NC Quest VI – Cycle VI

Summer 2009

Linking Science and Literacy

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OVERVIEW

LINKING SCIENCE AND LITERACY

"...if we teach today as we taught yesterday, we rob our children of tomorrow."

—John Dewey

Introduction

The challenge to foster long-term instructional improvement in any school district is a demanding task that requires reflection as well as action. In meeting this challenge, we face the complexities of school districts in urban, suburban, and rural settings that make the task all the more difficult.

In recent years, many school districts have responded to low standardized test scores in language literacy by focusing their educational efforts on these "core" subjects, often to the near-exclusion of other areas of the curriculum. This narrowed instructional focus threatens to significantly undermine the already limited commitment to science education in our elementary schools. The challenge to all of us is to understand and implement the idea that high-quality programs in science and language literacy need not be mutually exclusive: issue-oriented, materials-centered science instruction can support and contribute to the improvement of students' literacy skills. Research reported in the special issue on science, reading, and writing of the November 1994 *Journal of Research in Science Teaching* (*JRST*) has shown that student learning in science is improved through the introduction of activities that combine hands-on experiences with reading, writing, speaking, and listening. It is not only feasible to support the goals of language literacy while participating in science activities, but it can also prove to be mutually beneficial to both disciplines.

It is sometimes difficult for teachers to understand the link between science teaching and literacy and how to use both in concert. These two areas of instruction should not be considered mutually exclusive. Research has shown that the acquisition of literacy skills is significantly enhanced when reading and writing are used for specific purposes within a meaningful and stimulating context. In *The Foundations of Literacy* (1979), for example, Holdaway argues that "an effective learning

environment for the acquisition of literacy should be alive with activity which is felt to be deeply purposeful in all the ways of human meaning. The learning begins with immersion in an environment in which the skill is being used in purposeful ways" (see also Wells and Nichols 1985). It is important for teachers to understand the role of inquiry-based science activities in providing a meaningful context for literacy instruction.

In the elementary school curriculum, demonstrating that language-literacy instruction in concert with materials-centered science can provide precisely the "purposeful" environment needed to support and reinforce students' developing literacy skills can strengthen the place of science. Studies also have shown that student learning in science is improved by the introduction of literacy-related activities (see, for example, Rowe 1996, Bredderman 1983, Fellows 1994, and Holliday 1994). As Holliday (1994) notes, "Hands-on experiences are necessary, but not sufficient to learn many counterintuitive science concepts. Likewise, language is necessary, but not sufficient in initial learning of abstract concepts. The important factors are: What types of thinking and strategies are mutually beneficial in reading, writing, and science learning? How can experience and language activate the necessary internal mental processes?"

There are reciprocal processes between literacy and science learning, which means that it is necessary to identify the literacy skills students need to be successful in science. Science and literacy teachers—and recently published state and national standards for instruction in both subject areas—have remarkably similar goals for student learning.

Foremost is the pursuit and communication of meaning. While scientists collect evidence to understand and demonstrate the orderliness of the natural world, they must also communicate their findings to others. This is expressed in the *National Science Education Standards (NSES)* that state that students should "experience the richness and excitement of knowing about and understanding the natural world and engage intelligently in public discourse and debate about matters of scientific and technological concern" (NRC 1996, p. 13). The New Standards Project's performance standards for English and Language Arts, recently adopted by the New York City school system, also stress the importance of communication skills in transmitting ideas: "Speaking, listening, and viewing are fundamental processes which people use to express, explore, and learn about ideas" (NCEE 1997). Writing a report about the

results of a science investigation provides students with visible evidence of their thoughts and conclusions. Having done this, students are better able to discuss their ideas and conclusions with others, moving beyond the written word to grapple with what they do and do not understand about the concepts involved. Their language expression becomes a window into their thinking.

The process skills involved in both science and literacy are not limited to writing. Each time students are asked to observe, to compare and contrast, to predict, to sequence, to differentiate between fact and opinion, to use evidence to support their point of view, and to make inferences and draw conclusions, they are drawing upon skills that are integral to both subject areas. This Guide demonstrates that these skills can be reinforced and enhanced using materials-centered, inquiry-oriented science activities in conjunction with literacy activities. The activities highlighted in this Guide emphasize appropriate grade-level *NSES* Content Standards for "Science in Personal and Social Perspectives." These content standards are seldom stressed in many widely adopted elementary school science programs. Performance Expectations for the literacy components of each lesson will be developed as part of the design of embedded, authentic assessment approaches that will document student improvement in literacy. Overall, this Guide provides a general tool kit for accomplishing literacy objectives through science. It shows how the model activities, presented and proven in the classroom using SEPUP-based enrichment materials, can form the basis for an extension and enhancement of the adopted basic science program in any school or district.

For example, journal writing has become a daily practice in many science classrooms. However, students' ability to express their ideas often does not show significant growth over time, as measured by teacher assessments and standardized tests. This Guide demonstrates the usefulness of giving both students and their teachers a set of clearly stated performance expectations designed to improve students' written expression. In this way, students are given an understanding of what is expected of them from the perspective of both science and literacy, and teachers have a clear sense of how to assess students' work. This guide presents model activities, each incorporating science and literacy components, designed to help teachers understand how to link science and literacy. Participants will have experiences using literacy performance objectives so they can experience their potential value to students' growth in literacy expression.

Guide Objectives

The major objectives of this Guide are to:

- Highlight the importance of science in the elementary school curriculum. Demonstrate how it can be a meaningful vehicle for providing literacy contexts, while improving science instruction and learning for all students.
- Demonstrate the effectiveness of using quality science instruction as part of an integrated, effort to support and contribute to the improvement of students' literacy skills.
- Integrate specific literacy activities within the context of science activities.
- Provide examples of performance objectives for the literacy component of science activities to help students better understand how to effectively meet literacy expectations.
- Provide performance objectives for the teacher to assess students' progress and growth in literacy over time as part of their science instruction.
- Provide participants with experiences in aspects of language that enhance science learning. This will contribute to participants' emerging understanding of the similarities and differences in learning science and language and how they can use each to learn the other.

Finally, while it is important to ensure that every child can read, we must also recognize that reading is not sufficient for students coming of age in this new millennium. There must also be an understanding of mathematics, social studies, and science so that students are able to creatively and flexibly solve problems, understand their own learning styles, and then connect their accumulated knowledge from many disciplines to real world decision-making. In the many activities used in this Guide, there has been an attempt to include cross-disciplinary activities that require the integration of skills with a knowledge base. In the end, providing relevant opportunities for making these cross-curricula connections as part of the learning process will be the greatest challenge for the elementary school teacher.

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LINKING SCIENCE AND LITERACY

2 stirring sticks

2 magnifiers

For the facilitator

* Blackline masters found on pp. 103 and 104

Lesson 3 Part I: Understanding Literacy Performance Expectations

For the facilitator

* Blackline masters found on pp. 105-117

Lesson 3: Part II: Using Performance Expectations

For each group of four participants

* 10 cigarette ads

For the facilitator

* Blackline masters found on pp. 118 and 119

MATERIALS LIST

FACILITATOR AND PARTICIPANT MATERIALS

* denotes item supplied by the facilitator

Blackline masters and overhead transparencies are provided in the last section of this guide. Please make the needed copies for use in teaching these materials. In addition, you will need the following materials:

General Supplies

For each participant

*Journal or paper

*Pen or pencil

For the facilitator

* Overhead projector

* Blank transparencies

* Markers for the transparencies

* Poster paper or chart paper and markers

Lesson 1 Linking Literacy and Science

For the facilitator

* Blackline master found on (pp. 56-98)

Lesson 2 Part I: What Do We Mean by Literacy?

No materials required

Lesson 2 Part II: Understanding the Similarities between Science and Literacy

For the facilitator

* Blackline master found on pp. 99-102

Lesson 2 Part III: Experiencing Science and Literacy Processing Skills

For each group of four participants

1 dropping bottle of water

2 plastic sheets

Section 1

WHAT IS LITERACY? HOW DOES IT RELATE TO SCIENCE?

"Language is a pane of glass
through which we can view our thinking."

—M. Emmitt and J. Pollock

Lesson 1 | Linking Literacy and Science

Introduction

In the following reading from *Science & Language Links: Classroom Implications*, edited by Johanna Scott, participants will consider the roles that language plays in science learning and how language goes hand in hand with the development of scientific ideas. The concepts in this reading will be revisited after each lesson, as participants build their understanding of the relationship between language and science learning. After each lesson, participants will write in their journals using the following focus questions to reflect on the lesson, so that at the end of their experience they will have a written record of their emerging understanding of the issues:

- √ Describe the similarities and differences between learning science and language.
- √ How can we use science to learn language and language to learn science?

Goal

Participants will begin to see the relationship of science to reading, writing and oral language.

Time 45 minutes

Materials

For each participant

- Handout of *Science & Language Links* (pp. 56-98)
- Journal
- Pen or pencil

For the facilitator

Blackline master of *Science & Language Links* (pp. 56-98)

Advance Preparation

Make copies of the blackline master, *Science & Language Links* (pp. 56-98) for each participant.

Procedure

1. Give each participant a copy of the handout from *Science & Language Links* (pp. 56-98).

2. Divide the whole group into small groups of 4–6 people.

3. Use the following focus questions to do a Jigsaw*. Have each group select one of the three focus areas for an in-depth investigation:

   √ Science and Oral Language

   √ Science and Writing

   √ Science and Reading

4. Have each small group discuss its focus areas and write notes that the group members agree upon.

5. Ask participants to come together as a large group to share their ideas about their focus areas. To facilitate this discussion, be sure participants understand that it is more preferable for the skills related to oral language, writing, and reading to be practiced within the framework of inquiry-based science. Emphasize the idea that the science content gives students something of substance to read, write, and talk about. In addition, the science teacher has the opportunity to gain insight into the students' concept development. This can serve as embedded assessment for the students and a way to inform instruction for the teacher.

6. After completing the discussion, have participants write in their journals to reflect upon their understanding at this point based upon their reading and group discussion.

Literacy and Science Journal Reflection

Participants reflect in their journals upon new insights they have on the theme questions:

1. Describe the similarities and differences between learning science and language.

2. How can we use science to learn language and language to learn science?

*A Jigsaw is when groups focus on one specific part of the reading and then explain their segment in-depth to the whole group.

Lesson 2 | Part I: What Do We Mean By Literacy?

Introduction

This session helps participants understand the definition of literacy addressed in this guide.

Goal

After completing this session participants will understand that language literacy is an important component of scientific literacy. The component parts of literacy are reading, writing, listening, speaking, and viewing or response to media.

Time 30 minutes

Materials

For each participant

- Journal
- Pen or pencil

For the facilitator

- Large Chart Paper
- Markers

Procedure

1. Begin by discussing with participants their understanding of language literacy. Explore all of their ideas in a whole group discussion. Record participants' ideas on a large sheet of chart paper.

2. Explain that the definition of language literacy that forms the basis of this Guide includes reading, writing, listening, speaking and viewing, or response to media. Participants will most likely understand the reading and writing aspects of literacy, but may not be as familiar with the relationship among the fundamental processes of listening, speaking, and viewing. Ask participants what they think the functions of listening, speaking, and viewing might include. Record their ideas on a large sheet of chart paper.

3. Based on the ideas that emerge as a result of discussion, summarize and introduce the idea that the functions of listening, speaking, and viewing include gathering and sharing information, persuading others, expressing and understanding ideas, and selecting and critically analyzing messages. The viewing aspects of literacy include helping students make informed judgments about media such as television,

newspapers, and the Internet. Ask participants: Why can this be an important skill to develop as part of science learning?

4. As part of this discussion it is very important for participants to understand that these definitions of literacy will be explored within the context of hands-on, inquiry-based science instruction throughout this Guide. In addition, although we are discussing language literacy, this has a great effect upon scientific literacy, since language literacy directly impacts science literacy. Stress the interrelationship, by emphasizing that language is the vehicle students use to express their scientific understanding and therefore one cannot exist without the other.

Literacy and Science Journal Reflection

Participants reflect in their journals upon new insights they have on the theme questions:

1. Describe the similarities and differences between learning science and language.

2. How can we use science to learn language and language to learn science?

Lesson 2

Part II: Understanding the Similarities between Science and Literacy

Introduction

When we look at the correlation of reading skills to hands-on science in the upper elementary and middle schools, it is particularly important to examine the process skills in science that reinforce emerging literacy skills and the elements in science activities that draw upon the student's existing literacy skills. In science, each time students are asked to observe, to compare and contrast, to predict, to sequence, and to make inferences and draw conclusions, they are given an opportunity to develop and reinforce their emerging literacy skills as well. Similarly, when students are asked to differentiate between fact and opinion and to use evidence to support their points of view while doing hands-on science, they are simultaneously using the skills of literacy identified in all published literacy standards.

Goal

This session will help participants understand the similarities between the skills of reading and the skills of science and how participating in each can enhance the other.

Time 60 minutes

Materials

For each participant

- Handout of "Correlation of Literacy Skills to Hands-on Science" (pp. 99-102)
- Paper for recording ideas
- Journal
- Pen/pencils

For facilitator

- Blackline master of "Correlation of Literacy Skills to Hands-on Science" (pp. 99-102)
- Chart paper
- Markers
- Overhead projector
- Blank overhead transparencies

Advance Preparation

1. Make transparencies of the blackline masters "Correlation of Literacy Skills to Hands- on Science" (pp. 99-102).

2. Make copies of the handout (pp. 99-102) for each participant.

Procedure

1. Discuss with participants the similarities between the skills of reading and the skills of science. Use the set of overhead transparencies entitled: "Correlation of Literacy Skills to Hands-on Science" in order to explore these concepts with participants.

2. After discussing these correlations, ask participants to work in-groups of four to talk about science activities they have taught or have seen taught where they can identify these and other similarities. Ask the groups to write down examples of science activities that correlate to literacy skills.

3. Small groups share their ideas with the whole group, while the facilitator records the highlights of their correlation examples on a large piece of chart paper.

4. After completing this part of the discussion, the facilitator displays the list in front of the room. Participants review the list to expand their understanding of the correlation of science process skills to literacy processing skills.

5. To facilitate participants understanding of why it is important to understand this correlation, talk about the emphasis in the schools on literacy and the exclusion of science instruction to accomplish this goal. If they can understand this mutual enhancement, then science can be a very powerful factor in furthering the goals of literacy and can achieve its rightful place in the curriculum.

Literacy and Science Journal Reflection

Participants reflect in their journals upon new insights they have on the theme questions:

1. Describe the similarities and differences between learning science and language.

2. How can we use science to learn language and language to learn science?

Lesson 2

Part III: Experiencing Science and Literacy Processing Skills

Introduction

In this lesson, participants do an activity from the CHEM 2 enrichment program, which is an issue-oriented, hands-on science program appropriate for students in grades 4-6. This lesson will help participants concretely understand the similarities between science and literacy processes previously discussed. Prior to doing the lesson, suggest that participants focus their thinking on these similarities and how doing activities such as these can be beneficial in both disciplines.

Goal

After this session, participants will have a concrete understanding of literacy opportunities available in hands-on science experiences and will be able to identify specific similarities between literacy and science processing skills.

Materials

For each group of four participants

- 1 dropping bottle of water
- 2 plastic sheets
- 2 stirring sticks
- 2 magnifiers
- Handouts of:
    1. "Physical Properties of Water" (p. 103): four copies for each group
    2. "Idea Map" (p. 104): two copies for each group

For each participant

- Journal
- Pen/pencil

For the facilitator

- Blackline masters of:
    1. "Physical Properties of Water" (p. 103)
    2. "Idea Map" (p. 104)
- Large chart paper
- Marking pens

Advance Preparation

Make copies of the blackline masters "Physical Properties of Water" and "Idea Map" (pp. 103 and 104).

Time 45 minutes

Procedure

1. Have participants work in groups of four to do "Physical Properties of Water."

2. Instruct participants to use the "Idea Map" to brainstorm their observations about the similarities that they observed between science and literacy processing skills. Have small groups discuss their ideas.

3. Bring the whole group together to discuss each small group's brainstormed ideas. Add the new ideas to the large sheet of chart paper in the front of the room.

4. During the discussion be sure to help participants identify all of the literacy-related skills when they did the "Physical Properties of Water" activity. These include:

- √ The 4/2/1 SEPUP cooperative learning aspects of activity-based science when groups interact using speaking and listening skills.
- √ Group interaction such as listening, speaking, writing, and reading.
- √ The importance of students' understanding of science words through operational definitions; i.e. when participants observed "cohesion" and developed an operational definition for the word on their worksheets.
- √ The use of written language to describe the water droplets including adjectives as descriptors.

Literacy and Science Journal Reflection

Participants reflect in their journals upon new insights they have on the theme questions:

1. Describe the similarities and differences between learning science and language.
2. How can we use science to learn language and language to learn science?

Section 2

USING PERFORMANCE EXPECTATIONS TO IMPROVE LITERACY IN THE SCIENCE CLASSROOM

"Communication in the inquiry classroom goes beyond simply exchanging knowledge. It implies that socially gathered and shared information informs individual learning."

—Doris Ash

Lesson 3 | Part I: Understanding Literacy Performance Expectations

Introduction

The following performance expectations are a guide to what students should know and ways that they should be able to demonstrate that knowledge. When applied to the science classroom, we expect students to demonstrate the following skills while doing inquiry-based activities:

- Read and follow instructions on data sheets.
- Read and understand informational texts and literary works related to the science theme or topic.
- Produce writing that is related to their science investigation i.e. journals, data sheets, narrative procedures, reports, persuasive documents, and creative stories.
- Be proficient speakers who can express their points of view about a subject clearly.
- Be acute listeners, who can understand and interpret information given orally.
- Develop critical viewing skills, particularly with regard to the influence of the media on their lives. Since the media plays an integral part in most students' lives, students need to have adequate sophistication for dealing with that influence.
- Participate in cooperative learning groups where speaking and listening skills are used to share information, express and communicate ideas and coordinate activities with other group members.

Goal

The following lesson will introduce participants to the concept of using literacy-based performance expectations in the science classroom to improve literacy within the context of science activities. Participants will explore performance expectations related to writing, reading, listening, speaking, group interaction, and response to media or viewing as a method of assessing growth and improving literacy over time for their students. Participants will understand the usefulness of performance expectations as a method of informing them of appropriate literacy expectations for their students while doing science.

Time 45 minutes

Materials

For each group of four participants

- Handouts of:
    1. "Performance Expectations" (for teacher to use with students) (pp. 105-111)
    2. "Performance Expectations" (for students to use independently) (pp. 112-117)

For each participant

- Journal
- Pen/pencil

For the facilitator

- Blackline masters of:
    1. "Performance Expectations" (for teacher to use with students) (pp. 105-111):
    2. "Performance Expectations" (for students to use independently) (pp. 112-117)
- Chart paper
- Marking pens

Advance Preparation:

Make copies of the "Performance Expectations" (pp. 105-117).

Procedure

1. Ask participants to look at the set of "Performance Expectations." Then group them into one of five categories: reading, writing, listening, speaking, or viewing.

2. Have participants discuss how they might use these "Performance Expectations" in the science classroom. Have participants identify specific situations in which they would work effectively.

3. Ask each participant to select one "Performance Expectation" and share how he or she might use it. Ask each participant to identify strategies that could work when using the specific "Performance Expectation" to accomplish both literacy and science objectives.

4. While working in small groups, have participants write their ideas on paper in preparation for sharing with the whole group.

5. Bring participants together for a whole group discussion. Invite participants to share their ideas about the use of the "Performance Expectations." Record the major ideas discussed to enhance learning in both disciplines.

Note to facilitator

If participants do not present an example of this, you might suggest that when students record their ideas in their science journals, they could use the "Science Journal Entries" (p. 112). When students use these written language expectations, they are learning to record their ideas completely, accurately, and clearly. This is an important concept for students to understand because the idea of reproducibility is basic to science and can be more successfully accomplished by controlling the accuracy of data recording.

Literacy and Science Journal Reflection

Participants reflect in their journals upon new insights they have on the theme questions:

1. Describe the similarities and differences between learning science and language.

2. How can we use science to learn language and language to learn science?

Lesson 3 | Part II: Using Performance Expectations

Introduction

In this lesson, participants develop a greater understanding of "Performance Expectations" by using them as part of a science activity.

Time 45 minutes

Materials:

For each group of four participants

- Handouts of:
  1. "Cigarette Industry's PUBLIC Policy About Advertising" (p. 118)
  2. "Cigarette Industry's PRIVATE Policy About Advertising" (p. 119)
  3. "Performance Expectations" pp. 105-117
- 1 sheet of paper
- 10 cigarette ads

For each participant

- Journal
- Pen/pencil

For the facilitator

- Blackline masters of:
  1. "Cigarette Industry's PUBLIC Policy About Advertising" (p. 118)
  2. "Cigarette Industry's PRIVATE Policy About Advertising" (p. 119)
  3. "Performance Expectations" pp.105-117
- Overhead projector
- Blank overhead transparencies
- Marking pens

Advance Preparation

1. Make copies of the blackline masters (pp. 118 and 119).

2. Remind participants to bring in the "Performance Expectations" handouts (pp. 105-117) that were used in Lesson 3, Part I.

balancing of risks and benefits associated with choosing a course of action; giving up one thing in favor of another."

The following lesson will help participants experience the concept of trade-off.

Time 45 minutes

Materials

For each participant

- Handout of "Understanding Trade-off Activity Sheet" (p. 120)
- Journal
- Pen/pencil

For the facilitator:

- Blackline master of "Understanding Trade-off Activity Sheet" (p. 120)

Advance Preparation

Make copies of the blackline master, "Understanding Trade-off Activity Sheet" (p. 120) each participant.

Procedure

You may wish to use the following sequence to facilitate participants' understanding of trade-off.

Trade-off Vignette

The following vignette will help participants understand the basic concepts of trade-off:

When you buy a car, you may accept your second or third color choice in order to get a car that is available sooner. In this case, you trade off a more desirable color for a shorter wait. However, there are usually certain factors you are less willing to trade off than others are. Imagine that you want to buy a new car, and that you want it to be red, have an automatic transmission, power windows, and a sunroof, and that you must have the car within two weeks. After checking with several dealers, you find that you cannot get the car you want for two months, but that you can either get a white car, with all your other desired features, or a red car with everything but the sunroof. Which will you choose? Different people will make different choices about whether to trade off the sunroof or the red color. Trade-off involves giving up a desirable factor in order to gain another desirable factor.

1. Distribute the "Understanding Trade-off Activity Sheet" (p. 120).

2. Ask participants to work in groups of four. Have them brainstorm other examples of trade-offs.

3. Next to each example, have participants discuss and then list the decisions involved in the trade-off. Use some of the ideas listed on the activity sheet.

4. After completing the "Understanding Trade-off Activity Sheet," ask participants to share the process of their decision making and their ideas with the whole group.

Optional

If you think participants need additional experiences to understand the trade-off concept, try this optional activity: "Environmental Trade-off Activity Sheet" (p. 121).

Literacy and Science Journal Reflection

Participants reflect in their journals upon new insights they have on the theme questions:

1. Describe the similarities and differences between learning science and language.

2. How can we use science to learn language and language to learn science?

Lesson 4

Part II: Using Trade-off as Part of Development Decisions and Literacy

Introduction

In the following lesson participants need to demonstrate competency in a variety of literacy skills in order to successfully complete the lesson. Participants work in groups of four. While doing the lesson, participants analyze which literacy competencies are most important to complete the activity and how the performance expectations related to those skills might help students. In addition to the lesson instructions, participants use the set of literacy "Performance Expectations" to model their usefulness in the classroom in order to monitor student performance and growth over time.

Goal

In this lesson participants will make decisions about options for undeveloped land and learn to analyze which literacy competencies are needed to successfully complete the lesson.

Time 60 minutes

Materials

For each participant

- Handout of Activity 10.3 "Development Decisions" (pp. 122-127)
- Journal
- Pen/pencil

For the facilitator

- Blackline master of Activity 10.3 "Development Decisions" (pp. 122-127)

Advance Preparation

Make copies of Activity 10.3 "Development Decisions" (pp. 122-127).

Procedure

1. Give each participant a copy of "Development Decisions" (pp. 122-127). Explain to participants that they will now be doing this activity from *Science and Sustainability*. In this activity participants will access a variety of options for the future use of undeveloped land. As the third part of an activity that looks at sustainable development alternatives, participants will be challenged to determine the best use of undeveloped land located just outside of the Outer City of Beijing.

2. Have participants work in groups of four selecting one of the eight possible groups as explained on page 122-125.

3. Have participants follow the directions to complete this activity.

4. After completing the activity, ask participants to reflect on the Group Analysis and Individual Analysis questions listed on page 126. Discuss these perspectives in the whole group.

5. Use performance expectations" to debrief the "Development Decisions" activity. Use the following sequence:

a. Have participants work in groups of four. Ask participants to discuss which performance expectations, when used with students, would be most helpful for this kind of activity. Ask participants how they would use them.

b. Have participants list their ideas under the following five performance expectations categories: Group Interaction, Reading, Speaking, Persuasive Strategies, and Listening.

c. Discuss the following focus questions with the whole group:

1). How useful do you think performance expectations are in monitoring student growth and progress over time?

2). What specific performance expectations would you find most useful for this kind of an activity?

3). What additional ideas do you have about linking performance expectations to science activities?

Note to facilitator

When debriefing performance expectations encourage participants to analyze the components of the lesson before deciding upon which performance expectations would be most relevant.

After completing Lesson 4, Parts I and II, participants should have a clear idea of how the skills of listening and speaking can be important parts of literacy that can be developed and supported within the context of hands-on inquiry based science.

Literacy and Science Journal Reflection

Participants reflect in their journals upon new insights they have on the theme questions:

1. Describe the similarities and differences between learning science and language.

2. How can we use science to learn language and language to learn science?

Lesson 5 | Part I: Shared Inquiry in Science

Introduction

The "Shared Inquiry in Science" technique, adapted from the Junior Great Books Program, is used to discuss any literature selection that is integrated into a science unit. The teacher uses divergent questions and encourages students to use the text for evidence to support their points of view. These strategies not only encourage an open-ended dialogue among students, but also give teachers insight into students' level of comprehension by assessing the depth of their responses. This strategy also enables teachers to use facilitative teaching as part of an effective teaching repertoire. (For more information on facilitative teaching, see the ESTL Guides entitled: *Integration Across the Curriculum* and *Teacher as Facilitator: Asking Better Questions.)*

Goal

In this lesson participants will understand the power of facilitating students' learning by using inquiry-based teaching strategies to develop higher level thinking skills through science-related readings. They will also understand how to help students appreciate the dual role of using evidence in both science and literacy.

Time 45 minutes

Materials

For each participant

- Handouts of:
  1. "Junior Great Books: Reading for Meaning in Urban Schools" (pp. 128-131)
  2. " Shared Inquiry in Science" (pp. 132-135)
- Journal
- Pen/pencil

For the facilitator

- Blackline masters of:
  1. "Junior Great Books: Reading for Meaning in Urban Schools" (pp. 128-131)
  2. " Shared Inquiry in Science" (pp. 132-135)
- Large sheet of chart paper
- Marking pens

Advance Preparation

Make copies of the blackline masters (pp. 128-135) for each participant.

2. Remind participants to bring in the "Performance Expectations" handouts from Lesson 3, Part I, found on pages 107, 109, and 111.

Procedure

1. Distribute the handout, "Junior Great Books: Reading for Meaning in Urban Schools" (pp. 128-131) and ask participants to read it.

2. Have participants work in groups of four. Ask them to discuss the following focus questions and then record their responses:

- What are the main components of the shared inquiry strategy?
- Describe which components of this strategy you think are useful for the classroom. Explain your answer.
- Which components do you think will be difficult to master for students and/or teachers?
- If you choose to use these strategies, how do you think your classroom might be enhanced?

3. After completing the small group discussion on shared inquiry, invite participants to discuss these focus questions as a whole group. Use a large sheet of chart paper to record the key ideas that are discussed.

4. Using "Shared Inquiry in Science" (pp. 132-135), discuss the technique of shared inquiry in science with participants.

5. Suggest to participants that when doing shared inquiry in science, they use the following Performance Expectations (from Lesson 3, Part I) during their discussion to help them assess their students' progress over time:

- Reading Comprehension p.107
- Speaking p.107
- Using Persuasive Strategies p. 109
- Group Interaction p. 111

Literacy and Science Journal Reflection

Participants reflect in their journals upon new insights they have on the theme questions:

1. Describe the similarities and differences between learning science and language.
2. How can we use science to learn language and language to learn science?

Lesson 5

Part II: Practicing Shared Inquiry in Science

Introduction

In this lesson, participants gain experience using the "Shared Inquiry in Science" discussion strategy. This strategy is used to discuss *A River Ran Wild*, a literature selection that could be integrated into a science unit. Participants read the selection and practice asking divergent questions related to the text. After completing their "Shared Inquiry in Science" discussions, participants reflect on the power of this discussion strategy.

Goal

In this lesson participants will gain deeper understanding of the power of facilitating students' learning by using inquiry-based teaching strategies to develop higher level thinking skills through science-related readings. Participants will understand that this strategy is designed to encourage students to use the text as evidence to support their points of view.

Time 45 minutes

Materials

For each group of eight

- 4 copies of *A River Ran Wild* by Lynne Cherry

For each participant

- Journal
- Pen/pencil

For the facilitator

- (Optional) blackline master of "What are Divergent Questions?" (p. 136)

Advance Preparation

You will need multiple copies of *A River Ran Wild* by Lynne Cherry. If you do not have enough copies of this book, be sure to ask your librarian to order them. *A River Ran Wild* is a Gulliver Green Book. It is available through Harcourt Brace & Company, 15 East 26th Street, New York, NY 10010.

Procedure

1. Have participants work in groups of eight by combining their existing groups of four. Ask each group of eight to read *A River Runs Wild* by Lynne Cherry. Have one participant act as the "reader."

2. After completing the reading, ask each group to generate a list of three or four divergent questions related to the text.

Note to facilitator

If you find that participants have difficulty creating divergent, open-ended questions, refer to "What are Divergent Questions?" (p. 136) or you might refer to the ESTL Guide, *Teacher as Facilitator: Asking Better Questions*. If the groups continue to have difficulty generating divergent questions, they may select from the following list so that they may practice the "Shared Inquiry in Science" discussion strategy.

3. Divergent Questions:

- If you were an early inhabitant of the area, how would you react to the river slowly dying?
- Was there a difference in the goals of the two groups of people? Explain your answer.
- In what ways did the people coming later live differently than the early inhabitants?
- How can one person's vision be an effective catalyst for change?
- Was progress taking place here? Why? Why not?
- What is progress? How would you know it?
- What do you think the rhythm is that they saw?
- Why do people like products, but at the same time do not like the production of those products?

4. After participants complete their "Shared Inquiry in Science" discussions ask the groups:

- What are your ideas about the power of this strategy.
- How does this strategy develop higher level thinking skills?
- In what ways does this strategy help to enhance oral communication?
- In what ways can this strategy inform the teacher about the students' comprehension ability?
- Think back to the similarities between the skills of literacy and the skills of science discussed in Lesson 2 Part II, pages 15 and 16; which of the literacy and science skills are most enhanced using "Shared Inquiry in Science?"

Note to facilitator

Be sure that participants understand that this strategy is designed to encourage students to use the text as evidence for their points of view. In this way, students will understand the relevance these processes of science have to literacy and their lives. They will learn that evidence can be a very powerful factor in decision making.

Literacy and Science Journal Reflection

Participants reflect in their journals upon new insights they have on the theme questions:

1. Describe the similarities and differences between learning science and language.

2. How can we use science to learn language and language to learn science?

Section 4

RESPONSE TO MEDIA OR VIEWING

"...learning how to analyze as well as construct images is at the heart of media literacy..."

Education Update,
ASCD, volume 41, Number 7
November 1999

Excerpts from

Science & Language Links: Classroom Implications

edited by Johanna Scott

Heinemann Publishers
Portsmouth, NH, 1992.

INTRODUCTION

We know that children naturally attempt to make sense of their world and that language plays a key role in their learning. The roles that language plays in science learning, the ways that science can be used to develop children's language, and how increased knowledge of language goes hand in hand with the development of scientific ideas provide the key focus for this book.

Successful classrooms provide children with a range of science activities to investigate. Children pull apart toys to see how they work and then use this information to make their own toys. They collect and examine plants and insects and become fascinated by how the slater curls up when touched, how the snail safely negotiates a knife blade, with the structure of different leaves and the relationship between the animals and their habitats. While investigating, children have many opportunities to reconstruct their experiences: to use language to make sense of what might otherwise be chaotic impressions. Children are encouraged to talk about what they observe and try to explain it. They write down the things that magnets attract, draw pictures of the structures of leaves, make predictions about the result of placing a knife, blade up, in with the snails, and keep tallies of the number of times different balls bounce. The distances a toy truck travels after leaving an increasingly inclined ramp is recorded, then graphed so that children can draw conclusions about the relationship between slope and distance.

Children want to find out about the world around them and in the process observe, predict, explain, question and devise activities through talking, writing and reading to construct

their own meanings. As teachers, we need to understand how language supports science and how we can use science to develop children's language.

In this book, we examine the learning and teaching links between science and language. This introduction provides an overview by focusing on what we mean by learning science, what we mean by learning language, using language to learn science and using science to learn language. The rest of the book is divided into three parts: Science and Talking, Science and Writing and Science and Reading.

WHAT DO WE MEAN BY LEARNING SCIENCE?

If we look at science as being all that contributes to helping children to understand the world around them, then the knowledge that children may find out could include the following:

- the characteristics of living and non-living things and how they can be used to classify and label;
- how certain things behave or work to interact with other things;
- what is needed to change something from one position, state or form to another. (Harlen, 1990).

Freyberg and Osborne (1985) provide us with a useful perspective on the processes children use to learn science when they state that we are teaching science when we help children:

- to investigate things and explore ideas;
- to ask useful and productive questions;
- to seek and develop explanations that are sensible and useful to them, with respect to the natural and technological worlds that they confront daily;
- to broaden their experience of nature and technology;
- to become interested in the explanations of others about how such explanations have been obtained.

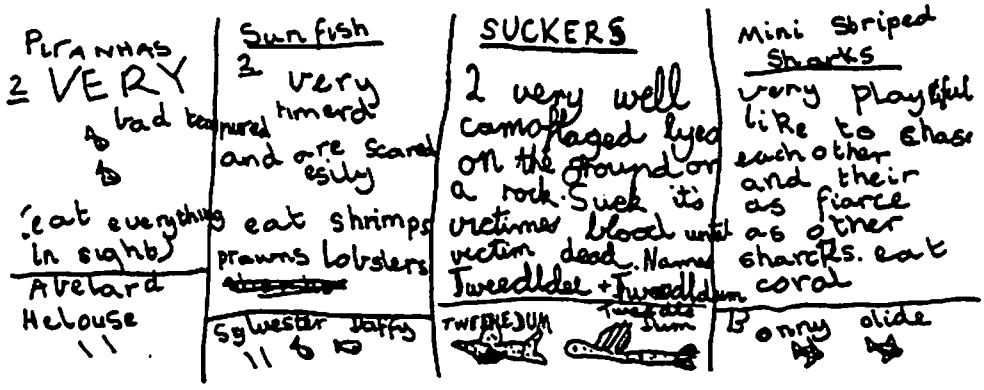
The similarities and differences between children's science and the science of scientists are of central importance in the learning and teaching of science. Children come to school with their own meanings for words used in science teaching and their own views of the world which relate to ideas taught in science. These views are strongly held and are often significantly different from those held by scientists. For example, the word 'animal' conjures up pictures of pets or farm animals in the minds of most children. They usually do not include

themselves in this category the way biologists do. Children often think that small things float and large things sink, that trees move to make the wind. These and other views seem sensible and coherent to children and they can remain uninfluenced or be influenced in unanticipated ways by science teaching. As teachers, we need to listen to children's xplanations to gain insight into the views they hold so that we can plan appropriate classroom experiences.

WHAT DO WE MEAN BY LEARNING LANGUAGE?

The conditions under which children learn to talk have been well documented. (Cambourne, 1988). Lindfors (1987) describes the processes children use to learn language. 'Children figure out the oral and written language in their environment by using powerful processing abilities, hypothesising, testing, confirming, disconfirming and revising underlying rules for meaning expression relations.' (Lindfors, 1987). These processing abilities are similar to the ones children use to learn science.

As they use language in varying social and physical contexts, children come to know more about the language itself. They realise the language that is appropriate to specific social settings or that is in books and texts around the home and school. In the same way, they also come to know about the language of science. Philip is a 7-year-old who turned his room into a museum one wet weekend.



PHILIP'S LABELS.

Philip ordered the physical world as he had noticed it in books and during his visits to the museum. His systematic labelling of the types of fish, with a name and a description of each, gives us information about Philip's knowledge of the language of science and of how science uses language to organise the world.

USING LANGUAGE TO LEARN SCIENCE

Language is closely bound to science, and indeed, everything we do. Emmitt and Pollock (1991) describe language as a pane of glass through which we can view our thinking. Looked at in this way, it appears obvious that language is the servant of science, a tool to help children make sense of their world. A greater grasp of language, however, increases our flexibility and ability to construct and reconstruct meanings. So it is important that as children learn science through language, they learn about language. This book is based on the belief that children are active learners, that they construct their own views which should be supported by school. A circuit was described by children as 'the path of an electric current' before they started investigations using batteries, wires and bulbs. Children could not elaborate on this dictionary definition: they did not have the knowledge to match the words. During the course of the unit, children had the opportunity to play with appropriate equipment, hypothesise about what would happen, to try it out, to experiment. They also collected words that started in the same way as 'circuit'. During this time, children constructed their own frames of knowledge which were refined and revised as their investigations progressed. By the end of their investigations, children were able to demonstrate various working circuits and explain the complexities of what was happening and why. 'A circuit is wires all joined together in a sort of a circle. Circuits make many things work. You can make a torch if you join wires, some batteries and a globe. Electricity from the batteries runs through the wires and makes the globe light up. If the light goes out then you have broken the circuit.'

Their teacher had provided the children with opportunities and had questioned, used appropriate vocabulary and encouraged them to talk as they explored to elaborate on their understandings and rework their frames of knowledge to clarify their understandings. The reframing of their concepts ran parallel to their refining of scientific language.

USING SCIENCE TO LEARN LANGUAGE

The specific nature of scientific language can sometimes confuse children because they are familiar with the words in another, everyday context. Take as an example the word, 'conductor'. Children know a conductor as someone who collects money on a bus or tram, or as someone who leads a group of musicians, choral or orchestral. In each case, the conductor is a person. When we look at 'conductor' in science terms, it is a thing, something that allows electricity, heat or sound to pass through it.

As well as learning about the language of science, the language children use during science investigations and learning varies according to its purpose. It is our role to assist children to learn about the language they need as they use it to learn science.

chapter REFLECTIVE QUESTIONS

David Keystone

INTRODUCTION

This is a case study of significant 'snapshots' of a science unit. These snapshots offer some insights into the way learning is influenced by children and teacher discourse, particularly in the area of questioning and answering.

The unit on Mirrors was planned and implemented in a multi-age class of twenty-nine 10- to 12-year-old children. The transcripted dialogue, the learning contexts and the evaluative comments reveal the importance placed on questioning and the way this influences and promotes thinking.

Osborne and Freyberg (1985) emphasise that the teacher and the children need to share common goals and purpose in class activity. The teacher's role becomes that of encourager, experimenter, guide, challenger and innovator. It is this teacher role that is explored in this study.

Starting and working with children's perceptions and building upon their past experiences makes learning enjoyable, goals achievable and acknowledges the learners as active participants in their own learning.

The teaching task then becomes that of designing and carrying out activities that best reflect the children's interests and ideas, of allowing them to raise their own questions, plan and carry out their own investigations and finally, of making sure that children draw conclusions based on sound evidence related to their personal experiences, either inside or outside the classroom.

Lyn Turner shows us how science activities are a wonderful vehicle for learning another language, whether that be English or a community language.

part

SCIENCE AND TALKING

We spend a great deal of time controlling children, asking them questions to which we know the right answer. If we are to engage children in their own learning, we must provide them with opportunities to talk with one another, as well as with teachers and relevant others.

This thought often challenges accepted ideas, enabling, even forcing, children to reorganise their thoughts.

Two functions of talk, exploratory and presentational, are identified by Barnes (1988). Exploratory talk is where children collaborate and talk, often in a hesitant manner, to consider and arrange their ideas. Presentational talk is where children report on what they have discovered. It has an important evaluative function. If, however, we want children to construct their own meanings, then we need to place a greater emphasis on exploratory talk.

As they engage in exploratory talk during their investigations, children collaborate to build up joint hypotheses and add new ideas to what has gone before. They explore interrelationships and rearrange information to determine its significance.

In this section of the book, David Keystone writes of the positive role he plays in the talk that accompanies science investigations about mirrors in his classroom. He listens to children, makes suggestions, questions the children and encourages them to ask questions of themselves and one another.

Correlation of Literacy Skills to Hands-On Science

Literacy Skills	Hands-On Science
Noting Details	In **Everyday Chemicals**, students look closely at the physical properties of baking soda, water, vinegar, pepper and cornstarch with and without magnifiers. They learn to look for small details. They share their findings with each other and write a description on their worksheets.
Comparing and Contrasting	Students look at what happens when they mix water with pepper, pepper with vinegar, cornstarch with water and then with vinegar, milk with water and then with vinegar. They compare and contrast what happens. They look for likenesses and differences and discuss them.

Correlation of Literacy Skills to Hands-On Science

Literacy Skills	Hands-On Science
Prediction	Prior to mixing, students are challenged to predict what will happen when various substances are mixed together.
Cause and Effect	Students recognize cause and effect when they observe what happens when enteric and regular aspirin are dissolved in acidic and basic solutions.

Correlation of Literacy Skills to Hands-On Science

Literacy Skills	Hands-On Science
Sequence of Events	In **Good to the Last Drop** students follow step-by-step procedures to test two different filters using the same mixture.
Fact/Opinion	In all CHEM activities, students are encouraged to talk about what they observe and what they think, but evidence is stressed as a powerful factor in deciding on what is fact and what is opinion.
Making Inferences	In **Smoking and My Health** students use a "smoking machine" to observe a cotton ball to see how dark it gets after the cigarette is "smoked." They make inferences about what happens to a person's lungs when smoking a cigarette.

Correlation of Literacy Skills to Hands-On Science

Literacy Skills	Hands-On Science
Words and Meanings	Operational definitions are used in science. Understanding is based upon experience, as students internalize the ideas of *solutions, mixtures, cohesiveness,* after they have experienced the activities in **Good To The Last Drop.**
Drawing Conclusions	Teachers ask divergent questions to get students to think beyond what they have done. They might ask: "Why is it important to know about chemical interaction?"

Date _____ Name _____

Physical Properties of Water

In this activity you will observe and describe the property of water called cohesion.

Materials

For each group of four students:
- 1 dropping bottle of water

For each pair of students:
- 1 stirring stick
- 1 piece of plastic wrap
- 1 sheet of white paper
- 1 hand magnifier
- Paper towels

Procedure

Record your observations on the data table below.

1. Place the plastic wrap on top of the sheet of white paper.
2. Use the dropping bottle of water to place on the plastic wrap 10 drops of water that do not touch one another.
3. Look at each of the water drops with the hand magnifier. Record your observations.
4. Use the stirring stick to move the water drops slowly around on the plastic wrap. Be sure they still don't touch one another. Record your observations.
5. Now move the water drops so that they do touch one another. Record your observations.

Water	Observations
Separate Drops	
Moved Drops (not touching)	
Moved Drops (touching)	

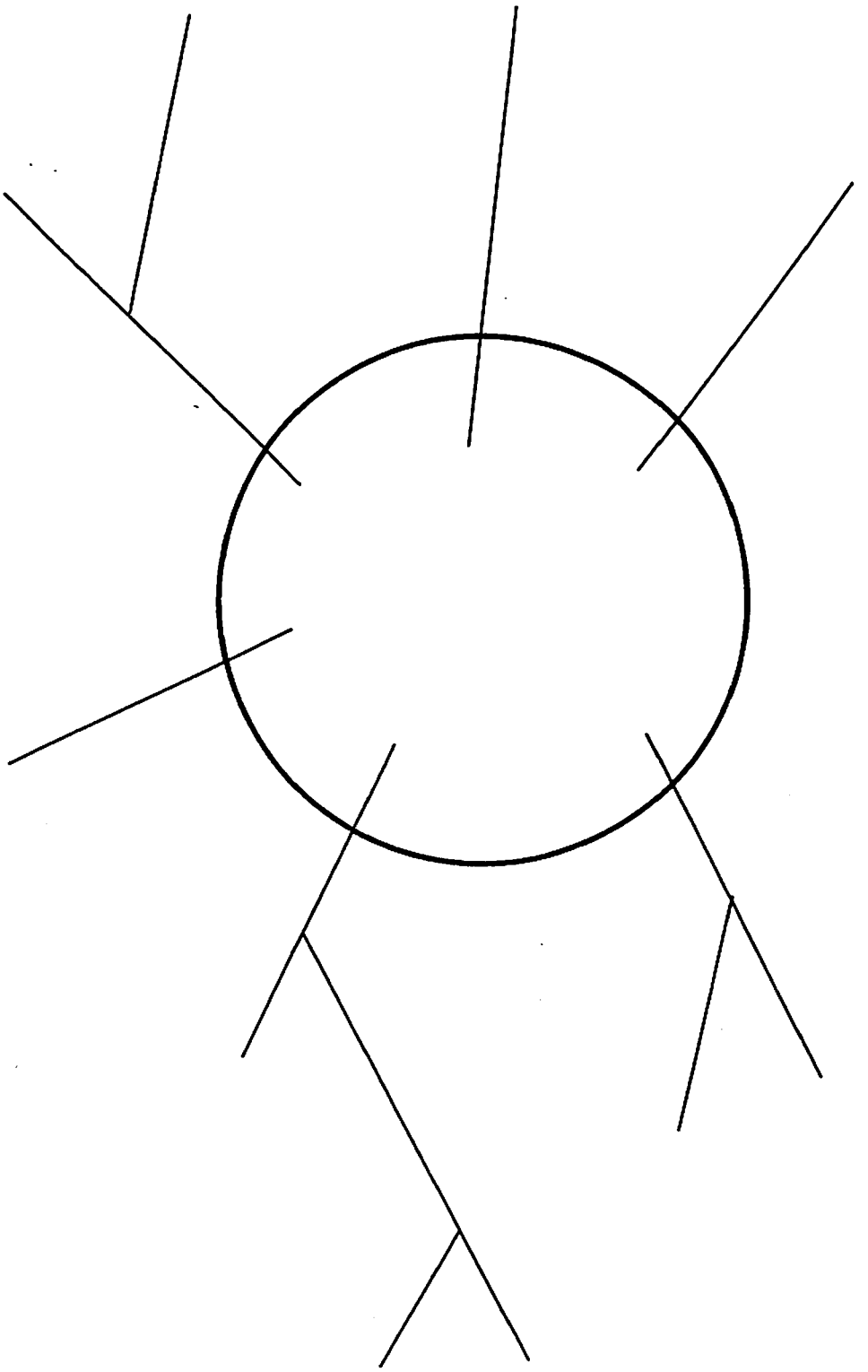
Question

In step 5, you observed **cohesion**. Based on your evidence, record below how you might explain cohesion to someone who has never observed it.

_____

_____

IDEA MAPPING



Performance Expectations

Adapted from *The New Standards Performance Standards*
The National Center on Education and the Economy (NCEE)
University of Pittsburgh
Pittsburgh, PA, 1997.

Performance Expectations

For the teacher to use with students

Generic Writing

- Engages the reader by establishing a context.
- Develops a controlling idea that conveys a perspective on the subject.
- Includes appropriate facts and details.
- Excludes extraneous and inappropriate information.
- Provides a sense of closure to the writing.

Producing Reports

- Reports, organizes, and conveys information accurately.
- Includes relevant narrative details, such as scenarios, definitions, and examples.
- Anticipates readers' problems, mistakes, and misunderstandings.
- Uses a variety of formatting techniques such as headings, subordinate terms, foregrounding of main ideas, hierarchical structures, graphics, and color.
- Establishes a persona that is consistent with the document's purpose
- Employs word choices that are consistent with the persona and appropriate for the intended audience

Performance Expectations

Reading Comprehension

- Makes and supports warranted and responsible assertions about the text.
- Supports assertions with elaborated and convincing evidence.
- Uses evidence to interpret and apply ideas.
- Compares and contrasts themes and ideas.
- Makes perceptive and well-developed connections.
- Evaluates writing strategies and elements of the author's writing.

Speaking

- Initiates new topics in addition to responding to adult-initiated topics.
- Asks relevant questions.
- Responds to questions with appropriate elaboration.
- Uses language cues to indicate different levels of certainty or hypothesizing, i.e. what if, very likely, I'm unsure whether....
- Confirms understanding by paraphrasing the adult's directions or suggestions.

Performance Expectations

Oral Presentation

- Shapes information to achieve a particular purpose and to appeal to the interests and background knowledge of audience members.
- Shapes content and organization according to criteria for importance and impact rather than according to availability of information in resources and materials.
- Uses notes and other memory aids in order to structure the presentation.
- Develops several main points relating to a single thesis.
- Engages the audience with appropriate verbal cues and eye contact.
- Projects a sense of individuality and personality in selecting and organizing content, and in delivery.

Performance Expectations

Instruct participants to use these performance expectations when doing tasks that involve using persuasive strategies either written or verbal.

Using Persuasive Strategies

- Engages the reader by establishing a context, creating a persona, and otherwise developing reader interest.
- Develops a controlling idea that makes a clear and knowledgeable judgement.
- Includes appropriate information and arguments.
- Excludes information and arguments that are irrelevant.
- Anticipates and addresses reader concerns and counter-arguments or alternative points of view.
- Support arguments with detailed evidence, citing sources of information as appropriate.
- Provides a sense of closure to the writing clearly stating conclusions.

Performance Expectations

Use the following Performance Expectations to monitor a student's response to a literacy-related presentation.

Analyzing a Public Speaking Performance

- Takes notes on salient information.
- Identifies types of arguments and identifies logical fallacies (i.e. over generalization, inferring causation from correlation).
- Accurately summarizes the essence of each speaker's remarks.
- Formulates a judgment about the issues under discussion.

Response to Media (Viewing)

(newspaper, television, radio, and film)

- Demonstrates an awareness of the presence of the media in the daily lives of most people.
- Evaluates the role of the media in focusing attention and in forming opinion.
- Judges the extent to which the media is a source of entertainment as well as a source of information.
- Defines the role of advertising as part of a media presentation.

Performance Expectations

Have participants use these performance expectations when doing tasks that involve their participation in group work. They can use these to "observe" themselves or others within the group.

Group Interaction

- Displays appropriate turn taking behavior.
- Actively solicits another person's comment or opinion.
- Offers own opinion forcefully without dominating.
- Responds appropriately to comments and questions.
- Volunteers contributions and responds when directly solicited by teacher or discussion.
- Expands on a response when asked to do so and gives group members similar opportunities.
- Gives reasons in support of opinions expressed.
- Employs group decision-making techniques such as brainstorming or a problem-solving sequence i.e.(recognize problem, define, identify possible solutions, select optimal solutions, implement solution, and evaluate solution).
- Divides labor so as to achieve over all group goal efficiently.

Cigarette Industry's PUBLIC Policy About Advertising

As early as 1963, the cigarette industry announced its policy of neither advertising nor promoting cigarettes to young people.

Excerpts from the cigarette industry's PUBLIC policy about advertising state that cigarette manufacturers will

- continue to avoid advertising directed to young persons
- not...use testimonials from athletes or other celebrities who might have special appeal to young people
- refrain from depicting smokers engaged in sports or other activities requiring stamina or conditioning beyond those required in normal recreation
- avoid advertising which represents that cigarette smoking is essential to social prominence, success, or sexual attraction

Cigarette Industry's PRIVATE Policy About Advertising

These statements that talk about how to get young smokers to use cigarettes came from a study done for a major tobacco company.

- Create a situation taken from the day-to-day life of the youngster, but, in an elegant manner, have this situation touch on the basic symbols of the growing up, maturity process.
- Present the cigarette as one of the few ways of showing everyone that the smoker has entered the adult world.
- Present the cigarette as part of the illegal or forbidden pleasure category of products and activities available to young people.
- To the best of your ability, relate cigarettes to "pot," wine, beer, sex, and other similar things.
- Don't communicate health or health-related points.