learners, then should we not be assessing that which we say we truly value even though it is indeed harder to measure? It is certainly more difficult to create divergent tasks that compel students to apply concepts to a broader perspective. It takes teachers who are firmly grounded in their subject areas and who are not afraid themselves to think "outside the lines" to foster a spirit of wonder and delight in learning.

In his book, *Awakening Genius in the Classroom*, Thomas Armstrong (1998) strongly advocates models that promote a natural rhythm to learning. He is concerned about tapping the source of what drives the learning process in every child. The learning cycle seems to be a good fit with his twelve aspects of students' intrinsic motivation to learn – curiosity, playfulness, imagination, creativity, wonder, wisdom, inventiveness, vitality, sensitivity, flexibility, humor, and joy.

In summary, it can be said that teaching for understanding requires different strategies from those that were traditionally used for instruction. In a lesson designed to meet the needs of many marchers, students' misconceptions are addressed through exploration and discussion. Students explore their own questions as a way of acquiring new knowledge. In the educational community, there is agreement that traditional direct teaching is not the most effective way to promote conceptual change or real understanding of new concepts. It is generally agreed that the learning cycle is more suited to individualizing instruction and thus more successfully meets the needs of all learners in terms of student motivation, understanding, and development of higher level thinking skills.

Learning Cycle Check-List

Exploration Phase

_____ 1. The lesson begins with an engaging activity, provocative question, or interesting observation that provides or draws on a common experience.

_____ 2. The students are given sufficient time to interact with the materials and/or explore open-ended questions.

_____ 3. Students are asked to collect and organize data.

Conceptual Development Phase

_____ 1. Explanations are based on emerging patterns observed in the exploration phase.

_____ 2. The concepts and vocabulary developed are natural outgrowths of the exploration activity.

_____ 3. Questions have been designed to purposefully move students towards deeper understandings and meanings.

Concept Application Phase

_____ 1. Students interact with one another and compare ideas and explanations.

_____ 2. Students are required to apply newly learned concepts to "real life" situations.

_____ 3. Assessments are designed that allow students to demonstrate their ability to use newly acquired information and skills in novel and unique ways.

COOPERATIVE LEARNING:

In working with 4th grade through secondary learners it is important to remember that:

- Group members are responsible for the performance of each individual learner.
- Group members are individually accountable and must be able to report on or explain the team's results.
- The groups are to be assigned by the teacher. Their make-up should be heterogeneous with respect to sex, race, socioeconomic status, ability/learning styles, cliques, and other important factors.
- Leadership is shared on a rotating basis. Each team member has a job and responsibilities.
- The teacher is a resource; students are in charge of their own learning.
- Time must be allowed for group processing and self-evaluation.

The job assignments I use for traditional grouping are these:

Group Leader

1. Reads all directions to group
2. Leads the discussions
3. Checks the data sheet
4. Helps with clean-up
5. Is the only one who can ask a question of the teacher

Materials Manager

1. Is responsible for collecting and returning all materials & supplies to the appropriate place(s)
2. Is the only one who can get up for materials and supplies
3. Makes sure the everyone in the group has equal access to the materials and supplies
4. Checks the data sheet
5. Helps with clean-up

Time Keeper

1. Holds the team stopwatch (or watches the clock)
2. Keeps group on task and reminds them about time
3. Is responsible for getting the group to finish on time
4. Checks the data sheet
5. Helps with clean-up

Data Collector

1. Collects the data for the activity
2. Records data on the appropriate form or sheet
3. Returns data sheet to teacher and/or records group data on class data sheet
4. Makes sure all other team members check the data sheet

5. Helps with clean-up

Since this is not a perfect world, and all class populations are not divisible by four, I have a fifth job that can be assigned in a group:

Encourager

1. Monitors other team members to make sure they do their own jobs
2. Takes responsibility for praising and affirming jobs that are well done
3. Records comments and actions that show positive interpersonal communication
4. Reports recorded data to group at de-briefing session
5. Helps with clean-up

If a group of four has one member absent, two of the jobs can be combined for that day.

Part of the group's participation grade is based on how well each team member performs her/his job. Points are deducted if one team member does another team member's assigned responsibility.

Group Participation Number Line

Date: ____________________
Group Number: ___________
Group Members Present: _____________________________________
____
____

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0

Participation Points Earned: __________

There is nothing chaotic about cooperative learning that is well-planned and well-managed. Teachers should plan activities that are challenging and yet doable if the group members work together. Tasks should require the concentrated efforts of all team members doing their jobs and working with in the allotted time. Materials and supplies should be out and sorted before students arrive. During the cooperative learning activity it is the responsibility of the teacher to monitor the students and:

- Give immediate feedback and reinforcement for learning
- Re-teach certain concepts if necessary
- Clarify directions
- Encourage oral elaboration
- Affirm positive interactions and efforts

- Informally assess student learning and collaboration

Another way to ensure that the cooperative learning activity is organized and has a smooth closure is to allow time after clean up and whole group information sharing to ask the groups to evaluate how they interacted with one another. Either verbally or in their journals students can answer questions like these:

- Tell how involved each of your team members was in the decisions your group made.
- How do you feel about the work your group did today? Why?
- What would you would like to tell your teammates about how you felt during today's activity or the way you feel now?
- What could your team do to improve the way you get along and/or work together?
- What is your favorite thing about being on this team?

Teachers need to keep a close watch on the personal interactions going on within groups. Happy well-functioning groups matched with appropriate tasks and given adequate time constraints run smoothly.

Remote Control Cartesian Diver

By Dr. Bill Deese, Louisiana Tech University

You can amaze your students by operating your Cartesian Diver by "remote control." Start with the standard Cartesian Diver set-up. Drill a hole in the bottle top just large enough to accommodate a piece of aquarium tubing. Use another bottle (any size, but smaller is usually more convenient). Drill a hole in its cap also large enough to accommodate the aquarium tubing. Fill the second bottle with water and insert a piece of aquarium tubing 3 or more feet long inside each bottle.

By squeezing the small bottle, you will increase the pressure in it. The increased pressure in the small bottle will result in an identical increase in pressure in the large bottle, thus sending the Cartesian Diver to the bottom of the large bottle by a "remote control" device.

Some sneaky teachers we know even hide the "remote control" so that they can seemingly command the Cartesian Diver to dive by voice control alone. We highly recommend this procedure! It really causes the students to think about what is happening.

This activity demonstrates the principle that pressure is the same throughout a fluid.

Measuring Liquid Volume With a Graduated Cylinder

Names-

____

____

Purpose: To develop skill in measuring with a graduated cylinder.
To use the metric system in measuring volume.

Materials:
red, blue, and yellow food coloring mixed in water
3 containers
6 labeled test tubes/ test tube stand
50 ml graduated cylinder

Procedure:

1. Into test tube A, measure 19 ml of red water.
2. Into test tube C, measure 18 ml of yellow water.
3. Into test tube E, measure 18 ml of blue water.
4. From test tube C, measure 4 ml and pour the 4 ml into test tube D.
5. From test tube E, measure 7 ml and add it to test tube D. Mix.
6. From the container of blue water, measure 4 ml and pour it into test tube F. Then from the container of red water measure 7 ml and add it to test tube. Mix.
7. From test tube A, measure 8 ml of water and pour it into test tube B. From test tube C, measure 3 ml and add it to test tube B. Mix.

Observations and Conclusions:

After you have completed steps 1 - 7, complete the data table on the next page by listing the final colors in each tube. Give the total amount of water in each test tube.

Test Tube	Color of Water	Total Amount of Water
A		
B		
C		
D		
E		
F		

COLORFUL COLUMNS

Objective:
Students will note that 5 different liquids form layers in a large test tube. They will understand that the liquids "stack" because they have different densities. They will determine which of the liquids can be mixed and which cannot.

Materials:

For the class: Several sets of liquids A, B, C, D, & E in labeled containers (see below).

For each group:
- 25 x 200 mm test tube & test tube rack
- Small beaker (or baby food jar)
- Dawn dishwashing liquid
- Corn oil
- Water with red food color in it
- Rubbing alcohol with green food color in it
- Dark Karo™ Syrup
- Medicine measuring cups (about 30 ml)
- Toothpicks or stirring sticks

Preparation:

1. Label medicine measuring cups A,B,C, D, and E (1 set per group)

2. Place 15 ml of solution into each medicine measuring cup as follows:
   A = Dawn dishwashing liquid, blue
   B = Corn oil, yellow
   C = Water, red (add food coloring)
   D = Dark Karo™ Syrup
   E = Rubbing alcohol, green (add food coloring)

3. Give each group of students a set of the 5 liquids in their medicine cups, a large test tube, a test tube rack, a small jar, and a toothpick.

4. Tell students to pour the liquids into the test tube one at a time in the order A,B,C,D,E. (The order is **important**

because alcohol and water will mix if they come into direct contact.) Do not tell the students what the liquids are.

5. Liquids should be poured slowly down the inside side of the test tube held at a 45^{o} angle.

6. Students should observe each liquid carefully and note what happens as liquids are added to the test tube.

7. Ask students to describe what happens as the liquids are added.

8. Ask students why the different liquids do not mix. Students might say that the liquids are ones that cannot be mixed or that they are two substances that cannot stay together.

9. Encourage students to experiment with the liquids in the containers by mixing some of them together in a small beaker or jar. Give them a few minutes and ask for their results. Students should find that all of the liquids can be mixed except for the corn oil, which will not mix with any of the others. Tell students the word used to describe this situation is **immiscible**. Corn oil and water are immiscible because they separate spontaneously when mixed.

10. Explain to students that these solutions formed layers because they have different **densities** (mass per unit volume). If you measure one ml of each of these liquids and compare their masses (weight), the more dense liquids will weigh more than the less dense liquids. If you have not already mentioned it, ask students if any of the liquids they poured into the test tube ended up *below* other liquids that had been put in first.

11. Explain to students that water is a dense liquid. Both of the liquids that were above the red water in the density column are less dense than water. The two liquids below the red water are solutions in which other substances were mixed with water, making those solutions denser than pure water.

(from Project LIFE, Louisiana Tech University)

Names- ____

COLORFUL COLUMNS
(Student Sheet)

In this activity you are going to place 5 different liquids, one at a time, into a large tube and observe what happens.

1. Observe the liquids in the cups labeled A,B,C,D, & E. Do not taste these liquids nor allow them to contact your skin. Wear safety glasses when working with any chemical.

2. What do you observe about your liquids?

LIQUID	OBSERVATIONS
A	
B	
C	
D	
E	

3. You are going to pour the liquids into the test tube one at a time in this order; A,B,C,D,& E. Predict what you think will happen when the liquids are poured into the test tube.

   ____

   ____

4. *Slowly* pour the liquid in Cup A into the test tube allowing the liquid to flow down the inside of the tube. Next add the liquid in Cup B and so on until all five liquids have been added.

5. In the left margin of this page draw a picture to show the results you have when all of the liquids have been added.

6. Was your prediction correct? ____________________

7. On the back of this page explain what you think caused the liquids to behave as they did.

(from Project LIFE, Louisiana Tech University)

Hands-On Performance Assessment

____

In front of you are 4 cups of liquid (red, blue, yellow, and green) plus one empty cup and a straw.

Dip the straw into one of the cups of liquid to a depth of about 1 cm. Put your thumb over the top of the straw so that the liquid stays in the straw when you take the straw out of the liquid.

1. What color is the liquid in the straw? ____________________

Without removing your thumb, dip the straw into a second color of liquid to a depth of about 2 cm. Release your thumb so that the liquid will enter the straw, then put your thumb back on top of the straw and take it out of the liquid.

2. What color is the liquid in the straw? _____________________

Now try to produce 4 separate different colored layers in the straw. (Place your used liquid from the straw in the empty cup.)

3. When you have 4 distinct, separate layers in the straw, list the colors from TOP to BOTTOM. ____

4. Explain the process you used to get the liquids to form layers. Describe your method.

____

____

____

5. Why do you think the liquids form layers in the particular order that you observed?

____

____

____

6. Write an appropriate title for this assessment in the blank at the top of the page.

(adapted from Project LIFE, Louisiana Tech University)

For the Teacher:

Salt Solution Assessment

Set-up

Color	**Salt**	**Food Color**	**Liter of water**
Yellow	0 tbsp.	10 drops	1
Green	1 tbsp.	10 drops	1
Red	2 tbsp.	10 drops	1
Blue	3 tbsp.	10 drops	1

This activity measures:
- Critical Thinking
- Knowledge of Density

Teacher Demonstration Checklist

In deciding whether a particular activity or demonstration is consistent with good science teaching, the following checklist (adapted from J. Abruscato's *Teaching Children Science,* 2001, p. 83) may prove helpful:

____ 1. Did the teacher have all the necessary materials ready? Did the demonstration take place without unnecessary delay?

____ 2. Was the demonstration straightforward and free from confusing complexities or details?

____ 3. Could all the students observe the demonstration without problem?

____ 4. Was the teacher prepared and confident? Was it obvious the teacher had practiced and was knowledgeable about all aspects of the concepts being conveyed?

____ 5. Was the teacher able to build suspense with the demonstration? Were the students surprised by an unexpected or dramatic result?

____ 6. Was the demonstration made with attention to the safety of all involved? Did the teacher model correct safety procedures? (i.e. wearing safety glasses, using a mitt, etc.)

____ 7. Did the demonstration directly relate to the topic of study and/or essential science understandings?

____ 8. Was the appropriate amount of time allocated for this demonstration? Was time given for drawing conclusions?

____ 9. Did the students have an opportunity to give reactions, ask questions, make statements?

____ 10. Did the demonstration provide an important learning experience for the students?

Performance Assessment

Performance tasks are often used in science to assess a student's ability to manipulate materials or apparatus as well as apply knowledge to solving real life problems. For example, a student might be asked to measure the volume of an irregular object with the use of an overflow can, a graduated cylinder, and water. Students can demonstrate successful performance by applying their knowledge and skills to a new situation or in a new way.

The assessment developer should have in mind a clear picture of what a successful performance would "look like." Development of the criteria (rubric) by which the performance will be assessed can involve both the assessor and the assesses. Clear standards must be communicated to the assesses beforehand so that they fully understand what is expected of them. The best assessments are woven into the instructional strategies and serve to reinforce the concepts expected to be mastered.

Demonstration Assessment

Because performance assessments are sometimes limited by the amount of time and supplies a teacher is able to devote to them, a satisfactory alternative is that of a demonstration assessment. For this assessment students watch their teacher or another performer make a presentation that incorporates their prior knowledge but forces them to apply it in a new way or to a new situation. After observing the occurrence, the student is required to bring together understanding of processes, procedures, and concepts in order to explain the phenomena. Generally students are asked to describe observations, use appropriate vocabulary, make appropriate inferences. A demonstration assessment requires a pre-determined general rubric and should be clearly communicated to students before the actual assessment.

Floating and Sinking Ping Pong Balls

Materials:
2 different colored ping pong balls
Glass or plastic container (1500 ml or larger)
Large bag of unpopped popcorn kernels
1 pack BB's
Hot glue gun, clear tape, or SuperGlue™

Procedure:

Prior to the demonstration-
- Poke a small hole in one of the ping pong balls large enough to put in a BB. Put in as many BB's as the ping pong ball will hold. Then seal the hole with hot glue, tape, or SuperGlue™.
- Place the popcorn kernels in a large clear glass container (I use a small fishbowl; a large Pyrex™ measuring bowl works well, too). Hide a different colored regular ping pong ball under the surface of the kernels.

In class-
- Put the ping pong ball weighted with BB's on top of the popcorn kernels.
- Gently shake the bowl. The weighted ping pong ball will "sink" and the unweighted ping pong ball will pop out of the kernels!

Explanation:
Because the weighted ball is much more dense than the unpopped popcorn kernels, it will sink. The gentle shaking motion of the kernels causes them to act like a liquid. Since the kernels are less dense than the ball, the shaking causes the ball to fall to the bottom of the container.

The unweighted ball, however, is less dense than the unpopped kernels. It is held in place temporarily by stacking a large number of kernels on top of it, but once the bowl is shaken and the kernels begin flowing as a liquid, the less dense ball rises to the top.

Tips:
This demonstration is a real motivator for students. It makes an Excellent introduction to a unit on density and/or buoyancy. My favorite way to use, though, is an assessment at the end of the unit (see rubric).

General Scoring Rubric for Student Responses

(Students may also choose to illustrate their explanations)

0 Makes no observations or inaccurate observations

1 Makes accurate observations, but no accurate inferences.

2 Makes accurate observations, uses some appropriate vocabulary to draw some accurate inferences.

3 Makes accurate observations, accurate inferences, cites evidence, uses appropriate vocabulary.

Floating and Sinking Ping Pong Balls

Scoring rubric for student responses
(Students may also choose to illustrate their explanations)

0 No observation. No explanation.

1 My teacher put a white ping pong ball in a fish bowl that had popcorn in it. When she took the bowl it sunk, but then it came back up, and it was yellow and black. I think the ball was really yellow and black, but my teacher covered the ball with some white stuff. When she shook the bowl, it got rubbed by the popcorn, and the white stuff came off.

2 My teacher put a white ping pong ball in a fishbowl that had unpopped popcorn kernels in it. When she shook the bowl the white ball sank into the kernels. She kept shaking, and a yellow and black ball popped up. I think she already had the yellow and black ball in the kernels, and it popped up when she shook the bowl. I think the white ball weighs more than the yellow and black ball.

3 (All of the above plus) We learned that objects less dense than the liquid they are in will float, and objects more dense than the liquid they are in will sink. I think the popcorn kernels acted kind of like a liquid when they were swirled, so the white ball is more dense than the popcorn kernels, and the yellow and black ball is less dense than the popcorn kernels.

Beakers & Balances

(from *Jr. Boom Academy* (1992). B.K. Hixson & M.S. Kralik

Purpose: It is important for students to learn how to measure accurately using common science equipment such as beakers and balances.

Materials:

- 1 400 ml beaker
- 1 1000 ml beaker
- 1 double pan or triple beam balance
- 1 assortment of goodies to weigh

Procedure:

1. The markings on the side of the beaker are in milliliters. This is abbreviated "ml." It is one one-thousandth of a liter. When you record the volume of a container, you must always put the unit that you are using. In this case it will always be "ml." Practice filling and reading the beaker for the other members in your lab group. Fill the container to the following volumes: 10 ml, 125 ml, 750 ml, 30 ml, 950 ml. You may want to use different-sized beakers for the different measurements. Check each other to make sure that you are reading the beaker properly.

2. There are several kinds of balances and your teacher will have you instruct you on how to use the scales that you have at your school. After you have learned how to use them, record the weights of ten different objects in the data table.

3. Your teacher has set out five beakers for you to read. When it is time for your lab group to read the beakers, record your measurement in the space below.

BEAKER Number	**1**	**2**	**3**	**4**	**5**
Volume (in ml)					

Data and Observations
Weight Measurements

Object #	1	2	3	4	6
Mass (g)					
Object #	6	7	8	9	10
Mass (g)					

For the Teacher – Going Further:

1. Find a metric recipe and have the kids measure the ingredients for cookies using graduated cylinders, beakers, and balances.

2. Have the first annual Measurement Relays. Break the class into teams of five kids and head into the gym. At one end of the gym the kids line up. At the other end of the gym are the judges who can be parents, various school employees, or other volunteers. There are index cards with volumes or masses written on them (10ml, 43 ml, etc.), a graduated cylinder, various beakers, and a large beaker of water. At the signal sound, the first student from each team races down to the other end of the gym and flips over the first card. There is a volume on that card, and the student then picks up the beaker of water and fills the graduated cylinder or beaker, whichever is most appropriate or indicated on the card, to the exact amount. The judge verifies the measurement and the student pours the water back into the beaker and runs back so that the next member of the team can zip over and flip the next card over. Proceed as you would in a normal relay race.

Floating/Sinking Cans

Key Scientific Topics:
Archimedes' Principle
Buoyancy
Density
Floating/sinking
Mass
Volume

Key Process Skills:
Predicting
Investigating

MATERIALS:
For the class:

- •10 gallon aquarium
- •Assorted soft drinks (some artificially and some sugar-sweetened) in 12-ounce cans
- •8 gallons of water
- •4 cups salt

For the inquiry:

- •assorted drinks in 12-ounce cans, including at least 1 of each type listed below:
  - artificially sweetened
  - sugar-sweetened
  - carbonated
  - un-carbonated
  - bi-metal can
  - aluminum can

PROCEDURE:

1. Place the aquarium of water where all students can see it.
2. Hold one can of artificially sweetened and one can of sugar-sweetened soda in the aquarium and ask students to predict whether they will sink or float.
3. Release the cans.
4. Ask students to describe and explain what happened.

5. Test various cans of soda to test their hypotheses.
6. Remove the cans from the tank.
7. Add 2 cups of kosher salt (so it won't get cloudy) to the water in the tank.
8. Repeat test on cans of soda.
9. Allow students to explore hypotheses by changing variables.
10. Create a data table or results.
11. Ask students to generate a statement about what they observed.
12. Ask students to compare their findings with the explanation in their textbook or other resources.

EXPLANATION: (*for the teacher*)
The volume displaced is very nearly equal for all cans, resulting in equal buoyant force. Therefore, the determining factor in sinking or floating is the mass of the full cans. The mass depends on 3 variables: 1) the amount of soda, 2) the density of the soda, and 3) the mass of the metal from which the can is made.

Soda sweetened with sugar has a greater density than soda with artificial sweetener because a greater amount of sugar is required to sweeten the soda than the amount of artificial sweetener needed for the same amount of soda. Steel or bimetallic cans have more mass than aluminum cans because steel is more dense than aluminum. The densities of soda cans are so nearly equal to the density of water that variations in the amount of soda in the can might cause unexpected behaviors.

Additional Resource:
wNET School
http://www.thirteen.org/edonline/nttidb/lessons/cb/sinkcb.html
The University of Arizona
http://student.biology.arizona.edu/sciconn/density/density_coke.html

Student Names:

____

____

Data Table

Type of Soda	Floated High	Floated Low	Sunk

Hypothesis: ______________________________________

____

____

How we will test our hypothesis: _______________________

____

____

Create Your Own Data Table:

Results:

____

Conclusion:

Helpful Internet Sites for Science Teachers

Activities for Secondary Science Students
http://www.asta.edu.au/st2003/audience/secondary.html
Excellent resource. Science & Technology Directory for 2003-2004.

Classroom Activities for Secondary Science
http://www.greece.k12.ny.us/task/activities/secondscience.htm
More resources and activities for secondary science teachers

KCK Secondary Science Assessment Prompts
http://kancrn.kckps.k12.ks.us/science/assessment/prompts.cfm
Great downloadable resources for alternative secondary science assessments

ICT Teaching and Assessing Science
http://ecs.lewisham.gov.uk/talent/secsci/TaLENT_SC5.htm
Ideas for teaching and assessing secondary science through ICT

Problem Solving in Elementary Schools
http://www.indiana.edu/~reading/ieo/bibs/probele.html
ERIC resources that address problem solving. Useful links to other Internet resources.

Science Lesson Plans
http://www.col-ed.org/cur/science.html#sci1
This site, sponsored by the Columbia Education Center in Oregon provides a tremendous collection of elementary/middle level science lessons.

Sensational Science Activities
http://www.tufts.edu/as/wright_center/fellows/jbm_info/jbm6.html
Home page created for secondary science educators by John Banister-Marx. Good stuff!

Supplements to Science Lessons
http://www.monroe2boces.org/programs.cfm?sublevel=350&subsubpage=82&subpage=54&master=3
BOCES2 website provides an array of elementary science lesson supplements. Excellent resources for teachers trying to differentiate instruction on particular topics.

Teachernet Science Resources
http://www.teachernet.gov.uk/teachingandlearning/subjects/science/primaryscience/
One of the best sites on the internet for all kinds of activities, ideas, and integrated lesson plans for primary school science.

Using Lower Secondary Science Activities to Engage Below Level Students
www.eddept.wa.edu.au/outcomes/**science**/suppLsec.pdf
This downloadable PDF file has excellent ideas for differentiating secondary science activities for below level students.

LIST OF RELATED CITATIONS

Matter and Density

Dr. Debbie Silver

Abruscato, J. (2001). *Teaching Children Science: Discovery Methods for the Elementary and Middle Grades*. Boston, MA: Allyn and Bacon.

Abruscato, J. (2000). *Teaching Children Science: A Discovery Approach (5th ed.)*. Boston, MA: Allyn and Bacon.

Bentley, M; Ebert, C; & Ebert, E.S. (2000). *The Natural Investigator: A Constructivist Approach to Teaching Elementary and Middle School Science*. Belmont, CA: Wadsworth/Thomson Learning.

Carin, A. A. & Bass, J.E. (1997). *Methods for Teaching Science as Inquiry*. Upper Saddle River, NJ: Prentice-Hall, Inc.

National Science Teachers Association. (1997). *NSTA Pathways to the Science Standards: Guidelines for Moving the Vision into Practice (both middle and high school editions)*. Arlington, VA: National Science Teachers Association.

Feldkamp-Price, B.; Rillero, P.; & Brownstein, E. (1994). "A Teacher's Guide to Choosing the Best Hands-on Activities." *Science and Children (31)* 6, pp 16-19.

Piaget, J. (1974). *To understand is to invent*. New York: Grossman.

Silver, D. (2002). *Drumming to the Beat of a Different Marcher: Finding the Rhythm for Teaching a Differentiated Classroom*. Nashville, TN: Incentive Publications.

Silver, D. (1998). Engaging students in the learning cycle. *Principal*, 77 (4), 62-64.

Vatterrot, C. (1995). Student-focused instruction: Balancing limits with freedom in the middle grades. *Middle School Journal, 28* (2), 28-38

Periodicals for Science Teachers

Science Scope (middle grades-- a journal of the National Science Teachers Association) 3140 N. Washington Blvd., Arlington, VA 22201 http://www.nsta.org

The Science Teacher (secondary—a journal of the National Science Teachers Association) 3140 N. Washington Blvd., Arlington, VA 22201 http://www.nsta.org

WonderScience (grades 4-6). American Chemical Society, P.O. Box 57136, Washington, DC 20037.

Internet Sites for Differentiated Instruction

Teach-Nology the Web Portal for Educators:
http://www.teach-nology.com/currenttrends/alternative_assessment/

CEC Information Center on Disabilities and Gifted Education:
http://ericec.org/faq/gt-nurt.html

Multiple Intelligence Resources for Teachers:
http://www.proteacher.com/040009.shtml

Tiered Curriculum Project
http://www.doe.state.in.us/exceptional/gt/tiered_curriculum/welcome.html

Adapt Lessons to Reach All Students
http://www.teachervision.fen.com/teaching-methods/special-education/3759.html

Enhance Learning With Technology
http://www.enhancelearning.ca

Applying Bloom's Taxonomy in the Classroom
http://www.teachers.ash.org.au/researchskills/dalton.htm

Tiered Instruction Examples
http://wblrd.sk.ca/~bestpractice/tiered/examples2.html

CAST Differentiated Instruction
http://www.cast.org/publications/ncac/ncac_diffinstruc.html