Contents

Introduction

The Science Cookbook presents experiments that are enjoyable simply as experiences, yet the book also presents a solid, structured course. It is not designed as a rigorous or theoretical science curriculum; rather, it is designed to encourage the curiosity of primary and middle school students and to foster the development of these students' powers of observation.

This book gives teachers a practical and useful base from which to launch science, maths, and language arts instruction. Parents who wish to make their children's learning experiences enjoyable and meaningful will find *The Science Cookbook* a valuable resource for introducing concepts of science and nutrition through cooking. *The Science Cookbook* can be used by scout leaders and teachers' aides as a basic introduction to scientific principles. Pre-school teachers can encourage participation, observation, and language development as they conduct the experiments. The lessons can also be adapted for use in teaching the learning or the intellectually handicapped.

I developed the units for a kitchen science curriculum in the Learning Disability School in the Kennedy Institute for Handicapped Children. Most of the lessons were conducted during a one hour activities period, while extra time was needed for three experiments (see "Drying Apples," "Cooking Dried Lima Beans," and "Making Meringue Shells"). Five or six students attended this activity on a rotating basis once every two weeks. The classroom I used had a stove and kitchen equipment, but I also held classes in a regular classroom using a hotplate, since most of the experiments do not require the use of an oven.

In the classroom, one teacher can teach and supervise a classroom of students, scheduling an experiment from *The Science Cookbook* once a week. The experiments may be conducted as demonstrations with student participation, or the students may be divided into small groups to perform the experiments independently.

Using *The Science Cookbook*

The nine major scientific topics developed in *The Science Cookbook* encompass most of what takes place in an area of immediate concern to everyone: the preparation of food. As such, these topics provide a meaningful foundation for the conventional study of science.

In using the experiment-recipes and accompanying material, students will develop awarenesses in the areas of chemistry, physics, and biology. They will set up conditions for, and observe effects of, dissolving, oxidizing, and evaporating. They will discover how cooking procedures cause changes in food substances that create the familiar consistencies of many foods. For example, they will learn how heat coagulates protein, softens cellulose, and causes starch to thicken liquids. Awareness of scientific principles will expand as students separate oil particles or protein strands by mechanical means in order to change the physical nature of food substances. They will learn that, by physical or chemical processes, gas can be incorporated into a mixture and then expanded by heat to provide a leavening effect. And, finally, they will become more knowledgeable about their own physical senses as they add herbs and spices to various dishes.

The nine major topics explored in *The Science Cookbook* are apparent in the unit titles. Accompanying each title is a focus question which is answered via the experiments in that unit.

The introduction to each unit touches on a few areas applicable to the focus question. This introductory discussion will help the teacher, leader, or parent to refresh his or her knowledge of the subject and to anticipate questions that students may raise.

Inevitably, the subject matter in the units is interrelated. To foster this relationship, cross-references are interspersed parenthetically. Each one serves as a quick reminder of an opportunity to preview or review a principle or concept developed in another unit.

Following the introduction, the specific teaching goals of a unit are listed as the *Objectives*. Next, a list of *Applied Skills* suggests how students may gain from the experiments in such ways as measuring ingredients, developing motor dexterity, or using mathematical formulas.

A list of *Key Ideas* gives the basic understandings that are introduced in the experiments to answer the focus question. This section also lists related concepts which will develop as the lessons evolve.

Each experiment within a unit has its own brief introduction, providing information and instructions that I have found useful in teaching the lessons. In parentheses, I quote an occasional question or comment that I have used to guide the students to a particular discovery. Vocabulary words to be introduced and defined in the course of the experiments are italicized when first used in this introductory section in order to call your attention to them as you plan your discussions.

The *Vocabulary* list immediately follows the experiment introduction. It provides definitions for words related to the scientific concepts developed as well as for words useful in understanding the recipe. The asterisked vocabulary words are words that appear on the student experiment pages but not in your introductory material. These words are asterisked to draw attention to the fact that you will need to explain them even though they are not referred to in the introductory text.

Introduce the vocabulary before or during the activity. Make vocabulary cards or use a blackboard for recording the words to provide visual reinforcement. Since the best opportunity for practicing new vocabulary will be during informal discussions with the students, be sure to make maximum use of the new words and call for their use throughout the activity.

A list of *Materials* gives you a quick check of what you will need for a given experiment. A hot plate will suffice as heat source, except for the few experiments in which an oven is specified. Most of the equipment called for is available in any kitchen. Certain basic items are *not* listed under Materials—a clock, pot holders, water, a vegetable scrubbing brush, paper towels, and cleaning implements. These should be regularly available for the experiments.

The eating utensils specified are sufficient for six persons, the optimum size for a working unit. Such a group is small enough to sit around a table so that members can help one another. They can participate frequently and observe together by the stove. And, it is large enough to encourage brainstorming and learning to wait for a turn.

A few special pieces of equipment are suggested as optional: a steaming rack, or steaming basket, that adjusts to fit most pots (for several vegetable recipes), a food mill, and an icing bag (for making Twice-Baked Potatoes). These implements are fun to manipulate as well as effective. A small scale also adds an element of interest and an opportunity to teach maths each time an ingredient is called for in weighed grams.

Discussion Questions are provided for an informal review of each experiment with the students and as a means of evaluation. Those using the experiments as science lessons in schools will want to keep these questions in mind as they proceed through the experiment.

A list of *Related Activities* suggests additional experiments and projects to further apply and reinforce the scientific principles covered in a unit. This section may suggest library research, field trips, alternative recipes, or other activities for expanding selected concepts developed in a given experiment.

The actual *Experiments* can be found on pages 55–82. These student worksheets are intended for the students' direct use. Permission is granted to copy this page, so that each child in a group can have his or her own sheet for easy reference. Copies can be laminated to cards to make them more durable.

Each experiment is usually, but not always, a recipe. The recipes will serve small tasting portions to six people. These portions are too small to spoil one's appetite before lunch or to appear unappetizing after lunch. To allow for different quantities and to provide practice in computation, some recipes call for cutting the recipe in half or for multiplying the quantities by several factors.

Goals

In formulating the directions on the experiment pages as well as in providing suggestions for discussions, I have kept several points in mind:

1. Experimenting and cooking by following written directions motivate reading. You will want to foster language skills guided by the individual needs of the students. It will seem natural to encourage some of the following cognitive, reading, and expressive skills while the experiments are being discussed and carried out:
   - listening
   - following oral directions
   - applying word-attack techniques
   - recognizing words and distinguishing between them
   - labelling and recording
   - following written directions
   - answering comprehension questions
2. Learning fundamental scientific concepts and using the scientific method are basic goals. The scientific techniques that can be practised during the experiments include:
   - hypothesizing ("What will happen if . . . ?")
   - labelling
   - measuring accurately
   - observing
   - collecting data
   - comparing
   - categorizing
   - drawing conclusions
   - summarizing
3. Developing motor skills with kitchen tools and applying maths skills complement the above goals by providing students with additional opportunities to enhance their self-esteem.

Motivation

With the listed skills and concepts as the ultimate goals, the obvious motivation for each experiment will be the finished product. Four other elements also basic to the cooking experiences will provide motivation:

1. *Healthy and appealing ingredients.* Crisp vegetables, toasted wheat germ, golden honey, and other nutritious ingredients are attractive and appetizing.
2. *Hands-on involvement.* The student who reads one item of a recipe should be the one to locate and measure the specific ingredient. Another student may read ahead in order to carry out one of the directions. Sharing a common goal, other members of the group will be motivated to lend a helping hand.

   If one of the goals is to teach word recognition, allow students to scan bags from health food stores or containers you have labelled yourself rather than the familiar commercial packages. Novel containers are suggestive of an exciting treasure hunt and create an exciting atmosphere.
3. *Hypothesizing about "What will happen if . . . ?"* Ask such questions to intrigue and encourage learning by observation. Be ready to supply some answers, though, so that the students are not straining to hypothesize too extensively for too long—*this* creates frustration.
4. *A hands-off attitude.* Allow plenty of time for students to do their own work. Gently call for checking if "teaspoon" is read as "tablespoon," "sugar" as "salt," or "cloves" as "chives." Encourage involvement. Let students solve their own problems, make errors, and try again. Let them discover ways to pour, beat, and measure. They will develop confidence from their many successes.

You may feel frustration as the students move slowly through tasks you could do far more quickly. They may pour a tablespoon of oil with exasperating deliberateness. They may be awkward in cutting the eyes out of potatoes, and they may ask why potatoes have eyes in the first place. It is worth "winding down" your own tempo and relaxing so that you can watch *them* enjoying the task in their own way. One student may demonstrate real skill in chopping vegetables with finesse. Another may show a new social awareness by spontaneously holding a bowl while a partner beats the ingredients. Thus, you may have a much-needed opportunity to give genuine praise for a specific behavior, something all of us need and like.

Teaching Approach

As the students are about to begin an experiment, stress the importance of following the directions in the order given. The experiment may be read through once, then discussed, and read again, one step at a time, or the directions may be simply read and followed step by step. Either way, make sure everyone is sure that step 1 has been completed before they tackle step 2.

Noses must not be so deep in the directions, however, that the students fail to notice what is happening. They should have time to express their observations, use new vocabulary, and formulate concepts.

Maths concepts as well as science concepts can be reinforced as the activity proceeds. Seize opportunities for applying skills already learned, for clarifying uncertainties, and for previewing future concepts. The recipes offer the perfect opportunity to apply and manipulate fractions using measuring cups and spoons.

Encourage the students to help explain the abstract concepts to each other. I once used Cuisenaire rods to illustrate ½ of 1½ and then expanded the demonstration by using diagrams of pies and measuring cups of water.

Some Practical Tips

These suggestions may be helpful in developing skills:

- Post two 13 x 18 cm cards, one under the other, with *teaspoon* written on one and *tablespoon* on the other. Supply measuring spoons which have the corresponding words clearly marked. Encourage everyone to double check teaspoon and tablespoon when reading the list of ingredients and selecting the correct measuring spoon.
- Supply cup, 500 ml and litre measures. Compare how 1 cup of water registers in each container. Relate this to ½ litre and smaller measurements.
- Include time as a measurement. Use a clock rather than a timer in order to develop facility in adding minutes to any given time.

At the start, clarify some basic safety rules to be observed throughout the experiments:

- Be aware of stove settings.
- Keep pan handles away from the stove's edge.
- Use potholders.
- Set aside breakable items and containers of ingredients when not in use.

Also review health rules:

- Wash hands before preparing foods. (But cool the sanitary ardor of those finicky students who want to wash every minute.)
- Keep hands away from mouth and hair and from dirty surfaces.
- Cover sneezes and coughs. Wash hands again before handling food.
- Scrub fruits and vegetables to remove chemicals and dirt. Use cold water.

Try these solutions to avoid the mess that can accompany cooking:

- Self-appointed cleaners often straighten or wipe up as the activity proceeds. Gently encourage this.
- Job appointments can be made by means of a chart, or more informally. Rotate jobs for each experiment. (Use paper towels to dry dishes, as a convenience and a health precaution.)

Extending and Improvising

As you try out the experiments, you may need to modify some of them to fit the capabilities of the students. Perhaps you will think of recipes of your own to write up for an appropriate unit. You may want to investigate why certain phenomena happen, or you may want to find additional information about certain foods. (See the BIBLIOGRAPHY, page 47, for ideas and inspiration.)

Your enthusiasm will be contagious. Your students will not only feel useful and gain confidence, but they will eagerly add to their store of concepts, thus enjoying both the tangible and intangible fruits of their labors.

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Dissolution: How Does Temperature Affect Dissolving Rate?

In this unit, students investigate the effect of temperature on molecular activity, or the speed at which molecules move. Dissolving takes place when molecules separate from each other and spread out, or diffuse, into a solvent. Temperature is a spectacular factor in determining whether this action will happen in a few seconds or in many hours. Whether hot or cold, molecules of all matter are in constant motion. Applying heat gives molecules extra energy and steps up their activity; chilling reduces their energy and slows down their movement.

Despite their activity, molecules of the same kind have an attraction toward each other which is a force called cohesion. There is always a lot of space between molecules, but when they are cool, they are relatively close together. Then the cohesion is very strong, and the molecules assume a solid form. When they gain energy from heat, the molecules move apart. Then, the cohesion is weaker, and the molecules take on a liquid form. In a gas, cohesion is so weak and activity so great that the molecules travel far apart in all directions; the volume of a gas is limited only by the container it is put in.

When honey is mixed with water, the ever-moving molecules of honey bombard themselves into the spaces between the ever-moving molecules of water, and vice versa. There they are attracted to the water molecules, to some degree, by a force called adhesion, or attraction of one kind of molecule to another kind. We say that the honey is dissolved, or if we are being scientifically precise, that the molecules of the honey have diffused among the water molecules. The hotter the liquid, the faster the process occurs.

Some kinds of molecules do not separate (diffuse) into any liquid, and some molecules can diffuse into some liquids but not others (for example, grease into petrol, but not into water). Dissolving some substances (for example, salt in water) involves the separation of the solute into ions rather than molecules, but this distinction is not developed in the following discussion.

Objectives

- To teach the concepts of molecular activity and molecular forces of cohesion and adhesion
- To relate the processes of dissolving and diffusion to the above concepts
- To demonstrate the effect of temperature on molecular activity
- To introduce hypothesizing, labelling, measurement, observation, and comparison within an experimental framework
- To encourage computation of required amounts for servings needed

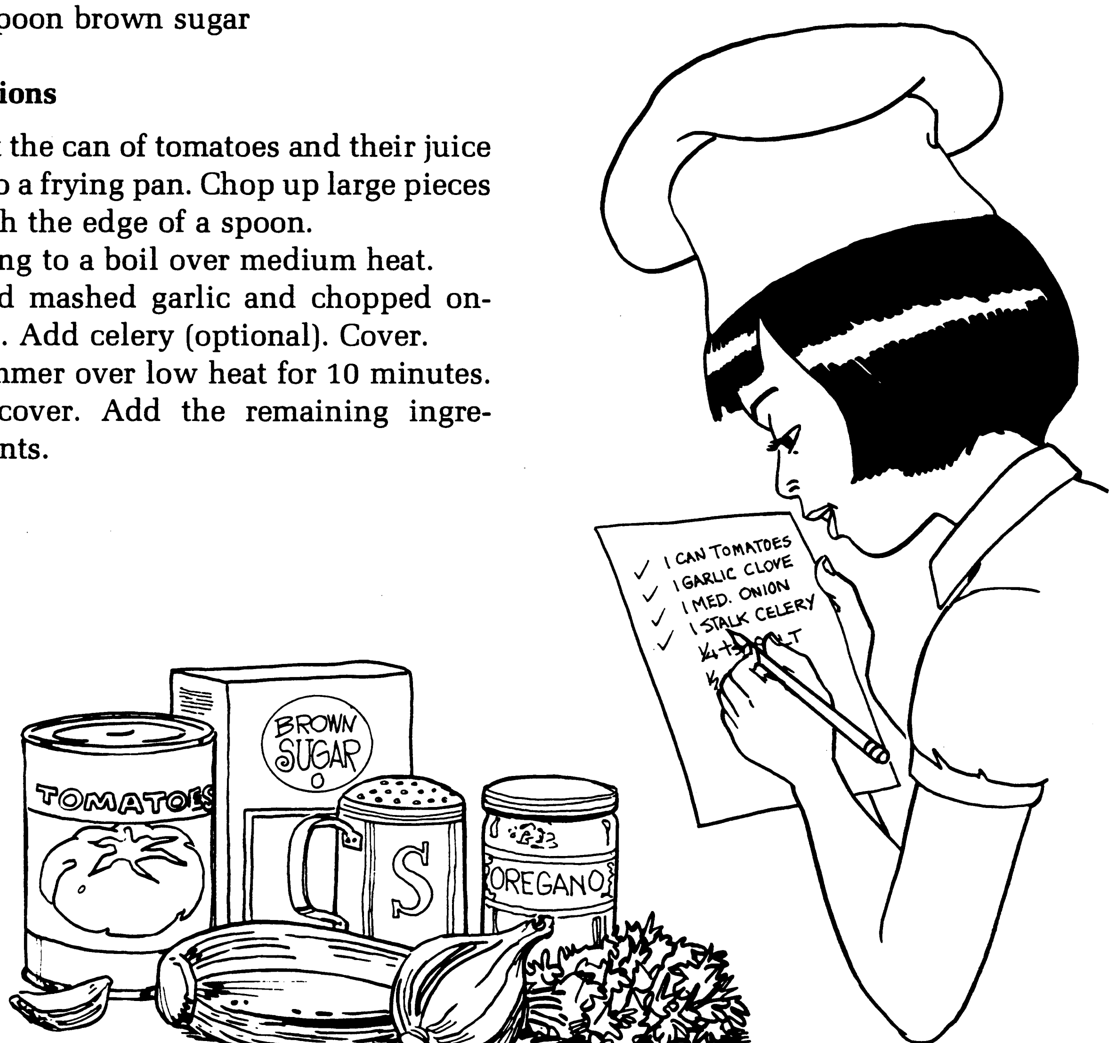
Evaporation Experiment: Making Stewed Tomatoes

Ingredients

1 450 gram can tomatoes
1 garlic clove, peeled and mashed with the broad blade of a knife
1 medium onion, chopped
1 stalk celery with leaves, sliced (optional)
¼ teaspoon salt
½ teaspoon dried oregano
1 teaspoon brown sugar

Directions

1. Put the can of tomatoes and their juice into a frying pan. Chop up large pieces with the edge of a spoon.
2. Bring to a boil over medium heat.
3. Add mashed garlic and chopped onion. Add celery (optional). Cover.
4. Simmer over low heat for 10 minutes.
5. Uncover. Add the remaining ingredients.
6. Simmer, uncovered, until the juice has evaporated (about 10 minutes). Stir now and then to prevent sticking.
7. Spoon onto plates and serve.



Coagulation Experiment:
Making a Cheese Omelette

Ingredients

4 eggs
¼ teaspoon salt
2 tablespoons vegetable oil
1 tablespoon grated Parmesan cheese

Directions

1. Measure the ingredients. Put them near the stove.
2. Break the eggs into a bowl.
3. Heat the frying pan over medium heat.
4. Put a serving plate near the stove.
5. Whisk the eggs with a fork just enough to blend them.
6. Check the pan to see if it is hot enough. Do this by sprinkling a few drops of water into the pan. The drops should dance in the pan, if it is hot enough.
7. When the pan is hot enough, pour in the vegetable oil. Spread it around with a spatula.
8. Sprinkle the salt over the surface of the pan.
9. Pour the egg mixture into the pan.
10. Count 10 seconds.
11. Sprinkle the grated cheese on the eggs.
12. Let the omelette become a little bit firm. Fold it in half with two forks or a spatula.
13. Cook the omelette for another minute.
14. Slide the omelette from the pan onto the serving plate.
15. Use a spatula to divide the omelette and serve it.