Let's Get Physical! Science Workshop Day 1

Presented by:
Debbie Silver, Ed.D.
www.debbiesilver.com

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.

The Ten Commandments of Science
Author Unknown

1. **Thou shalt use "hands-on" experience.**
2. **Thou shall instill an appreciation and value for the importance of science in today's society.**
3. **Thou shall honor thy process skills.**
4. **Thou mayest make mistakes in order to learn.**
5. **Thou shall respect and learn from the environment.**
6. **Thou shall relate science to other subjects.**
7. **Thou shall not rely on just a textbook to teach science.**
8. **Thou shall not rely on just a textbook to teach science.**
9. **Thou shall generate excitement in exploring science concepts.**
10. **Thou shall consider that all students are not at the same stage of development.**

Rules of the Laboratory

1. Listen to and read all directions.

2. Never eat or drink anything during lab.

3. Wear safety goggles when directed.

4. Report any breakage, chemical spills, or other accidents immediately to the teacher.

5. Obtain permission from the teacher before performing experiments you have modified or designed.

6. Wash hands thoroughly at the end of the lab.

Notes

Silly Putty

Summary: Students mix Elmer's® glue, liquid starch and water to create silly putty. Students then think about silly putty to learn more about polymers.

Estimated Time: 25-40 minutes [Depending on age and number of participants]

Materials Needed:

1/2 cup Elmer's Glue

1 cup Liquid Starch (Sta-Flo brand)

Touch of food coloring or water color

newspaper (put down first to protect the working surface)

***Use regular Elmer's® glue. Elmer's® washable glue is not as effective.**

Safety Notes: Students should not ingest any of the lab materials. Hands should be washed thoroughly at the end of the activity. Silly putty should not be put in a sink, on carpet, or in hair.

Think About It:

Elementary Level:

What happened to the glue? First it became runny when we added water then it became almost like a solid when we added the starch solution. It is almost like a solid but not quite. If you leave the silly putty sitting still on a table it will flatten out very thin. Why do you think the starch made the glue change from runny to stiff?

The starch links together these polymer chains. [As a visual, you can show two horizontal paper clip chains linked together with vertical paperclips. These vertical bonds represent the starch.] Now it is harder for each polymer to move, because it is attached to another polymer. The starch is called a cross-linker because it links the glue together.

(continued)

Middle/High School Level:

The glue contains a polymer called polyvinyl acetate resin. We changed the polymers when we added starch. What kind of change was adding the starch, physical or chemical? **[chemical]** Why? How do you know that? What did the starch actually do? The starch is called a cross-linker. It chemically "ties together" the long strands of the polyvinyl acetate. [See more detailed explanation above] This tying together changed the viscosity of the glue. It increased the viscosity because the new cross-linked chains interfere with the ability of the solution to flow. As a result the silly putty is "stiffer". It is not a solid though. How do we know this? If we leave the silly putty alone on a table it will flatten out.

Teaching Tips:

Food coloring can be used to create colored silly putty. If using food coloring, add it to the GLUE during preparation. Liquid starch can be found in stores as a laundry detergent.

Students may take their silly putty home in plastic ziploc bags. Over time the silly putty will dry out.

This activity also makes a good language activity. Students can listen to directions, tell directions and use many different adjectives to describe the silly putty and how it was made.

Notes

Finding the Polymer In a Real Baby Diaper

Start by collecting a number of disposable diapers. Any toddler's diaper will work. Invite your students to carefully examine the disposable diapers. Is there any trace of powder-like super absorbent polymer? What do you see? How do you think the manufacturer hides the super absorbent polymer?

The Pouring Test

Determine the amount of water a disposable diaper can hold by slowly pouring about 1/4 cup (approximately 50 ml) of warm tap water into the center of the diaper. Holding the diaper over a dishpan or sink, and continue to add increments of water. Tip the diaper back and forth after adding water each time. Record the amount of water the diaper holds before it becomes saturated and steadily leaks. Try testing different brands of diapers.

Finding the Secret Polymer

Place a new diaper on a piece of black paper. Carefully cut through the cotton lining and remove all of the stuffing material. Put this cotton-like material into a clean, zipper-lock bag. You should be able to see and feel traces of the polymer. Scoop up any of the polymers that may have spilled on the black paper and place it into the bag. Seal the bag (blowing a little air into the bag as you seal it, to make the bag puff up like a pillow). Shake the bag for a few minutes to remove the polymer powder from the cotton. Notice that the super absorbent polymer powder is resting on the bottom of the bag. Remove the cotton from the bag and measure the amount of polymer that you extracted. If you like, add 4 ounces of warm water to the bag and time how long it takes to gel the water.

So, How Does the Powder Absorb Water?

Most common synthetic polymers are said to be hydrophobic (water-fearing), which means that they do not absorb water. Examples of these polymers might include products such as plastic cups, bags, and plastic toys. There are also hydrophilic, or water-loving polymers. Many natural polymers such as cotton fibers are hydrophilic. The polymer found in the diaper is an example of a synthetic, hydrophilic polymer.

Water-Absorbing Crystals

Purchasing Information: Super absorbent crystals are sold at lawn and garden centers under many different trade names including HydroSource or SoilMoist. Just ask for help in finding water-absorbing polymer crystals.

Super absorbent polymers are rapidly becoming one of the most exciting environmental education topics in classrooms worldwide. Today, super absorbent polymers are widely used in such applications as forestry, gardening, and landscaping as a means of conserving water. Imagine using a substance that could store water in the soil and then release it, as the plants roots need it? Indeed, the super absorbent polymer in this package is able to reduce the amount of time that is spent watering a lawn, a garden, or even a house-plant by 50 to 80 percent! While we may consider water-absorbing polymers to be a modern convenience, imagine the impact that such technology is having on parts of the world that are plagued by drought.

Super absorbent polymer has hundreds of uses, is environmentally safe to use, and is one of the few fields of study where school age children are actually able to engage in scientific inquiry and make genuine contributions to science.

Retrieved from: www.fourh.umn.edu/ydca/youthnu_handouts/08_handouts/DC-PottersPotion -**Diapers**Experiment.pdf

Notes

Acid-Base Indicators from Red Cabbage

By Dr. William Deese
Louisiana Tech University

Description: A purple liquid is extracted from red cabbage. When added to various substances found around the house, this liquid changes color.

Materials: About half of a small head of red cabbage, 5 tall beakers (2-liter plastic bottles with the tops cut off will work). Vinegar, laundry ammonia, baking soda, and a colorless carbonated beverage. Knife, kitchen sieve, 1-liter beaker, stirring rod, and electric blender. Light box is optional.

Procedure:

1. Cut half a head of red cabbage into one-inch chunks, place in blender, and add distilled water. (Tap water will probably work fine.)
2. Blend the cabbage until it has been chopped into uniformly tiny pieces. Strain the liquid from the mixture into the 1-liter beaker.
3. Fill the large beakers about 2/3 full with distilled (or tap) water. Place each beaker on the light box display.
4. Pour about 100 ml of vinegar into Beaker #1, about 100 ml of carbonated beverage into Beaker #2, nothing in Beaker #3, about 1 Tbs. of baking soda into Beaker #4, and 100 ml of ammonia cleanser into Beaker #5.
5. Pour about 25 ml of cabbage extract into each beaker and note the colors. You should have 5 very distinct colors.
6. If desired, test other household materials in a similar fashion. (e.g. sugar, lemon juice, shampoo, milk, antacid tablets, aspirin, etc.)

Hazards: Very few. The solutions should be treated as if they are toxic. Wear safety goggles.

Clean up: Discard the solids in the trash. The solutions should be flushed down the drain with water. Wash the blender pitcher and beakers thoroughly.

Reference: *Chemical Demonstrations: A Handbook for Teachers of Chemistry*, Volume 3, Shakehashiri, B.Z., University of Wisconsin Press, p.50.

PLOP, PLOP, FIZZ, FIZZ

Purpose:

This activity illustrates the pH change caused by carbon dioxide dissolving and the use of acid/base indicators.

Materials:

Ziplock bag (quart size)
Alka Seltzer tablet
20 ml Bromothymol Blue

Procedure:

Add the bromothymol blue to the Ziploc bag. Add an Alka Seltzer tablet and quickly seal the bag securely. Note the color changes in the bag as the Alka Seltzer dissolves.

Why:

As the Alka Seltzer dissolves it liberates carbon dioxide gas. The carbon dioxide reacts with the water to form a weak acid, carbonic acid. This gradually cause the pH to drop as the liquid in the bag becomes increasingly acidic. As the pH changes, the bromothymol blue turns from blue to yellow.

Cabbage Juice Capers

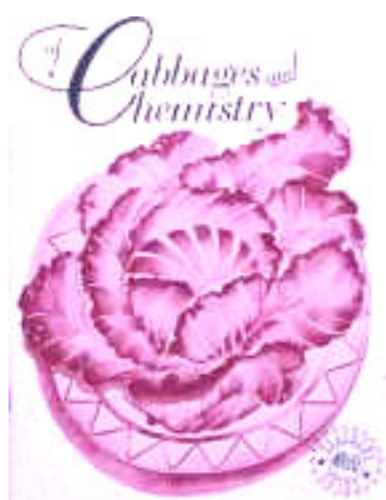
From Project LIFE, Louisiana Tech University

In this activity students mix cabbage juice with several household chemicals and classify the chemicals according to the colors produced. After a discussion of the classification schemes employed by the students, the terms **acid**, **base**, and **neutral** are introduced. The term **indicator** is employed to describe the function of the cabbage juice. Students are next challenged to make all the solutions pink (acidic) by adding one of the other solutions to each container. Students are next challenged to make all of the solutions green (basic) by adding one of the other solutions to each container. Discussion following this activity leads to the idea of **pH scale** and relates pH values to the terms acid, base, and neutral.

The idea that concentration affects the acidity or basicity of solutions is investigated as students compare the color of an original solution with one that is diluted by adding water. In addition, students compare the concentration of three acid solutions and three basic solutions.

Students next measure the amount of each of three acids required to change the color of a basic solution to purple (neutral) and correlate thee amounts with the concentration of the acids. The term **neutralization** is introduced in the discussion following the activity.

These activities are adapted from the GEMS guide *Of Cabbages and Chemistry*.



Selected Concepts

Acids and Bases

Student Discoveries Expanded Through Teacher-Guided Discussions

From Project LIFE, Louisiana Tech University

1. **Solutions of household chemicals can be placed in one of three groups depending on the color (pink, purple, or green) that is formed when each solution is mixed with cabbage juice.**

All aqueous solutions can be classified as acids, bases, or neutral solutions. The classification is based on the hydrogen ion concentration of the solution. A scale from 0 – 14 called the pH scale is used to rank solutions from most acid to least acid. Solutions with a pH less than 7 are acidic, with a pH equal to 7 are neutral, and with pH greater than 7 are basic. Cabbage juice is an indicator. Indicators are substances that are different colors at different hydrogen ion concentrations. Cabbage juice is pink in acids, purple in neutral solutions, and green in basic solutions.

2. **If a substance that turned cabbage juice pink is added to each of the solutions that are purple or green, the purple or green solutions can be turned pink. If a substance that turned cabbage juice green is added to each of the pink solutions, the pink solutions can be turned green. Color changes are from green to purple to pink or from pink to purple to green.**

When an acid is added to a basic solution or a neutral solution, the solution becomes more acidic as more hydrogen ions are added. When you add a base to an acidic or neutral solution, the solution becomes more basic as more hydroxide ions are added. The reactions are reversible. Acidic solutions have a hydrogen ion concentration that is higher than their hydroxide ion concentration. In neutral solutions the hydrogen ion concentration is equal to the hydroxide ion concentration. Basic solutions have a hydrogen ion concentration that is lower than their hydroxide ion concentration.

3. **A solution containing 4 drops of water and 1 drop of vinegar turns pink with a blue tinge when mixed with cabbage juice. A solution of 5 drops of vinegar turns bright pink.**

Acids or bases may be diluted (made less concentrated) by adding water; the diluted solution is less acidic or basic because there are fewer hydrogen or hydroxide ions per milliliter of solution.

4. **It requires 1 drop of lemon juice, 2 drops of vinegar, and approximately 26 drops of aspirin solution to change 10 drops of a drain cleaner/cabbage juice mixture from green to purple. The resulting purple solution is neutral.**

If you mix an acid with an equivalent amount of base, a neutralization reaction occurs; water and a salt are produced. If an excess of hydrogen ions is added, the solution becomes acidic. If an excess of hydroxide ions remains, the solution remains basic. Because it required the smallest volume of lemon juice to neutralize the drain cleaner, the lemon juice is the most concentrated.

Construct a Concept Map Using the Following Terms:

INDICATOR	**HYDROGEN ION CONCENTRATION**
ACIDIC SOLUTION	**BASIC SOLUTION**
NEUTRAL SOLUTION	**pH**
BAKING SODA	**CABBAGE JUICE**
VINEGAR	**WATER**
ALCOHOL	**DRANO**
LEMON JUICE	**ASPIRIN**

SALT WATER

TUMS

$H^+ = OH^-$

$H^+ > OH^-$

$H^+ < OH^-$

>7

<7

$=7$

BLUE/GREEN

PINK

PURPLE

Selected Concepts

Acids and Bases

From Project LIFE, Louisiana Tech University

1. **Solutions of household chemicals can be placed in one of three groups depending on the color (pink, purple, or green) that is formed when each solution is mixed with cabbage juice.**

All aqueous solutions can be classified as acids, bases, or neutral solutions. The classification is based on the hydrogen ion concentration of the solution. A scale from 0 – 14 called the pH scale is used to rank solutions from most acid to least acid. Solutions with a pH less than 7 are acidic, with a pH equal to 7 are neutral, and with pH greater than 7 are basic. Cabbage juice is an indicator. Indicators are substances that are different colors at different hydrogen ion concentrations. Cabbage juice is pink in acids, purple in neutral solutions, and green in basic solutions.

2. **If a substance that turned cabbage juice pink is added to each of the solutions that are purple or green, the purple or green solutions can be turned pink. If a substance that turned cabbage juice green is added to each of the pink solutions, the pink solutions can be turned green. Color changes are from green to purple to pink or from pink to purple to green.**

When an acid is added to a basic solution or a neutral solution, the solution becomes more acidic as more hydrogen ions are added. When you add a base to an acidic or neutral solution, the solution becomes more basic as more hydroxide ions are added. The reactions are reversible. Acidic solutions have a hydrogen ion concentration that is higher than their hydroxide ion concentration. In neutral solutions the hydrogen ion concentration is equal to the hydroxide ion concentration. Basic solutions have a hydrogen ion concentration that is lower than their hydroxide ion concentration.

3. **A solution containing 4 drops of water and 1 drop of vinegar turns pink with a blue tinge when mixed with cabbage juice. A solution of 5 drops of vinegar turns bright pink.**

Acids or bases may be diluted (made less concentrated) by adding water; the diluted solution is less acidic or basic because there are fewer hydrogen or hydroxide ions per milliliter of solution.

4. **It requires 1 drop of lemon juice, 2 drops of vinegar, and approximately 26 drops of aspirin solution to change 10 drops of a drain cleaner/cabbage juice mixture from green to purple. The resulting purple solution is neutral.**

If you mix an acid with an equivalent amount of base, a neutralization reaction occurs; water and a salt are produced. If an excess of hydrogen ions is added, the solution becomes acidic. If an excess of hydroxide ions remains, the solution remains basic. Because it required the smallest volume of lemon juice to neutralize the drain cleaner, the lemon juice is the most concentrated.

General Rubric for Scoring
Science Demonstration Assessments

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.

Scoring Rubric for
Acid/Base Demonstration Assessment

0 No explanations.

1 A clear liquid is poured into a second clear liquid. The mixture turns pink. The pink solution is poured back into the first container and the solution becomes clear.

2 (The above description plus) One solution was probably an acid and the other was a base. The color change was due to an indicator.

3. (The above plus) The indicator was clear at one pH and pink at the other. Because the color changed to pink and then back to clear, there must have been an excess of the reagent in which the indicator was clear.

Project LIFE, 1994.