Making Science Fun & Meaningful for Students

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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.**

Debbie Silver, 1998

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.

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Science Facts "Word Sense"

a. 9 = N O P in S S
b. 3 = N O B in the M E
c. 4 = N O C in the HH
d. 8 = N O P of the M
e. 93= N O M M from E to S
f. 7 = N O C in the R
g. 206 = N O B in the A S
h. 1,100 = N O F P S that S R
i. 21 = P of O in the A
j. 5 = N O C a C has in its S
k. 40 = N O F in the L of a GWS
l. 32 = N O T in most A H
m. 6 = N O P in M
n. 3 = N O N of A in a W M
o. 1 = N O of C in P
p. 3 = N O N of B P on an I
q. 2 = N O S P in a D
r. 8 = N O L on an O
s. 0 = N O B in a S
t. 0 = N O D C at which W F
u. 46 = N O C in most H C
v. 8 = N O L on a S
w. 1 = N O Q in a B
x. 70 = P of E C by W
y. 2 = N O P on a M
z. 6 = N O P on a S

Cartesian Diver

Introduction:

The Cartesian Diver was made popular in the 1800's by the philosopher Rene 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 cannot cause a decrease in volume.

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.

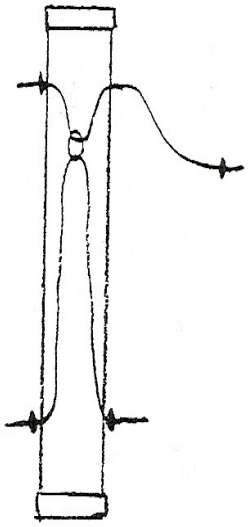
By squeezing the small bottle, you will increase the pressure in it. The increased pressure in the small bottle will result in an identical increase in pressure in the large bottle, thus sending the Cartesian Diver to the bottom of the large bottle by a "remote control" device.

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.

Critical Thinking and the Magic Tube

By William Deese
Louisiana Tech University



Description: A large cylinder with cords protruding from four holes is shown to the audience. When each cord is pulled, sometimes surprising results are obtained. The audience is challenged to explain how the magic tube is constructed.

Materials: 2-foot section of 2-inch PVC pipe
(2) 2-inch caps for the PVC pipe
7-foot section of 1/4-inch cord
(1) 1-inch metal ring

Construction:

1) Drill a 1/4 inch hole in the tube 3 inches from one end. Rotate the tube 180 degrees and drill another hole exactly opposite to the first one.
2) Drill two holes at the other end in analogous positions.
3) Cut the cord into 4-foot and 3-foot lengths.
4) Thread the 4-foot cord through a hole, through the metal ring, and out the hole on the opposite side.
5) Tie knots near each end of the cord.
6) Position the ring in line with the holes at the other end of the tube and thread the 3-foot cord through both holes and the ring.
7) Tie knots about 3 inches from each end of the second cord.
8) Pull one end of the long cord out and cut about 12 inches off. Tie knots about 3 inches from each end.

Procedure:

1) Display the magic tube to your audience and pull one of the Cords. Then pull the end exactly opposite the first one you pulled.
2) Now pull one of the cords at the other end and observe.
3) Continue to pull various ends of the cords while your audience tries to figure out how the magic tube works.
4) If your audience is a class, ask them to design their own tubes. There may be more than one design that works.

Hazards: Be careful when drilling the holes in the PVC pipe.

Reference: A hand-out by Bruce Hogue, Dustan Middle School

What is Cooperative Learning?

Cooperative learning is an instructional strategy that uses small groups of students working together and helping one another on specific learning tasks with an emphasis on group members supporting one another.
It is characterized by activities that:

1. **Require students to depend on one another for success**. Having students sit side by side working on something they could just as easily do by themselves in *not* cooperative learning. Students must be required to share materials, knowledge, time, talents, and effort (or any combination of these).

2. **Provide for individual accountability**. Group members share jobs and make group presentations. Group members are tested individually and/or as a group to ensure that each person has mastered the required learning.

3. **Utilizes face-to-face interaction among students**. For all group work students are arranged in close proximity of each other. They can be at tables, in desks or chairs pushed together, on the floor, or virtually anywhere they can do the task at hand separated from other groups.

4. **Focus on interpersonal and group skills**. Tasks are designed to include components of positive interpersonal communication skills such as active listening, building consensus, sharing, supporting, restating, using appropriate eye contact and gestures, and encouraging. Teams learn to stay on task and check each other for understanding.

Traditional Classroom	**Cooperative Classroom**
Learners are passive	Learners are active
Students work alone	Students work with 1 to 4 partners
Teacher directs work	Students direct work
Silence is valued	Learning noise is appropriate
Teacher initiates discussion	Students initiate discussion
Some students do not participate	All students participate
Individual accountability	Individual and group accountability
Independent learners	Interdependent learners
Affirmations come from teacher	Affirmations come from peers
Individual materials needed	Shared materials

Effective Use of Cooperative Learning Can

1. Increase achievement (at all ability levels)
2. Empower students to take responsibility for their own learning
3. Improve retention
4. Generate more positive feelings towards the subject matter
5. Provide more active learning
6. Focus more time on learning
7. Lower frustration and anxiety among students
8. Enhance a sense of community among students
9. Promote inter-personal communication skills
10. Boost feelings of self-worth

How To Use Cooperative Learning:

Cooperative Learning in the Early Grades

- Do not assign a cooperative learning activity that could just as easily (or more easily) be done alone. Be sure to create a *positive interdependence* in the way you structure the activity.
- Provide time for small group-building activities that are designed to help students develop awareness of others, build communication skills, foster trust, and provide practice for interacting successfully with others.
- Participation can be encouraged by grouping reluctant students with more nurturing students.
- Be sure that assigned group work is well-thought-out, organized, challenging, and reasonable.
- Help groups learn to write their goals and agree on major steps *before* they begin working.
- Constantly move among groups monitoring, encouraging, and providing feedback.

- If the activity is fun, no other reward may be needed since intrinsic rewards are most fulfilling. However, teachers of young learners may choose to use:
  - verbal praise
  - singing a favorite song
  - an art activity
  - game time
  - other suitable reinforcers
  - activities may be videotaped as a reward

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Differences Between Cooperative and Traditional Early Learning Groups

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

Cooperative Learning Groups	Traditional Learning Groups
Positive interdependence	No interdependence
Individual accountability	No individual accountability
Shared leadership	One appointed leader
Shared responsibility	Responsibility only for self
Task and process emphasized	Only results emphasized
Social skills directly taught	Social skills assumed and ignored
Teacher observes and intervenes	Teacher ignores group functioning
Groups process their effectiveness	No time for group processing

Cooperative Learning For Secondary Learners

In working with secondary school 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.

Alternative Ways to Use Cooperative Learning

1. **Within a lecture or presentation:**
   The teacher is discussing, modeling, or explaining something. S/he pauses to ask small groups to summarize, categorize, debate, describe, or otherwise react to the presented material.

2. **With higher level questioning:**
   The teacher asks small groups to come up with a team consensus on something to do with analysis, synthesis, or evaluation of the concept being discussed.

3. **As practice reinforcement:**
   The teacher asks students to get with their groups to practice, memorize, or review the given concepts.

4. **Decision-making/problem solving:**
   The group is to reach a decision or solve a problem presented by the teacher. The teacher is leading a class discussion on the separation of church and state in the United States Constitution. She asks small groups to meet and decide whether or not to include the words, “Under God” in the Pledge of Allegiance. Groups are to figure out a way for students to say the Pledge without violating the spirit of the law.

5. **As a review:**
   The teacher asks a question. Team members put their heads together to discuss the answer. The teacher calls out a color, and the person who has that color dot will answer the question as the teacher whips through the groups.

6. **In a tournament or game format:**
   There are several models for using cooperative learning in a tournament or game format. Student Teams-Achievement Divisions (STAD) and Teams-Games-Tournament (TGT) are two of the more popular ones.

7. **With peer editing:**
   Team members proofread each other’s work and offer suggestions for improvement. This practice helps both the “corrector” and the “correctee.”

8. As an assessment:

A Gallery Walk (sometimes called Carousel Walk) is a way to assess students in groups. The teacher puts large pieces of newsprint around the room. On the top of each is a question for which there are several answers. Student groups are given different colored markers and asked to write one correct answer to each question. Answers cannot be repeated on a page. The teacher can informally assess student learning by listening to them as they "think out loud" in their groups (Slavin calls this *oral elaboration*). Or teachers can more formally assess the answers by noting the flow of answers used by each colored group.

9. Research projects or group investigations:

Group work on projects can promote sharing of the load and commitment to a time line. Often times students who are procrastinators when it comes to doing their own work will get motivated by their peers to finish their part of the assignment.

10. Checking homework:

Even though homework is for independent practice, many teachers
Have limited time for checking and correcting it during a rushed day.
Group members can check each other's work for accuracy.

For more information on the specific techniques mentioned in this chapter or for lessons designed around particular age groups and subject areas consult your local bookstore or the Internet. Cooperative learning strategies abound. Using small group interactions is a powerful teaching tool that can be used to enhance the learning cycle and most other effective teaching strategies. Different marchers hearing different songs still need to learn to work successfully in groups when the need arises. Learning interpersonal communication skills helps students to become better citizens. Working in groups helps students "get better together."

Recommended Reading List

Johnson, D.W., Johnson, R.T., & Holubec, E.J. (1994). The new circles of learning: Cooperation in the classroom and school. Alexandria, VA: Association for Supervision and Curriculum Development (ASCD).

The Learning Cycle

The Learning Cycle's Three Phases

The **exploration phase** tries to initiate 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).

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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.

Gallery Walk

The **Gallery Walk** is an assessment that capitalizes on the "people smart" intelligence. It can be used as a diagnostic, formative, or summative assessment. The teachers poses challenge questions for students to answer in small groups (2 to 5). Student groups rotate among the questions written on large pieces of newsprint or giant poster paper placed around the room. Each group has a different colored felt-tip marker with which they give one answer per poster. Answers cannot be duplicated.

GALLERY WALKS

Imagine that you are a bright orange butterfly. A predator moves into your habitat that preys on bright orange butterflies. *What could you do so that the population of bright orange butterflies survives?*

1. Start coming out at night when predators can't distinguish color very well.
2. Sit with wings folded up tight so color can't be seen.
3. Sit underneath leaves where they are less likely to be seen.
4. Spend time in fields of bright orange flowers where they would be hard to see.
5. Migrate to an area where other bright orange colored butterflies contain a poison and predators avoid all brightly colored butterflies.
6. Move to a place where there are no predators.

Mitosis Assessment Activity

Assessment Goals:

- Describe what happens to a cell during **interphase.**
- Name each of the **four phases of mitosis** and present them in the correct order.
- Correctly identify each of the organelles present in each phase. Include these organelles: **centrioles**, **chromosomes**, **chromatids**, **spindle fibers**, **nuclei**,
- Explain the **actions of the organelles** in each phase.
- Show the actions of the **nuclear membrane** and **cell membrane** at each phase.

Date- _____ Title- _____

Group Members: _____

_____

PRESENTATION OR MODEL (25 points)- _____

- Describes the events of interphase.
  5 4 3 2 1
- Demonstrates each stage accurately.
  5 4 3 2 1
- Correctly identifies the major organelles present in each phase.
  5 4 3 2 1
- Correctly explains the actions of the major organelles in each phase.
  5 4 3 2 1
- Correctly explains the actions of the nuclear and cell membranes in each phase.
  5 4 3 2 1

TEACHING METHOD: (15) - _____

- Activity taught concept correctly.
  5 4 3 2 1

- All students *could* participate.
  5 4 3 2 1

- Activity promoted learning.
  5 4 3 2 1

ORAL PRESENTATION: (20) - _____

- Everyone has a part.
  5 4 3 2 1

- Part stated (not read).
  5 4 3 2 1

- Given accurately and clearly.
  5 4 3 2 1

- Definitions are explained correctly
  5 4 3 2 1

TOTAL SCORE - _____

COMMENTS: -

Different Ways to Find Out What Students Understand

Make a chart or diagram	**Do a demonstration**	**Create a dance**
Write a letter to the editor	**Make a scrapbook**	**Design a Web Quest**
Conduct a discussion	**Participate in a debate**	**Create a puppet show**
Create an advertisement	**Make an editorial video**	**Keep a journal log**
Participate in a simulation	**Develop a collection**	**Make a plan**
Create a poem	**Write and do a rap**	**Make a mural**
Do a photo essay	**Design a game**	**Create a new product**
Create an invention	**Present a news report**	**Do an experiment**
Teach someone else	**Judge an event**	**Make a model**
Write an analogy	**Conduct an interview**	**Develop a rubric**
Participate in a mock trial	**Create cartoons**	**Write a book**
Write an essay	**Design a structure**	**Create a report**
Design and teach a class	**Create a flow chart**	**Make a learning center**
Devise a new recipe	**Give a performance**	**Draw a blueprint**
Write a monologue	**Defend a theory**	**Do a self-assessment**
Illustrate a math concept	**Create a brochure**	**Solve a mystery**
Do a multimedia presentation	**Develop an exhibit**	**Critique a book**
Write a diary from the perspective of someone else	**Set up a system of checks and balances**	**Do a Gallery Walk (Carousel Walk)**

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.

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).

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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.

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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.

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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?

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Science Facts "Word Sense"

a.	9 = N O P in S S	(number of planets in the solar system)
b.	3 = N O B in the M E	(number of bones in the middle ear)
c.	4 = N O C in the HH	(number of chambers in the human heart)
d.	8 = N O P of the M	(number of phases of the moon)
e.	93= N O M M from E to S	(number of million miles from earth to sun)
f.	7 = N O C in the R	(number of colors in the rainbow)
g.	206 = N O B in the A S	(number of bones in the adult skeleton
h.	1,100 = N O F P S that S R	(number of feet per second that sound travels)
i.	21 = P of O in the A	(Per cent of oxygen in the atmosphere)
j.	5 = N O C a C has in its S	(number of chambers a cow has in its stomach)
k.	40 = N O F in the L of a GWS	(number of feet in the length of a Great White Shark)
l.	32 = N O T in most A H	(number of teeth in most adult humans)
m.	6 = N O P in M	(number of phases in mitosis)
n.	3 = N O N of A in a W M	(number of atoms in a water molecule)
o.	1 = N O of C in P	(number of continents in Pangea)
p.	3 = N O N of B P on an I	(number of body parts on an insect)
q.	2 = N O S P in a D	(number of seed parts in a dicot)
r.	8 = N O L on an O	(number of legs on an octopus)
s.	0 = N O B in a S	(number of bones in a shark)
t.	0 = N O D C at which W F	(number of degrees Celsius at which water freezes)
u.	46 = N O C in most H C	(number of chromosomes in most human cells)
v.	8 = N O L on a S	(number of legs on a spider)
w.	1 = N O Q in a B	(number of queens in a beehive)
x.	70 = P of E C by W	(percent of earth covered by water)
y.	2 = N O P on a M	(number of poles on a magnet)
z.	6 = N O P on a S	(number of points on a snowflake)

Helpful Elementary/Middle Internet Sites

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.

Compiled by Debbie Silver, 2005

LIST OF RELATED CITATIONS
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Dr. Debbie Silver

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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.

Like Captured Fireflies

In her classroom our speculations
ranged the world.
She aroused us to book waving discussions.
Every morning we came to her carrying new
truths, new facts, new ideas cupped
and sheltered in
our hands like captured fireflies.
When she went away a sadness
came over us,
But the light did not go out.
She left her signature upon us,
The literature of the teacher who
writes on children's minds.
I've had many teachers who taught
us soon forgotten things,
But only a few like her who created in me a new
thing, a new attitude, a new hunger.
I suppose that to a large extent I am the unsigned
manuscript of that teacher.
What deathless power lies in the hands
of such a person.

John Steinbeck