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ABSTRACT

Designed to provide teachers with new knowledge about the goals of science instruction and practical recommendations for instructional practice, this third of a three part series of guidebooks provides guidance for teachers in incorporating the scientific literacy components into different scientific topics. A review is provided of the major components of scientific literacy and directives are outlined on how to use these components as an organizing theme within which the explaining of content takes place. Ideas and suggestions are offered for: (1) selecting a topic (providing guide questions in assessing the relating components of topic areas); (2) planning topic lessons (including guidance and a format for a daily activity plan and for outlining the major content concepts and relating concepts); (3) sharing the planning experience (proposing questions for group discussion); and (4) general guide for recitation lessons (recommending specific classroom procedures). An appendix contains training notes for inservice programs and materials for overhead reproduction. (ML)

HOW TO BUILD OPPORTUNITIES FOR SCIENTIFIC LITERACY INTO YOUR CURRICULUM

A Guidebook for Teachers of Life Science at the Intermediate Level

Intermediate Life Science Study Series, Volume III

Far West Laboratory for Educational Research and Development

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PREFACE

This guidebook is the third in a series of teacher inservice materials produced by the Secondary Science and Mathematics Improvement (SSAMI) Program at the Far West Laboratory for Educational Research and Development. The goal of the SSAMI Program is to study and improve instruction in science and mathematics at the secondary level. During the 1983-1984 school year, one of the ongoing projects of SSAMI was the Intermediate Life Science Study. This guidebook and its predecessors represent an effort to translate the background and findings of the Intermediate Life Science Study into a set of materials that provides teachers not only with new knowledge about the goals of science instruction and its current practice, but also with practical recommendations for moving each teacher's current practice closer to these goals. A set of training instructions, to be used in conjunction with each guidebook in workshop meetings, also is provided.

We wish to thank Dr. John Taylor, Teaching and Learning Division, National Institute of Education, for his support in this and other work. His interest in exploring innovative ways of approaching the problems that confront educators and their encouragement of educational excellence is appreciated.

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PURPOSE

In the previous two guidebooks we have reviewed the meaning of scientific literacy and also seen evidence that the relating components of scientific literacy receive little attention in most current science instruction. Now, it is time to explore some practical steps for improving this situation! Indeed, the purpose of this guidebook is to give you experience with a general approach to planning the incorporation of the scientific literacy relating components into different science topics. We hope that once you are familiar with this approach, you will begin to use it for planning some of your regular instruction.

There are several things to keep in mind as you go through this guidebook:

1. Think generally! In the context of one workshop, you have the opportunity to plan one topic at a general level--namely, thinking out the kinds of activities you want your students to engage in and the basic scientific literacy concepts you want to communicate during those activities. There will not be time in the workshop to develop specific plans for the things you say to your class or the assignments you give them; nonetheless, we hope you have time later to develop these ideas on your own, and we give you some guidelines for doing so. In short, for this practice, we'd like you to work on "the big picture" and not worry yet about fine details.

2. Your best resource is you! In going through this guidebook during a workshop, you will not have all the planning resources that you ordinarily might have (e.g., a scientific literacy resource folder, science books and periodicals). However, for your first planning exercise, this may not be such a disadvantage. Rather than spending your time searching through resources to give you ideas, we prefer that you use your own background, imagination, and judgment to do your planning.

3. The right planning process is one that fits best with you and your students! There are no right and wrong results to the planning process in this guidebook. It is possible for any science topic to be taught in light of any scientific literacy relating component. Thus, we hope you use your own individual background and interests--as well as those of your students--to help you select a particular combination that will work well in your situation. This is likely to be the best recipe for success.

Before beginning the planning process, it's a good idea to review the scientific literacy framework.

A Review of the Scientific Literacy Framework

The scientific literacy framework consists of five components:

1. Explaining the Content of Science.
2. Relating Content to the Social Historical Process of Science.
3. Relating Content to the Reasoning Process of Science.
4. Relating Content to the Societal Impact of Science.
5. Relating Content to the Personal Use of Science.

As we have seen, when most teachers teach a science topic, they focus almost exclusively on the first component, explaining the content of science. The purpose of this guidebook is to learn how to plan instruction of a science topic by including one of the remaining four relating components as an organizing theme, within which the explaining of content takes place. Table 1 reviews the definition of each of the five scientific literacy components.

SELECTING A TOPIC

This guidebook and the accompanying workshop will give you hands-on experience in working with the scientific literacy components. You will look at several of the topics you teach and get some ideas about how to think about the relating components. Then, you will be asked to look at <u>one</u> of those topics in more depth -- to give you an idea of how to go through from beginning to end in planning a topic in terms of scientific literacy. Then, we will share ideas with each other, and you can take all the ideas with you and use them in planning your next topics.

A Topic List

The first step in this planning process is to list some topics that you want to work with. While any life science topic is acceptable, we suggest you select topics that you teach regularly each year for at least one week--i.e., ones that you are familiar with and spend some time on. Furthermore, it may help you to select topics that you particularly enjoy teaching.

To get yourself started, turn to Table 2. In the left-hand column of this table, list <u>four</u> different topics that you would consider working with.

Table 1

Five Components of Scientific Literacy

Explaining the Content of Science:

Terms, facts, and concepts are fundamental to specific life science topics. This basic content is the foundation for understanding many of the essential phenomena of earth's life systems. For example, if you are teaching students about the digestive system of mammals, the names and functions of several organs as well as the role of digestion are basic content you need to explain.

Relating Content to the Social Historical Process of Science:

Scientific knowledge is not discovered as a set of preexisting facts; rather, it accumulates as the work of individual scientists. This work must be recognized and accepted by other scientists and the public at large. Often both the scientific community and lay public are slow to recognize and assimilate new theories and discoveries. You can communicate this social historical process of science in specific or general terms. In specific terms, you can refer to the contributions of particular individuals in history and the way that these contributions took hold. For example, you could organize a topic on genetics using the history of the work of Mendel and his scientific community. In general terms, you can often indicate that some aspects of scientific knowledge are the collective work of many individuals working on similar problems, without mentioning specific scientists.

Relating Content to the Reasoning Process of Science:

Scientific knowledge is accumulated through a set of agreed upon methods and standards, and not in an arbitrary fashion. You are relating to this component when you take a particular topic and illustrate how you can learn about the topic by observing natural events and formulating and testing hypotheses. In the course of such a presentation, you may also have occasion to cover the concepts of deductive and inductive reasoning, randomness and probability, as well as the tools and methods of measurement.

Relating Content to the Societal Impact of Science:

Scientific knowledge in a particular topic area has led to technologies that, in turn, influence society. Often, you can make a direct link between a technological product (e.g., a new fertilizer) and its social consequences (e.g., more productive farming, increased land use, more pollution). You also will find that this component lends itself especially well to the presentation of at least two points of view (e.g., the advantages and disadvantages of organ transplants), thus modeling parts of a decision-making process that students can apply in their role as citizens.

Relating Content to the Personal Use of Science:

Science has implications for students' everyday lives. Here, it is possible to illustrate that scientific knowledge in particular topic areas can help students make informed decisions about their own health and their selection of food, household goods, and sources of energy.

Table 2

Topic Selection Guide

Name: _____

Date: _____

Life Science Topic	Possible Relating Components
1.	
2.	
3.	
4.	

Adding the Relating Components

Now, consider the four topics you have listed in Table 2. For each one, think of at least one relating component that you think could be a useful theme in presenting the topic content. In this thinking process, it may help if you ask yourself the following questions:

1. What do I find most intriguing about teaching this topic?
2. What do I personally (or as a member of our society) find most interesting about this topic?
3. Why is it important for my students to be exposed to the information covered in this topic?
4. Would tracing the history of this topic help me organize (or my students understand) the content of this topic?
5. Have scientists investigating this topic made contributions that my students might find especially interesting?
6. Does this topic provide any good opportunities to illustrate how to approach or solve a scientific problem?
7. Does this topic provide any good opportunities for me and my students to develop and test our own hypotheses?
8. Does this topic provide a good opportunity to show the link between scientific findings and current technological developments that students are familiar with?
9. Does this topic have relevance for issues that face our society at large?
10. Does this topic offer information that students can use to make decisions about their health and consumerism?
11. Is there a way to frame this topic content by looking into my own or my students' own "backyard"?

As you consider each topic in light of these questions, write down in the right-hand column of Table 2 at least one relating component that you consider appropriate for presentation of each topic. Keep in mind that there is no one "right" choice for each topic; rather, your selection should be based on your own sense of what would work best for you and your students. An example of a completed version of Table 2 appears in the Appendix.

A Final Selection

Now that you have generated some possible topics and accompanying relating components, it is time to select the ones you want to use for today's planning session. Here, we ask that you turn to Table 2 and select from your choices one topic and one relating component for this topic. Again, your selection should be based on your own judgment about what you would most like to work on. You can always repeat the planning process for the other topics at a later time.

PLANNING TOPIC LESSONS

A Daily Plan

Now that you have your one topic and its relating component chosen, it is time to think through at a general level how you will instruct your students in the topic. Here, it probably will be most helpful for you to think in terms of the daily class activities you are likely to conduct. By activities, we mean blocks of time that are distinguished by different forms of social interaction--e.g., teacher lecturing to students, students watching a film, students carrying out a laboratory in groups while a teacher monitors, etc. As indicated in the second guidebook, all class activities can be grouped into nine categories: 1) recitation; 2) seatwork; 3) laboratory exercises; 4) surrogate instruction; 5) demonstration; 6) group discussion; 7) transitions, interruptions, waste time; 8) procedures; and 9) nonacademic instruction. These categories, then, can serve to remind you of all the different kinds of class activities that can happen in your class.

Table 3 is a chart of daily activities for you to fill out. There are three major things to consider before you begin. First, you must decide how many days you are likely to spend on your selected topic. While we realize that you usually cannot predict this number exactly, you need to make an estimate for purposes of doing the chart. You should count all days from your first introduction of the topic to any final exam on the topic. Table 3 allows room for up to 10 days. If you estimate more than 10 days, you do not need to fill out a chart for the remaining days.

A second consideration for filling out Table 3--one closely linked to the first--is the nature of the various activities that

Table 3

Daily Activities Guide

Name: _____

Topic: _____

Relating Component: _____

Day 1	Day 2	Day 3	Day 4	Day 5

(continued)

Table 3 (continued)

Daily Activities Guide

Name: _____

Topic: _____

Relating Component: _____

Day 6	Day 7	Day 8	Day 9	Day 10

will occur on each day. You need to be able to generate your best guess as to what these activities will be. Here, it may help you to review the kinds of activities for this topic that you have used in the past as well as any new activities you have considered trying. The categories of activities already listed may help jog your memory and ideas.

The third consideration for filling out Table 3 is to identify those activities that represent opportunities for including the concepts from the scientific literacy relating component that you have chosen. Here, it is optimal if you can think of at least one opportunity per day; in this way, it is more likely that you will be able to use the relating component as a theme for presenting the topic information. This consideration may cause you to rethink and revise some of your daily activities. For example, if you had thought of teaching students the topic primarily through seatwork and laboratory exercises, you should question whether this will provide enough opportunities to convey the relating component concepts. Generally speaking, you can be most certain of conveying these concepts clearly--and to all your students--if you do so in a lecture (i.e., recitation) format. These lecture segments do not necessarily have to be long--indeed, they can consist of a few minutes before or after another activity. Once the relating concepts are introduced in lecture, you can then reinforce them through other activities such as your seatwork assignments.

With the above thoughts in mind, you should take time now to think about and fill out Table 3. (For an example, see the Appendix). For each day, you should list the activities you plan in chronological order. (Use a pencil so that you can make changes!) Beside each activity that is an occasion for the relating component concepts, place an asterisk (*).

Relating Component Concept Plan

Now that you have a daily activity plan for your topic, you should go back and pay extra attention to those activities where you want to include the relating component concepts. As indicated in the first guidebook, the successful use of a relating component depends on being explicit and consistent, so that the component serves as a clear theme for the topic content. While there is no time here to develop your use of the relating component in great detail, there is time to develop for yourself an outline of the basic content and relating concepts you want to cover. You can then use this outline to build more specific plans for your recitations and assignments.

Table 4 is a chart for outlining the major topic concepts. The left-hand column is for you to outline the major relating concepts you want to cover during the selected activities. The middle colum is for you to outline the content concepts you will cover in connection with the relating concepts. Finally, there is room in the right-hand column for you to note any resources

Table 4

Relating Concept Guide

Name: _____

Topic: _____

Relating Component: _____

Relating Concepts	Content Concepts	Possible Resources

(continued)

Table 4 (continued)

Relating Concept Guide

Name: _____

Topic: _____

Relating Component: _____

Relating Concepts	Content Concepts	Possible Resources

that may be useful for given concepts. Again, the idea with this table is to outline the "big picture" in relationships among the concepts you will present; do not worry about the precise accuracy of these concepts at this time. An example of Table 4 is in the Appendix.

SHARING THE PLANNING EXPERIENCE

An important part of this workshop is having the opportunity to share your planning experience with other teachers. If your workshop group is small (8 or fewer teachers), you may wish to meet as one group at the end of the planning. If your group is larger, split into smaller groups. Here are several ideas and questions you can use to guide your group sharing:

1. Have each teacher state his/her selected topic and relating component and briefly summarize <u>when</u> and <u>how</u> he/she intends to use the relating component.

2. What did each teacher feel worked really well in the planning process? What did each teacher feel caused difficulties in the planning process?

3. What, if anything, would each teacher do differently if they planned this topic again?

4. What did each teacher learn from this planning session that would apply to planning other topics?

GENERAL GUIDE FOR RECITATION LESSONS

We cannot prescribe exactly how a topic should be taught, but we can recommend some general guidelines that should strengthen your teaching of the scientific literacy components. (These may be old hat, but they are still worth reviewing.) We will focus on recitation lessons as we expect that most teachers will use this approach to "teach" scientific literacy.

- Begin the lesson with an overview of the topic to be covered. This orients students and primes them for learning.

- Don't cover too much in any one recitation session. Stick to the several main points and use concrete examples to illustrate these points.

- During the recitation, check for students' understanding of the lesson by asking specific questions that require students to repeat to you what they have learned (Don't ask, "Do you understand?").

- Beware of getting off the track. While digressions can spice up a lesson, they can also confuse students about what is important to remember. Keep the main points of the lesson in mind and return to them repeatedly.

- When you ask the class a question, don't only call on students who raise their hands. Over the course of several days, ask all students in your class a question.

- At the end of the lesson, ask students to summarize what they have learned. Correct any errors or misconceptions.

- Assign seatwork and homework that reinforces the recitation lesson and includes a relating component. (Science textbooks often ignore relating components; you may have to design the assignment yourself.)

APPENDIX

TRAINING NOTES

The preceding materials are designed for an inservice workshop to be conducted with intermediate life science teachers. They give teachers actual experience in developing their own applications of scientific literacy to a life science topic. The workshop can be held during or after school. A minimum of three hours will be required to cover the basic materials. The materials also lend themselves to longer planning and discussion during an entire inservice day or over the course of several shorter inservice workshops. When more time is available, the trainer has the opportunity to work individually with teachers in planning activities and concepts that link their science curriculum and the scientific literacy components.

However these materials are used, it must be remembered that they present ideas that may be new to many teachers and that imply a change in typical intermediate life science instruction. The role of the trainer is to facilitate a process that demystifies the scientific literacy components and provides concrete examples of the use of these components in regular science lessons. In so doing, the trainer should recognize that there is no absolutely wrong way to plan a link between a science topic and a relating component. Nonetheless, some selections and combinations may pose more difficulties than others. Thus, the trainer should attempt to determine if each teacher has taken a reasonable course so that the teacher can experience a stimulating and rewarding first planning exercise.

We believe this workshop can be conducted most successfully with teachers who teach the same science courses (e.g., 8th grade life science; 7th grade general science) and who use the same science textbook. The trainer should be familiar with the curriculum of the courses taught by the teachers attending the workshop and the content of the textook they use.

Try to establish a warm and relaxed atmosphere so that teachers will feel comfortable working and discussing new ideas. If possible, seat the participants in such a way that they are able to see each other. Begin the workshop by briefly reviewing what was covered in the previous two workshops. Then introduce teachers to the purpose of this workshop, outlining the major steps in the planning exercise. Give concrete examples of the planning exercise using the accompanying overheads. Once teachers embark on their own planning, circulate among them to answer questions and check general progress. Be sure you allow enough time for teachers to read the booklet <u>and</u> fill out the charts. Try to keep all teachers working at about the same pace. Once teachers have completed their planning, bring them together in a group (or groups) to share and discuss the planning process.

At the end of the workshop ask teachers to complete the workshop evaluation form. Also complete one of the forms yourself so you can check your own impressions against those of the participants.

Table 2

Topic Selection Guide

Name: _____

Date: _____

Life Science Topic	Possible Relating Components
1. Seed Plants	• Relating Content to the Societal Impact of Science • Relating Content to the Reasoning Process of Science
2. Human Circulatory and Respiratory Systems	• Relating Content to the Personal Use of Science • Relating Content to the Social Historical Process of Science
3. Cell Structure and Genetics	• Relating Content to the Social Historical Process of Science • Relating Content to the Societal Impact of Science
4. Vertebrates	• Relating Content to the Reasoning Process of Science • Relating Content to the Personal Use of Science

Table 3

Daily Activities Guide

Name: F.W. Lab

Topic: Human Circulatory and Respiratory Systems

Relating Component: Personal Use

Day 1	Day 2	Day 3	Day 4	Day 5
Opening transition	1. Opening transition	1. Opening transition	1. Opening transition	1. Opening transition; teacher collects essays
Teacher recitation to introduce topic*	2. Teacher recitation on functioning of heart, providing answers to ditto*	2. Teacher reviews, and students discuss yesterday's film*	2. Teacher recitation on blood*	2. Students take topic test*
Student seatwork; read text on heart and complete ditto	3. Teacher assigns essay homework due Friday*	3. Teacher recitation on circulation and lung functioning*	3. Teacher blood test demonstration with student volunteers	3. Students discuss their essay findings and ideas*
Teacher previews topic activities	4. Teacher shows film on circulatory system	4. Teacher answers questions regarding essay assignment	4. Teacher preview of tomorrow's test; some oral quizzing of students	

Table 4

Relating Concept Guide

Name: F.W. Lab

Topic: Human Circulatory and Respiratory Systems

Relating Component: Personal Use

Relating Concepts	Content Concepts	Possible Resources
1.2. Importance of topic to personal lives; heart and lung diseases as major killers in U.S.A.	1.2. N.A.; overview topic. Make explicit theme of personal use.	
2.2. Mention and exemplify three major kinds of heart disease and some forms of treatment.	2.2. Explain four heart chambers, role of veins and arteries.	2.2. Popular magazines, free literature on heart disease.
2.3. Ask students to consider and research what they can do personally to reduce heart and lung disease.	2.3. N.A.; assign homework essay.	2.3. Suggest above resources for students.
3.2. Review kinds of heart disease.	3.2. Review relevant anatomy covered in ditto and film.	3.2. Illustrations in several texts.
3.3. Mention and exemplify major factors associated with heart and lung disease (e.g., smoking, cholesterol, stress).	3.3. Explain pattern of body circulation and role of lungs in oxygenating blood.	3.3. Same as 2.2.