# TAKE 10 FOR SCIENCE:

## *Integrating Writing and Science in the Multigrade Classroom*

By Larry D. Burton

One of the primary purposes of elementary science education is to help students learn to deal with scientific processes.[1] Because many of these processes are complex, they require that students first master basic skills. (See Figure 1.) Surprisingly, many teachers and even scientists overlook communication as a scientific process. Others relegate this process to writing final project reports or published articles. However, communication is vital in every phase of scientific inquiry, from initial observations through formulating hypotheses and drawing conclusions. Communication—including writing and discussion—is critical in both constructing and sharing scientific knowledge.

While not engraved in stone, perhaps the following techniques will help your students combine serious writing and science. These 10 techniques are user-friendly for both teacher and student in multigrade schools.

### Technique 1: *Observation Breaks*

Observation is a crucial foundation for both basic and complex processes. Without the ability to make observations (identify attributes or characteristics), students will be unable to classify (group by attributes), measure (quantify observations), or draw inferences (derive meaning from observations).

Observation Breaks help students to systematically observe and record their observations. The following steps can be used with any scientific inquiry process or experiment:

1. Begin the activity.
2. Make initial observations.
3. Set a timer for five to 15 minutes (depending on how fast the activity will unfold).
4. When the timer sounds, have students record additional observations.
5. Reset the timer and repeat step three as appropriate.

To use this technique successfully with young or older-yet-inexperienced students, provide structured forms to guide them in recording their observations.

Here's how this might look in a lower-elementary, multigrade classroom: Pair students, combining a younger and an older child. Give each pair a single-serving-size box of breakfast cereal, some highly sugared, others not. Have the students crush the cereal and pour it into a zippered plastic bag. They are then to add 1/2 cup (change measures to metric as needed) of warm water (about 38 degrees C) and one teaspoon of rapid-rise yeast, expel the air, seal the bag, and gently squeeze its contents.

Next, they are to make their initial observations, using as many senses as possible. (Never ask students to taste during experimental processes. Teach them to use a wafting motion when smelling.) The students then return to other work. Each time the timer sounds (every 10 minutes), student pairs make observations about their bag. Nonwriters can use pictures to record their observations, dictate to an older partner, or use invented spelling until the other partner has finished his or her observations and can assist them. This continues for about an hour or until all students have recorded their observations at least four times. Each pair then prepares and presents a brief report to the class based on their observations. As each team reports (using the scientific process of communication), record the results on the chalkboard so the class can compare data and benefit from the knowledge constructed by others.

As they compare the data, the students will notice that the bags containing sugary cereals tend to fill with more air than the other bags. They will won-

der if sugar has an effect on the yeast (inferring, isolating variables). They will also wonder if they can make the bags fill with more air. One student may suggest that she can make her bag pop by adding more yeast (formulating hypotheses). The students are now ready to begin developing experiments (another scientific process) to test their hypotheses.

**Technique 2: *Field Narratives***

Field experiences, such as nature walks, field trips, and scavenger hunts, are important parts of science education. Too often, however, these are only "events." We tend to inadequately engage students before and after they occur. To maximize the learning potential of these events, have your students write Field Narratives, stories describing the experience from their own viewpoint.

The Field Narrative begins before the experience. Students discuss with the teacher and one another the types of experiences they are likely to have while out of the classroom. They make plans for observation and data collection. Ideally, they will take notebooks in order to record observations while in the field. If that is not possible, they need to do so immediately after returning to the classroom.

When students reassemble in the classroom, they should interact with their peers and teacher. Each student should be given the opportunity, in small groups or with the whole class, to share his or her observations and perceptions of the field experience. With young students, the teacher or an older

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**Figure 1**

## Scientific Processes

| | |
|---|---|
| **Basic Processes** | |
| Classifying | Grouping by attributes |
| Collecting and Recording Data | Selecting information and storing it in a usable form |
| Communicating | Sharing scientific knowledge |
| Comparing | Exploring similarities |
| Contrasting | Exploring differences |
| Describing | Expressing what is observed |
| Identifying Variables | Determining what could be responsible for what is happening |
| Inferring | Making meaning from observations |
| Measuring | Quantifying observations |
| Observing | Using the senses to identify attributes |
| Predicting | Forecasting behavior based on prior knowledge |
| Questioning | Learning to ask "Why?" and "What if?" |
| Representing Data | Using graphs, tables, etc. |
| Using Spatial Relationships | Exploring shapes and movement |
| **Complex Processes** | |
| Controlling Variables | Differentiating between constant variables and those to be manipulated |
| Defining Operationally | Describing what is to be done and observed |
| Drawing Conclusions | Evaluating results and constructing support for claims |
| Experimenting | Manipulating variables to produce a result |
| Formulating Hypotheses | Proposing reasonable, testable answers to questions |
| Inducing | Forming generalizations based on data patterns |
| Interpreting Data | Finding patterns in data |
| Verifying | Using repeated measures or data collection techniques |

(Adapted from Alfred E. Friedl, *Teaching Science to Children*, p. 1)

student can record the order on the chalk board. As each child uses the writing process to report his or her experience, this chronology can serve as an organizer.

**Technique 3: *Venn Diagrams***

As they engage in the observation process, students often need help organizing their observations. A Venn Diagram can help them to do this. Venn Diagrams are graphic organizers that compare and contrast objects by representing each with overlapping circles. In the shared area, the students record the similarities between the objects or concepts. Where the circles do not overlap, students record their unique attributes.

Recording and organizing observations is not the only function of Venns. They are excellent starters and organizers for student writing. After recording their observations, students can use the Venn to help them write a comparison essay. The essay begins with an introduction to the two objects or concepts,

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continues by describing their differences, moves on to their similarities, and concludes with a summary.

For most elementary students, the essay could be short—five or six sentences. For older students, each part of the essay could require one written paragraph. Figure 2 provides an example of a Venn Diagram in which a fifth grader compared a wristwatch and a small desk clock, and wrote an essay on the subject. (In fact, the section of this article comparing Science Logs and Reflective Journals was written using this process: [1] make the Venn, [2] introduce the concepts, [3] describe the differences, [4] describe the similarities, [5] conclude the writing.)

**Technique 4: *Concept Webbing* and *Mapping***

Concept Webbing is another graphic organizer that helps students make sense of information and observations. By having students construct Webs of the same concept at different times during a unit, you can assess their growth in understanding.

To construct Concept Webs, the student begins by placing the concept (noun) in a circle at the center of the page. Then he or she writes related ideas, encloses them in circles, and connects the circles to one another with lines to illustrate their interrelationship. Webs allow students to concretely demonstrate their understanding of the complex interconnections between scientific concepts.

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To take Webs to a higher level, students can add verbs and arrows to the connecting lines to explain the connections. This type of graphic organizer is called a Concept Map. Figure 3 is an example of a Concept Map created by a pair of students in grades three and five. They began by creating a simple Web. Then the teacher asked questions to help them describe the connections they saw, using the language and structure of the Concept Map. After they complete a Concept Map, students can create a paragraph.

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**Technique 5: *Elaboration***

Most teachers have little time to develop their own assessment instruments. The Elaboration technique offers a powerful technique to supplement traditional multiple choice, true-false, and short answer exams. Elaboration turns each of these test item types into "mini-essays." For true-false items, the student either explains briefly why the item is false or gives additional information about it if it is true. For each multiple-choice test item, students can write two or three sentences explaining their answer. For short-answer items, they can write several sentences telling what else they know about the concept.

**Techniques 6 and 7: *Science Logs* and *Reflective Journals***

Science Logs and Reflective Journals are long-term records of science class learning. The Science Log, which typically has a more structured format, demonstrates personal growth in knowledge. Specific items can be designed for inclusion such as class notes, observations of experiments, and examples of a student's best work or the project he or she found most challenging. Requirements for the Log will vary according to teacher preferences and the content being studied.

The Reflective Journal, which is less structured than the Science Log, helps students think about their learning. The teacher provides general guidelines, but does not usually require specific entries. Guiding questions for Reflective Journals can include the following:

- What did I do (learn) well?
- How could I improve my learning in science?
- Does this learning make a difference to my life? Where does it fit with what I already know?
- What do I want to study in more depth?

Students can express their feelings about science in the Reflective Journal or assess specific projects or activities.

Logs and Journals require students to evaluate themselves in at least four areas:

- strengths and successes
- weaknesses and plans for improvement
- differences this makes in their lives, and
- things they want to study in greater depth.

Teacher response is critical to the success of both Science Logs and Reflective Journals. If we expect students to invest time in creating a quality Log or Journal, we must invest time into reading it and responding. Reflective Journals require more frequent reading than do Logs. Daily reading of Journals is best, but you can use a rotation system, reading each student's Journal on alternate days. The response schedule for Logs will depend on the content being studied and the age level of the student. In some cases, weekly reading may be adequate. But the general rule is "the more often read, the better."

**Technique 8: *Response Journals***

The Response Journal is a variation of the Reflective Journal. In Response Journals, students respond to the teacher's prompt. For example, after completing a science unit, you could say: "In your journals today, tell me what you know about the body parts of insects." This allows students to include their prior knowledge, observations in

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class, and ideas presented by the teacher.

If the students have already demonstrated their basic understanding of the subject, you will need to nudge them toward a higher level of thinking by requiring application, analysis, synthesis, or evaluation. For example, you could ask: "How would insects change if they suddenly only had two body parts instead of three? Draw a picture and explain it in writing."

**Technique 9: *Direct and Personal Analogies***

Personal Analogies are a natural way to help students learn to compare unlike objects or ideas.[2] In creating a Personal Analogy, the student imagines what it would be like to be something or someone else. During the initial phase, student response is usually oral, with the teacher or an aide serving as scribe on the chalkboard. Students can also be asked to act out their responses to a series of specific questions such as the following:

1. You are a small seed. Someone places you in the cold, moist ground. How do you feel? What do you do?

2. After a few days, you are feeling a little different. It's almost like you are stretching. Suddenly you break through the ground and see a shiny bright yellow object in a big blue space above you. How do you feel? What do you do?

3. As the days go on, you notice you are getting taller and taller. Show how you are growing. How does this make you feel?

4. Suddenly, a big, round, flat object begins to grow at your top. One day, you notice there are beautiful yellow petals all around its edge. All day long, your round yellow face follows the path of the big yellow sun across the blue sky. Show your movement. How do you feel now?

After they respond orally to the prompts and learn more about plant growth, have students describe in writing the life story of a sunflower seed.

**Figure 2**

**Venn Diagram comparing a clock and a wristwatch**

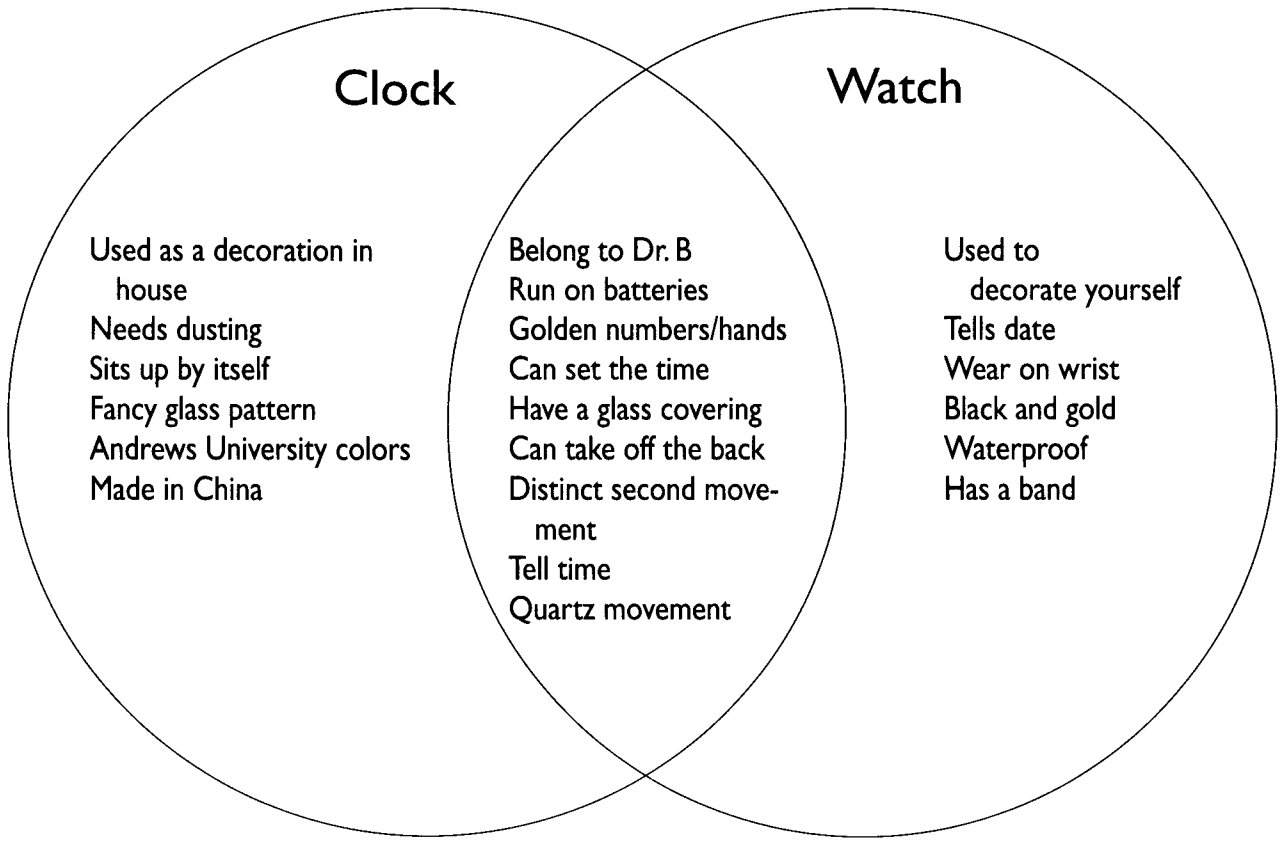
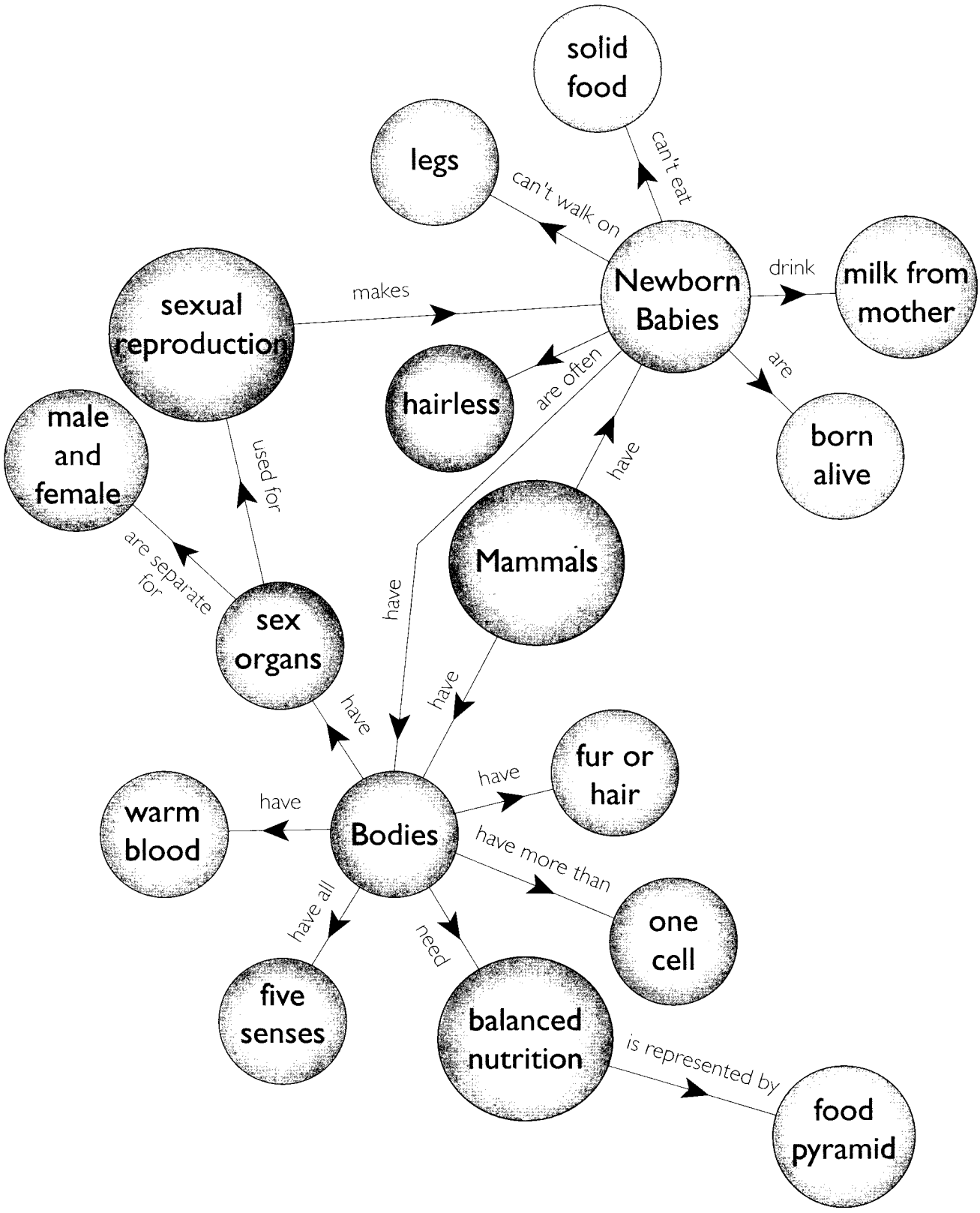


**Figure 3**

## Concept map on mammals developed by a pair of multigrade students



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This process can be repeated for other content as well.

Students usually also enjoy Direct Analogies, in which they describe similarities between unlike objects or ideas. At first, they will need help, but with consistent practice they can be taught to do this on their own. Here are some sample prompts:

- How is a garden hose like a snake?
- How is a child like a computer?
- How is music like fear?
- How is a microscope like Jesus?

Some analogies will be more difficult than others. However, don't underestimate the ability of even young children to find many similarities. Giving them the opportunity to respond in writing combines the scientific process of comparison with the development of higher-order thinking skills.

**Technique 10: *Simple Parables***

One of my favorite techniques, usable with learners of all ages, is a variation of Christ's parable methodology. Whether on an "observation" hike or sitting in a classroom, Simple Parables are easy to implement. Although similar to the analogies above, their focus is explicitly spiritual, as the student tries to discover what characteristic(s) a physical object shares with an eternal truth or reality. Here is how it works:

1. Give students a collection of familiar objects related to the topic of study, for example: rocks, bits of fabric, mini-sculptures of animals, tools, mugs, shrubs from the playground, and so on.
2. Each student selects one object that appeals to him or her.
3. Students make notes about the attributes of their object.
4. Pose a guiding question. For example, "How is your rock like Jesus?" or "What does your fabric teach you about eternal life?"
5. Students then take time to think before responding, basing their response on characteristics of their object. Initial responses are given orally to the class.
6. Finally, students write a simple one- or two-sentence parable. For example, "My rock has a scar on its surface. That reminds me that Jesus will always carry scars from the cross."

This activity allows students to combine observational skills with analysis of spiritual truths. And it allows teachers to assess students' proficiency in the scientific process and their understanding of spiritual concepts. It is important to give the learners actual objects to hold, touch, and observe. As a result, they will bond with their object (and therefore with their parable or concept). (See Figure 4.)

My colleagues and I have used this technique (and variations of it) with learners from age 6 to 60 and have found it equally powerful with all ages. Perhaps the most moving sharing has occurred in multi-generational settings. Try it at a Home and School meeting or at a school-sponsored vespers program and prepare to be inspired.

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**Conclusion**

So now that you are inspired to integrate writing into your science instruction, let me offer some tips for successful implementation of these 10 techniques. First, start small. Select one technique that you are not currently using, and incorporate it into your instruction. Only after you are comfortable using it should you add another technique to your repertoire. Second, don't give up until you have tried the technique at least 10 times over a period of a month or more. Third, make a copy of this article and place it with your lesson planning materials. Fourth, and most importantly, share your learning with your colleagues. Talk to a fellow teacher about your use of these techniques and ask how he or she integrates writing and science. Build a support team of colleagues, and you cannot fail to improve your teaching!

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REFERENCES

1. Alfred E. Friedl, *Teaching Science to Children: An Inquiry Approach* (New York: McGraw-Hill, 1997), pp. 1-7.

2. The technique of forming Personal Analogies is derived from the work of William J. J. Gordon and his synectics process for teaching creative thinking and problem solving (Bruce Joyce and Marsha Weil, *Models of Teaching* [Boston: Allyn and Bacon, 1996], pp. 239-244).

**Figure 4**

## Observations about a tin and Simple Parables written by a third grader

| *My Observations About My Tin* | *How Is My Tin Like Jesus?* |
|---|---|
| it is hard and solid like a rock. | Jesus is the Rock of my salvation. |
| It has strawberries on it. | Jesus is the Creator of strawberries and all good things. |
| It has a candle inside that smells good. | Jesus is filled with love for me. |
| The candle is red. | The red color makes me think of Jesus' blood when He died for me. |
| The candle burns and gives light. | Jesus gives light (the Bible) to see the way in the path to heaven. |