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ABSTRACT

Research findings are reported concerning the extent to which writing assignments in contrasting examples of upper elementary science curriculum materials are likely to engage students in higher order thinking and problem solving, and to facilitate meaningful learning of scientific concepts. Organized around a common set of elaborate framing questions which are appended, critiques focused on three types of curriculum materials: a commonly used curriculum series in the elementary grades; another widely used series that contrasts with the first in organization and sequencing of content and/or methodology for teaching content; and two or more distinctive curricula selected for emphasis on higher level thinking or problem solving in the content area. Discussion focuses on the following topics: (1) a rationale for the curriculum materials study; (2) study methodology and the analysis of writing assignments in science materials; (3) contrasts in goals and subject matter content; (4) the form and function of writing assignments; (5) the function of the written assignments in the learning process; (6) how writing assignments provide different learning opportunities; and (7) using text materials to bring about meaningful learning. (RH)

How Communication Processes Shape Subject Matter Learning:

An Analysis of Commonly Used and Distinctive Curriculum Materials

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Overview

The research reported in this paper comes out of one of a series of studies undertaken by the Center for Learning and Teaching of Elementary Subjects. The Center's five years of research and development focus on elementary level (grades K-6) teaching and learning of mathematics, science, social studies, literature, and the arts (music and art), with particular emphasis on the teaching and learring of higher level thinking and problem solving in each content area. One three-year study involves analysis and critique of both commonly used and distinctive curriculum materials and assessment devices in each content area. The critiques include a content analysis of curriculum materials as well as a comprehensive, integrated, qualitative analysis of intended student outcomes, instructional methods and activities, and the ways in which student progress is assessed. The purpose of the study is to provide descriptive information and suggestions for improved design and use regarding the range and nature of curricula available to classroom teachers interested in teaching for higher level thinking and problem solving in each content area.

This paper reports on preliminary findings from one aspect of the larger study, the extent to which writing assignments in contrasting examples of upper elementary science curriculum materials are likely to engage students in higher order thinking and problem solving and to facilitate meaningful learning of scientific concepts.

What Can Be Learned From Another Curriculum Materials Study?

Current critiques of curriculum materials, particularly of the commonly used textbook series, focus on features such as the quality of the writing in the text (Davison & Kantor, 1982; Graves & Slater, 1986), the overall textbook design such as use of photographs and illustrations (Woodward, 1988) or the selection and organization of subject matter content (Armbruster & Anderson, 1983; Beck & McKeown, 1988; Calfee & Chambliss, 1988; Campbell & Fey, 1988; Elliott, 1988; Elliott & Nagel, 1987; Elliott, Nagel & Woodward, 1985; Larkins & Gilmore, 1987). These studies make apparent many problems with the content of student texts, such as coverage of too many topics, lack of depth of coverage, boring and superficial coverage, lack of conceptual focus on content, lack of clarity in relation to instructional goals, and inadequate explanation of important concepts. It is argued that such problems with the content in student texts make teaching for higher order thinking and problem solving in the subject areas very difficult. Without a effective content treatment in the text, the argument goes, how can teachers do a good job?

Understanding curriculum in a classroom requires examining more than just the content selection, organization, and explication in the text materials students read. Curriculum materials and assessment devices also play important roles in determining teaching methods used to teach the subject matter and ways in which student learning is assessed (Porter et al., 1986; Roth, Anderson & Smith, 1987). While our analysis of curriculum materials necessarily focuses on studying the organization and structure of subject

matter content, we are particularly interested in learning more about the *communication processes* related to classroom teaching and learning that are embedded in the materials. That is, when the student text is used in the classroom along with suggested activities and assignments in the teacher's manual, to what extent would this enacted curriculum promote student understanding and higher order applications of the subject matter?

Why is this an important question or a different question than the content analysis that has typically been the focus of inquiry in curriculum materials studies? Teaching and learning activities that center around curriculum materials (e.g., reading, writing, discussion, drawing, forms of play) are both cognitive and social acts where communication or language is an important mediator between one's thought and action (Vygotsky, 1962). It is through speech (or other forms of communication) that children can realize and express intentions and purposeful action through symbolic representation (Vygotsky, 1978). Thus, focusing on communication processes is a way of understanding the underlying communication system that develops in a classroom, which shapes a great deal of the instruction that occurs (Barnes, 1979; Cazden, 1986). At the same time, foc. ing on the substance of the communication, the subject matter content, reveals ways in which the content of instruction shapes ongoing communication. Focusing on communication serves the dual function of looking at what is intended in communication, and what actually gets communicated (Hymes, 1980).

A broader analysis of curriculum materials that goes beyond mere examination of content selection, organization and explication in student

texts brings us closer to envisioning and understanding the enacted curriculum that would result if teachers follow the guidelines given by the authors of a curriculum series and use the supplementary materials provided with the series. This in-depth consideration of curriculum materials affords greater opportunity for researchers to identify strengths and suggest improvements that go beyond rewriting the material students read in the text. Therefore, our analysis of the curriculum materials focuses on describing both the forms of communication embedded in the materials (the amount and nature of discourse, various kinds of writing and drawing activities, forms of play such as creative dramatics or role playing, ways in which teachers assess student progress) as well as studying how those particular forms are likely to function in providing occasions for elementary students to engage in (or learn to engage in) higher order thinking and problem solving in the five subject areas.

This paper reports on one set of preliminary findings from the larger study, providing examples and discussion of ways in which one communication process, writing, is used in two contrasting sets of upper elementary level science materials. The use of instructional discourse to improve classroom learning has long been advocated (e.g., Barnes, 1976; Cazden, 1986), and many researchers are beginning to identify more specifically the qualities of discourse that are particularly effective in improving subject matter learning (e.g., Atwell, 1984; Lampert, 1988; Nystrand, 1988). Moreover, the use of writing assignments in content area learning is often promoted as a valuable form of instructional discourse and an effective teaching tool (e.g., Ammon &

Ammon, 1987; Britton et al., 1975; Calkins, 1986; Emig, 1977; Langer & Applebee, 1987). To provide further insights into this issue, findings from analysis of the writing assignments in two pieces of curriculum materials illustrate the extent to which these assignments are likely to facilitate development of higher order thinking and problem solving in science.

Methodology

Materials Selection

Center researchers are studying both typical and distinctive curriculum materials in five content areas where such materials are available. Critiques focus on three types of curriculum materials: a commonly used curriculum series in the elementary grades (based on overall nationwide sales and teachers' reports of their use); one other widely used series that contrasts with the first one in its organization and sequencing of content and/or methodology for teaching the content; and two or more distinctive curricula selected for the authors' intended emphasis on higher level thinking or problem-solving aspects of the content area. We focus on these three types of curricula to provide an analysis and description of the range of ways to organize and sequence content, and the accompanying communication processes designed to facilitate conceptual level understanding of the subject matter. Contrasts across the three types can help define strengths and limitations of ways to organize subject matter content and identify various communication processes used to help students comprehend the subject matter.

Analysis of Materials

The research team developed a common set of framing questions organized around eight categories that provide a structure for researchers to follow in their critiques of curriculum materials within the five subject areas (see Appendix A). This set of framing questions will also be used to facilitate comparison and contrast along common dimensions across the subject areas. The first category, goals, includes questions about the the series as a whole, seeking descriptive information and evaluative judgements about the nature of the goals, their clarity, and the interrelationship among different kinds of goals. The next three categories each include key questions seeking descriptive information and evaluative judgements about the subject matter content: selection; organization and sequencing; and explication. Questions about content selection, organization, and sequencing are being applied to the series as a whole as well as to more detailed analysis of smaller pieces of the series. Questions about content explication in the text require detailed examination of smaller pieces of the series so they are being used with commonly used materials at the second and fifth grade levels[1].

To capture the interactive nature of the way curriculum materials might be used in teaching and learning activities, researchers developed questions seeking descriptive information and evaluative judgements for three additional

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[1] The second and fifth grade levels were chosen to correspond with those chosen for another of the Center's studies in which panels of experts critiqued the same materials. Researchers wanted to study materials from both early elementary and upper elementary levels.

categories: teacher-student relationships and classroom discourse; activities and assignments; assessment and evaluation. An eighth category, directions to the teacher, includes questions about the amount and nature of support that the materials provide to the teacher for becoming familiar with and implementing the curriculum. Questions in the latter four categories are being applied to commonly used materials at the second and fifth grade levels. Decisions about application of the questions to distinctive materials are being made based on the nature of the materials, since some of them include materials for only one or two grade levels instead of the K through 6 spectrum.

Since the analysis is primarily qualitative, researchers are using the framing questions to guide their inquiry as they work back and forth between study of the materials on a general level across all the grades and study of particular units of instruction within grade levels. This includes, for example, considering questions about specifics such as activities and assignments in light of questions about the series' stated goals, or questions about the content selection and organization in the series. Researchers also work back and forth across and within particular categories of questions, to consider the interaction between the subject matter content (questions about content selection, organization and sequencing, explication) and the communication processes (questions about teacher-student relationships and classroom discourse, activities and assignments, assessment and evaluation). To develop defensible answers to the framing questions, general impressions are recorded, particular instances and examples are noted, discrepant cases

that might dispute generalizations are sought, and generalizations are modified as evidence is more closely studied and evaluated. In addition, contrasts between commonly used and distinctive materials are noted, and used to sharpen the level of detail at which researchers further examine materials.

Analysis of Writing Assignments in Science Materials

Of particular interest to the findings reported in this paper are framing questions pertaining to communication processes and ways in which these processes help students understand the subject matter content. Descriptions of and evaluative judgments made about writing assignments were developed by using framing questions in three categories: teacher-student relationships and classroom discourse, activities and assignments, and assessment and evaluation. In particular, two questions listed under F-6 (see Appendix A) were the overarching framing questions for this portion of the analysis: To what extent do activities and assignments call for students to write beyond the level of a single phrase or sentence?; To what extent do the chosen forms engage students in higher order thinking? To avoid making judgements about the writing assignments out of context, framing questions F-6 were used in relation to what was learned from using the overall sets of questions about communication processes. Thus, the chosen form of the assignment (e.g., essay, interview, report, worksheet) and the way writing assignments related to surrounding activities (e.g., discussions, projects, reading assignments) was considered. In addition, the topics for the writing assignments were evaluated in light of questions about subject matter content (selection, organization and sequencing, and explication). In particular, the

extent to which a writing assignment seemed likely to help students understand a particular topic at a particular point in a lesson series was considered, as well as considering the nature of thinking involved in creating the written product (e.g., factual recall, open-ended exploration, synthesis of ideas, analysis of ideas, critique of information).

Three categories from Applebee and Langer's (1987) study of the functions of writing in secondary classrooms were used to identify the major function of each writing assignment:

> 1. To draw on relevant knowledge and experience in preparation for new activities
>
> 2. To consolidate and review new information and experiences
>
> 3. To reformulate and extend knowledge (p. 41).

Langer and Applebee make the case that while these three functions also describe general pedagogical functions and do not uniquely pertain to writing, they are useful categories for focusing on the way knowledge is used. The first category, called "elicit prior knowledge" in this study, refers to writing assignments that are used to bring out what students already know about a topic (stimulate interest, remind them of their knowledge, assess their prior knowledge). The second category, called "consolidate and review knowledge" in this study, typically involves getting students, through various writing activities (journals, summaries, note-taking, study exercises), to review new learning, especially new information. The third category, called "reformulate and extend knowledge" in this study, involves using writing as a

tool to get students to reflect on and reorganize their knowledge. This kind of writing requires knowledge use such as figuring out how to classify information, tracing cause and effect, explain motivation, or speculate about future developments.

Findings from analysis of writing assignments in two pieces of curriculum (chapters on plants that both include the topic of photosynthesis) in one subject area (science) are discussed in this paper. One piece is a chapter (student text and teacher's guide) in a fifth grade life science unit, "Discovering the Plant and Animal World," published by Silver Burdett & Ginn in a commonly used text series, Science (Mallinson et al., 1989). Entitled "Activities of Green Plants," the first chapter is divided into five lessons (Plants and Animals are Alike; Transporting Materials; Food Making in a Leaf; Using the Energy in Food; Producing New Plants) and ends with a review section. The second piece is a set of materials (student text and teacher's guide) entitled "The Power Plant" developed for use with middle school students by researchers and published by the Institute for Research on Teaching (Roth & Anderson, 1985). The student text is divided into four chapters (Introduction: What is Food?; Using Experiments to Find Out About Food for Plants; How Plants Use Sunlight to Make Their Own Food; Using Your Knowledge About Food for Plants).

These two pieces were chosen for discussion in this paper for several reasons. First, their topic treatment has sufficient overlap to enable comparison of goals and subject matter content (selection, organization and sequencing, explication). The commonly used series treats the topic of

photosynthesis within the broad context of learning about "Activities of Green Plants," and therefore teaches about photosynthesis as one of a series of topics in the chapter (e.g., life processes; transporting materials in plant; respiration; plant reproduction). The second piece of curriculum specifically focuses on the topic of "Food for Plants" throughout the lesson series, and therefore teaches about photosynthesis in the context of what it has to do with the scientific concept of food (e.g., what is food; how to find out about food; using knowledge about food). A second reason for selecting these two pieces of curriculum is that both contain some writing activities to enable comparison of how writing is used to help students learn the central concepts. Third, both sets of materials are intended for use with upper elementary students. Fourth, they are examples of the two main types of curriculum focused on in this study. One piece is from a commonly used text series, and therefore represents curriculum materials that are typically available to classroom teachers and are reported to be used by them. If teachers' claims are accurate, then the enacted curriculum resulting from using this series might be considered what is "typical" around the nation. The other is an example of what the research team has defined in this study as "distinctive" in that its authors intended to provide alternative materials for teachers designed to make their teaching more effective than it would be if they used materials commonly available to them. Specifically, the authors intended to provide more adequate treatment of a difficult scientific concept (photosynthesis) in the student text and more effective teaching strategies

(described in the teacher's guide) for bringing about meaningful understanding of the concept.

Findings

Analysis of the writing assignments in the two pieces of curriculum necessarily started with a content analysis, since assignments require students to write about subject matter content. Although a content analysis is not the focus of this paper, a brief summary of the goals and content in the materials will be given before discussing the writing assignments.

Contrasts in Goals and Subject Matter Content

Goals

The goals for each piece of curriculum, despite some similarities in topic coverage, are quite different. The widely used series has broader goals that are stated in general terms. For example, the goals for the entire unit "Discovering the Plant and Animal World" are to "...provide the students with basic knowledge of how plants and animals function and the interrelationships that exist among living things." As more specific goals are listed for each chapter, the language is still general, using terms such as "acquaints the students" and "gain an understanding of" the topics specified. Objectives within chapter 1, "Activities of Green Plants," include having students use their knowledge in the following ways: discuss, identify, name, list, describe, explain, trace, and compare and contrast. Most of these objectives (e.g., discuss, identify, name, list, trace, compare, contrast) do not make

clear what students will do with the knowledge they are "provided with" in the everyday world other than to describe or explain.

In contrast, the authors of "The Power Plant" materials offer a lengthy introduction to the series of lessons in which they reject the traditional notion of thinking of learning in science as absorbing or memorizing scientific content. Instead their goal is to bring about conceptual change in students by helping students "reassess and change their commonsense, everyday understandings of the world...abandon their misconceptions or habits of thought that have served them well all their lives in favor of new and unfamiliar ideas." Moreover, as students begin to replace their naive ways of thinking with scientifically correct views, they are expected to use their knowledge to explain and predict scientific phenomena. Thus, the authors want students to be able to go beyond recall of information or mere description (e.g., discuss, identify, name, list, trace, compare, contrast) to being able to use it to explain and predict things in the world around them.

Subject Matter Content

Concept mapping of the central concepts (and accompanying details included in the text) in each piece of curriculum was a useful tool for comparing the content. One contrast that emerged through the comparison is in the amount of information each set of materials covers. It provides a good illustration of the issue of "depth versus breadth" of coverage that is often mentioned in content analyses. Figure 1 shows the central concepts and accompanying scientific terminology included in the five lessons of "Activities of Green Plants," and is a good example of the breadth of coverage

that is typical in textbooks. The darker circles represent the main ideas included in the text material, and the central idea of each lesson is numbered inside the appropriate darkened circle on the map (lesson 1--life processes; lesson 2--transporting parts of the plant; lesson 3--photosynthesis; lesson 4--respiration; lesson 5--plant reproduction). Another point worth noting is the number of scientific terms included in the text in five lessons; each lesson topic is taught through the use of extensive scientific vocabulary.

Insert figure 1 about here

Figure 2 shows the same aspects for "The Power Plant" materials: central concepts, scientific terminology, and central ideas of each chapter. This set of materials is an example of covering a fewer number of topics in greater depth. Depth refers to emphasis on understanding relationships among concepts rather than emphasizing the scientific vocabulary associated with the concepts. For example, in lesson 3 of "Activities of Green Plants" (represented in figure 1 in the circle labeled photosynthesis), scientific terms (e.g., chloroplast, chlorophyll, stomata, veins, hydrogen gas, carbon dioxide) are used to explain the process of photosynthesis. In contrast, in "The Power Plant" materials (see figure 2), more everyday language is used in explanations (e.g., food stored in plant cells), and the materials do not discuss photosynthesis at a molecular level.

Insert figure 2 about here

Thus, a striking difference between the two pieces of curriculum is the amount of content coverage. "Activities of Green Plants" covers a vast amount of information per lesson. The overarching concept for the chapter is "life processes" and three of those (getting food, releasing energy, and reproducing) are given emphasis in subsequent lessons. "The Power Plant" covers less information overall, and centers around the overarching concept of the scientific definition of food. Moreover, "The Power Plant" concepts are emphasized across chapters so that the information from one chapter is used in another (see chapter numbers listed with concepts in figure 2). These kinds of connections across lessons are only emphasized in the "Activities of Green Plants" chapter across lessons 2 and 3 (transporting materials in the plant and photosynthesis) and photosynthesis in lesson 3 is briefly contrasted with respiration in lesson 4. In "The Power Plant," the scientific definition of food is emphasized as a key concept to connect ideas in chapters 1, 2, and 4 (see figure 2). Also, connections among concepts are emphasized, so that chapter 4 emphasizes how the scientific definition of food is related to food stored in plants, and how the food stored in plants is related to photosynthesis. Thus, in addition to contrasts in the amount of information treated, the two sets of materials contrast in the importance and emphasis they place on the way concepts are related to each other.

How Knowledge is Used

When curriculum materials provide students and teachers with activities to complete (e.g., discussions, projects, experiments, worksheets, writing paragraphs, group work), they are providing ways for students to use subject matter knowledge. Since the focus of this paper is on writing assignments, this section addresses the issue of how knowledge is used in writing assignments in the curriculum materials.

The Form and Function of Writing Assignments

Neither set of materials contains any required extended writing assignments. "Activities of Green Plants" suggests a few options to the teacher for enrichment activities, or for "interested students," but does not build extended occasions for writing into the lessons. It also has a section prior to the chapter labeled "Science Springboard" in which some general writing assignments are suggested (e.g., have the students pretend they are a plant for a day, research its characteristics and needs, then write two paragraphs about what would happen or what the plant would need; summarize a news article in correct sequence; write new verses to a song about plants). However, there are no guidelines given as to when and how the assignments might be used most effectively, and the topics seem distantly connected with the lesson topics. The introductory pages in the volume also include a page entitled "Writing and Thinking in the Science Curriculum," where an overall

suggestion is made to have students write learning logs throughout the lessons--before starting a lesson, as a place to ask questions, recording thoughts and ideas immediately after a lesson--to record and develop their ideas. It is also suggested that students share their learning logs on a regular basis. However, this page in buried among several other introductory pages and there is no further mention of the logs anywhere in the text, so that unless the teacher is motivated to implement their use and can identify strategic times to get the most out of using the logs as a tool, it seems likely that this suggestion will not be forgotten along the way.

The most common form of writing used as part of the chapter materials in "Activities of Green Plants" is the worksheet. Eight copymaster worksheets are provided with the materials for the five lessons in chapter 1. These come in the form of four skills sheets that work on skills such as vocabulary readiness, vocabulary comprehension, sequencing of ideas, and distinguishing between an observation and an inference. In addition, one activity worksheet is provided for use with a lab activity, where students are asked to record their observations when they look at a leaf, and speculate about what would happen to the leaf in a different situation. A "Take-Home Science" worksheet is provided for use with an experiment students can do at home; students are asked to record their observations, and explain why a particular procedure was used. One "Challenge/Critical Thinking" worksheet is provided which focuses on the topic of carnivorous plants, a topic that was briefly discussed in a boxed in area in lesson 2. Students are directed to read a paragraph at the top of the page about carnivorous plants, and then asked to answer questions whose

answers can be found in the reading. Finally, a two-page "Chapter Checkup" worksheet is provided that contains factual recall questions about main ideas in the chapter.

In the teacher's manual, there are also end-of-chapter questions provided for teachers to use during the "reinforcement" segment of the lesson (following a "motivation" and a "concept development" section). These questions, like the Chapter Checkup worksheet questions, are factual recall questions about main ideas (e.g., What is a cell?; How do green plants get the materials they need to make food?). Responses to the questions on the worksheets generally require single words, phrases, or one to two sentences. There is no direction given to the teacher as to what to expect from the written assignments, or how to use them for further planning or assessment of student learning.

"The Power Plant" student text is written in workbook format, with an interactive style of asking students to read, think about questions raised in the text, write down their ideas (e.g., record their current thinking about a topic, make a prediction, use something they have learned to answer a new question), continue reading (accompanied by class discussion of the text), and to revisit their previous written ideas and decide if and how these ideas have changed. Responses to the questions or problem situations posed generally require single words, phrases, or short paragraphs. The teacher's manual contains detailed information for the teacher about probable student responses, and ways to help students clarify their thinking. The authors encourage teachers to pay attention to student responses as indicators of

their current understanding of concepts and as information for the teacher as to what needs further emphasis.

In the analysis of both sets of materials, drawing sketches and diagrams or labeling a drawing is included as a writing assignment, since the focus of this analysis is on the function of assignments that require students to record their ideas in written form. Moreover, subject areas such as science, mathematics, art and music lend themselves to using graphic representation for ideas in much the same way that written words function in social studies and literature.

The Function of the Written Assignments in the Learning Process

The written assignments in these two pieces of curriculum may appear to be similar, since their form requires single word and short-answer responses. When they are examined for the way the assignments are likely to function in helping students develop their knowledge and understanding of the concepts, there are some major contrasts. The three types of functions of knowledge in writing assignments previously discussed (see p. 9) were used to analyze and categorize the writing assignments in the two pieces of curriculum. Since "The Power Plant" student text is in an interactive workbook format that intersperses short writing tasks with reading and discussion (instead of the more typical pattern of assigning a worksheet at the end of a lesson), there are instances when asking for a single answer or phrase is counted in the analysis as one "assignment." The reason for this is that the writing task, regardless of how short, functions in a particular way in the learning

process. Likewise, the worksheets in "Activities of Green Plants" each counted as one assignment, since they would typically be assigned to be completed as one assignment, and their full completion would serve a particular function in the learning process.

"Activities of Green Plants" Writing Assignments. Summarized in table 1 are the functions of writing assignments in "Activities of Green Plants." Of the 15 required (i.e., included as a regular part of the curriculum and not labeled as "extra" or "optional") and 4 optional assignments, 1 is used to elicit students' prior knowledge. Another form of eliciting prior knowledge that is used quite extensively in the chapter is included regularly the "motivation" section at the beginning of each of the five lessons. The students are asked to think about the lesson topic in a certain way, and this discussion is used to launch the lesson topic. In the case of lesson 2 (Transporting Materials), the students were asked, in groups, to examine a small green plant that has been removed from the soil and washed. The focus of the examination is on asking students to determine how materials such as air and water might enter the plant. Students are asked to hypothesize how this might occur, and then sketch their plant and show how water and air might enter the plant. Thus, student' prior knowledge is typically elicited at the beginning of each lesson, and in the case of lesson 2, this was accompanied by a writing task. There is no mention of this piece of writing again, even at the end of the chapter in the "reinforcement" section of the lesson when the teacher is directed to return to the "opening question" of the lesson: "How do green plants transport the materials needed for food?" In parentheses the

answer is given, but no mention is made of having students return to their drawings to discuss or focus on differences in their thinking.

Insert table 1 about here

Of the 15 required and 4 optional writing assignments, "Activities of Green Plants" contains 11 required and 2 optional writing assignments that require students to consolidate and review their knowledge. As previously mentioned, each lesson has questions on the Chapter Checkup worksheet that students can complete as they go through the chapter or at the end. The manual directs the teacher to have the students complete the pertinent questions at the end of each lesson. These questions require mere factual recall, such as: "What three things do green plant need to make food?"; "Define the term photosynthesis." These kinds of questions mirror the suggested discussion questions teachers are to pose during lessons as well. For example, after reading the description in the text on photosynthesis, the teacher is directed: "To insure that the students understand the process of photosynthesis, ask: What does the chlorophyll do to sunlight? What two gases does the water become? What happens to the oxygen? What two gases join? What is made? What is this process called?" (Teacher's Manual, p.14). Thus, the major type of knowledge use in the text, through discussion, and through follow-up written work after discussion and activities is to consolidate or review the specific terms that were used. Students could perform well by simply giving back the content of the text.

Of the 15 required and 4 optional writing assignments, there are 3 required and 2 optional assignments that engage students in reformulating and extending their knowledge. For example, at the end of chapter 1 after students have learned about the three basic needs of all living things, and after they have completed that Chapter Checkup questions pertaining to this topic (e.g., "Name three things that plants and animals need to stay alive."), they are asked to apply that knowledge to a particular situation. The assignment is to list important items needed in a survival kit. The teacher is then directed to "point out" that people can survive for as long as a month or more without food, but would die without water within a week and would die without air in minutes. No mention of this assignment or its application to later lessons is made in the chapter.

A second required assignment that gets students to reformulate or extend their knowledge is a "Take-Home Science" Worksheet assigned at the end of chapter 4 (Using the Energy in Food). Students are directed to do an experiment aimed at helping them answer the question, "Is the water used by plants renewable?" After doing the experiment, they are asked to report their observations ("Do plants put water back into the air? How doe you know?"), and to explain one of the procedures used in the experiment ("Why was the lollipop stick placed in one of the tumblers with the water?"). Although this activity and worksheet were apparently designed to illustrate to students one of the features of respiration emphasized in the book (water is produced and given off), no mention is made of how this activity relates to respiration, or of any follow-up discussion that might take place.

A third required written assignment designed to get students to reformulate or extend their knowledge is a skills worksheet asking students to look at a diagram of flower parts. Statements about the diagram are listed under it and students are asked to label the statements as either an observation or an inference. At the bottom they are asked to write one observational statement and one inferential statement about the diagram. This task goes beyond the typical naming and labeling that students are asked to do in the chapter, and asks them to critically appraise the nature of the information they are dealing with.

The two optional assignments that require students to reformulate or extend their knowledge are not very closely tied to the chapter's content. They are cast as possible activities for "interested students," who would research the topics, write a short report, and share them with the class. One topic is finding out more about carnivorous plants··where they grow, and what mineral is usually lacking. This ties in with the chapter's discussion of materials that plants transport (minerals are transported through water), and focuses on differences between how carnivorous plants get minerals compared to other plants. However, it seems to be included more because it might be an interesting topic to children than because it helps children understand the concepts in the chapter. A second optional topic for research in lesson 5 is for students to find out about hay fever··what time of year symptoms of the allergy usually occur and why. Again, it is tangentially connected to the study of plant reproduction, but does not provide a way for students to deepen their understanding of the main concepts in the lesson.

Of those assignments provided to help students reformulate and extend their knowledge, only one (creating the survival list) focuses on helping students make connections or reorganize their knowledge about central concepts covered in the chapter. In the majority of the 19 possible assignments, students are mostly asked to recall central concepts through tasks asking them to review their knowledge, and this kind of writing activity is supported by discussions that do the same. Moreover, the 19 assignments are unconnected; no mention is made in the teacher's manual or the assignments themselves of previous written work or previous activities and how one might build on another.

"The Power Plant" Writing Assignments. Shown in table 2 are the functions of writing assignments included in "The Power Plant" student text. These materials contain a different pattern of writing activity compared to the "Activities of Green Plants" materials. Of the 20 assignments (all required as part of the interactive workbook format), 8 are used to elicit prior knowledge, 2 are used to consolidate and review knowledge, and 10 are used to reformulate and extend knowledge. Moreover, there is a pattern of asking students (as part of the assignment) to look back at their previous work to examine what they thought earlier in the lesson series, and to ask them to rewrite or revise their thoughts in written form. Thus, writing serves the function of providing a written record that students and teachers can use to examine and later revise or change as the learning proceeds. It is built into the workbook format that the assignments connect and will be used in a connected fashion.

Insert table 2 about here

In chapter 1 (Introduction) students write down their preconceptions of what food for plants is and learn about the scientific definition of food. In chapter 2 (Using Experiments to Find Out About Food for Plants) they are given instances in which they are asked to decide what is or is not food for plants. These instances are based on the authors' research about what students typically think is food for plants (e.g., soil, minerals, water). Table 2 shows the pattern of using writing to elicit students' prior knowledge about food for plants (4 instances of asking them to write down their current knowledge in chapter 1), and asking them to begin immediately to apply the new knowledge they have learned (the scientific definition of food) to test out their understanding of the concept (2 instances in chapter 1 of asking students to revise and apply their definition of food as they learn, and 3 instances in chapter 2 of making predictions about whether soil, minerals or water are food for plants). Thus, application tasks are *part of* concept development in these materials, which contrasts with the pattern of the "Activities of Green Plants" materials that provide application tasks *after* concept development.

Chapter 3 continues to elicit students' prior knowledge about further concepts introduced (movement of food in plants) by asking students to label a diagram provided. Then another kind of writing activity is introduced. Students are asked to fill in a chart in which they are asked to "sort out"

what goes into and out of the "leaf factory" (a leaf making food for plants). They are asked to list what goes in the plant, and for each substance on the list they also are asked the following questions: "Does it contain energy? Is it food for the plant? Is it needed for photosynthesis?" For those materials going out they are asked: "Does it contain energy? Is it food for the plant? Is it needed by plants?" This chart requires students to do more than merely recall what the student text has explained. It requires them to make sense of and organize their knowledge in a particular way, and to think systematically about the various materials they have learned about. It is more than a reading comprehension or recall task. The extent to which students can correctly fill in the chart is also useful feedback for the students and the teacher about their current understanding. This task is quite different from the questions asked in the worksheets in "Activities of Green Plants" where students are simply asked to name items, or to put the steps of photosynthesis in a sequence.

Following the consolidation and review task in chapter 3 of "The Power Plant," students are once again asked to apply their newly-consolidated knowledge to explain three situations. One situation asks them to return to an experiment they had previously read about and discussed in the text and explain something about it. A second set of situations asks them to use their newly-learned concept of photosynthesis to explain three situations. The teacher is directed in the manual to listen carefully to a discussion of the students' answers to detect the presence of misconceptions, and to make sure they require students to explain and clarify any answers they give. Thus, the

activity serves as an opportunity for students to use the knowledge they have learned, and as an opportunity for the teacher to assess students' current understanding.

Chapter 4 is geared toward providing opportunities for students to continue practicing application of their newly-consolidated knowledge, and for the teacher to continue to assess understanding. This gives both an opportunity to clarify information, and to continue work on understanding if necessary. Another chart is provided for students to use to compare their understanding of food for plants with their understanding of food for humans (discussed in the opening chapter). Again, the chart serves as a means for students to organize (or reorganize) their thinking about the concept of food for plants. Finally, students are asked to return to their original definition of food for plants (their beginning writing assignment) to determine how they would change or add tc their original definition to make it more accurate. They are also asked to do the same with the diagram they labeled. This fosters student reflection about their own understanding, and provides a concrete means for them to see how they have reformulated, reorganized, and extended their understanding.

The writing tasks included in "The Power Plant" materials function as a pedagogical tool to help students throughout the learning process: (a) elicit and become aware of their own knowledge; (b) consolidate and review new information as they learn it so they have a way to organize it and make sense of it; and (c) reformulate and extend their knowledge in relation to their prior beliefs and understanding. For teachers, the writing tasks make each

student's understanding explicit so they know where work is needed, and can provide the necessary support for continued learning. These materials are an interesting example of ways in which brief writing tasks can be used as valuable teaching tools that promote understanding beyond mere memorization and recall.

How Writing Assignments Provide Different Learning Opportunities

Authors of both sets of materials claim to facilitate active construction of meaning in learning science. However, given the emphasis in writing assignments in "Activities of Green Plants" on factual recall and review of basic vocabulary and facts versus the emphasis in writing assignments in "The Power Plant" on using well connected and well organized knowledge to explain and predict scientific phenomena, a different kind of learning would result from the use of these two pieces of curriculum.

Figure 3 represents the contrasts in the two sets of materials' use of writing as a communication process (intended and enacted curriculum), and the resulting learning (actual curriculum) that would take place. As represented in the top circle in figures 3a and 3b, the "Activities of Green Plants" chapter takes on a much larger chunk of disciplinary knowledge to teach in five lessons (also see figure 1)--three life processes (food production, releasing energy, reproduction) and the specific explanations of how each occur in plants. "The Power Plant" materials (figure 3b) take on a much smaller chunk of disciplinary knowledge (also see figure 2). The latter

focuses on one life process (food production in plants) in approximately six lessons. As previously discussed, these two sets of materials are a good illustration of the breadth versus depth of coverage issue. "Activities of Green Plants" materials must focus on covering a large amount of information to get through the three processes in five lessons. "The Power Plant" materials take on a more modest goal in six lessons and therefore can focus more on connections among major concepts and ways in which the information students are learning about can be organized.

Insert figure 3 about here

The middle circles in figures 3a and 3b represent the intended and enacted curriculum. In "Activities of Green Plants," writing assignments are mostly of one type and function mostly in one way--to review newly learned information. They are not connected with each other, but instead are assigned as isolated tasks that are completed in a linear fashion across the chapter. Most of "The Power Plant" writing assignments function to elicit students' prior knowledge or to help them reformulate and extend newly-learned information by asking them to predict and explain phenomena. Assignments are used to consolidate and review at strategic times to help students clarify their own understanding and get ready to apply their understanding to explain or predict scientific phenomena. All three kinds of assignments are well connected by making use of work from on task in subsequent tasks.

The resulting student learning (actual curriculum circles in figures 3a and 3b) is different in nature. In the "Activities of Green Plants" chapter, students are taught to work with basic information in a manner that requires recall of information, which is consistent with the stated goals and objectives in the series: identify, name, list, describe, explain, trace, compare and contrast. Of those objectives, very little explanation is called for in the actual work students are expected to complete; most of the work requires identifying, naming, listing, describing, and tracing. As long as students can give back the information in the text through discussion and written work, it is implied that "learning" has taken place.

In "The Power Plant" materials, students are expected to make sense of the information in the text so that they can use it to explain and predict situations that are built into the curriculum, not just so they can recall it. Learning is measured in terms of *ability to use it* rather than to repeat information. Students are also expected to change their thinking, which is represented in figure 3b by the "prior knowledge" circle that contributes to the actual curriculum. Although the "Activities of Green Plants" chapter starts with students' prior knowledge as a motivational device (shown in figure 3a as input for the intended and enacted curriculum at the top), teachers are never encouraged to return to students' original *preconceptions* during the concept development phase of the lesson, but instead are directed to return to the original opening question at the end (during the reinforcement phase), as though the *question* is important, but what the students originally thought about it is not. In contrast, "The Power Plant"

builds in reflection on prior knowledge and beliefs as an integral part of the learning process. Thus, the resulting learning is based on active construction of meaning--sometimes extending knowledge and sometimes reformulating and changing it--that takes in students' thinking as an important part of the learning process. This is consistent with the authors' stated goals of conceptual change and teaching students to use their scientific understandings to explain and predict phenomena.

Using Text Materials to Bring About Meaningful Learning

Findings reported in this paper suggest improvements needed in text materials that emphasize recall of information over meaning construction. There are also some implications for how curriculum materials typically available might be evaluated and used in classrooms.

A major problem with the "Activities of Green Plants" materials is in their surface coverage of too much material. Looking at the amount of content included in the student text (see figure 1) makes it obvious that in five lessons (the typical length of a book chapter in these materials) it is not possible to teach for in-depth understanding of the concepts. Moreover, it is not possible to spend time emphasizing the connections among the major concepts when there is so much information to cover in the first place. One remedy for this problem is to be more selective in choosing teaching topics. The content choices in "The Power Plant" materials are an example of how this might be done. Instead of teaching briefly about plants carry out three life

processes, the materials emphasize one life process--food making--in depth, and work at bringing out important connections among a limited number of key concepts.

However, materials like "The Power Plant" are not readily available to teachers on a wide array of topics. Teachers who must use materials that sacrifice depth for breadth of coverage must figure out ways to *impose coherence* on the subject matter content and emphasize connections among key ideas. This involves going beyond helping students develop a surface level or literal interpretation of the text or even a knowledge-based interpretation of it (Beck & McKeown, 1988) to also develop a "mental model" of the situation in which the information fits (Kintsch, 1986). The developers of "Activities of Green Plants" did seem to have such a mental model in mind as they developed the five lessons, as evidenced in figure 1. They understood how the chapters on transporting materials, food-making, and reproduction fit in with the introductory chapter on life processes--they are key examples of life processes. However, they failed to find a way to communicate successfully that "mental model" to students through the text material and assignments. The text itself makes little reference to connections among topics. For example, the life processes introduced in lesson 1 are never mentioned again as the three examples of life processes--making food, releasing energy, and reproduction--are discussed in subsequent lessons. Moreover, as the previous discussion in this paper makes clear, there is no attempt to make such links through the written assignments either.

Teachers could attempt to bring coherence and conceptual linkages to the materials as they are used by making more explicit to students, through discussion and activities and assignments, how the five topics covered in the five lessons fit together conceptually. They could point out the important connections to students, and ask students to revisit key ideas from one lesson and discuss how they relate to subsequent lessons. In addition, they could be selective about which key ideas and which details they emphasize in teaching the various lessons. For example, the lessons on transporting materials and photosynthesis mention several vocabulary words (e.g., veins, stomata, chloroplast, chlorophyll) that do not necessarily help students understand the main concept of how plants make their own food. Students do not necessarily need to know such words in order to understand the photosynthesis process and how it works. Such words and accompanying worksheets could be de-emphasized in favor of focusing on comprehending the key concepts. Teachers may also need to supplement some concepts with additional materials (e.g., additional short readings, films, field trips, guest speakers) when the text does not adequately explain them. By developing a clear overview of the content for themselves, and by understanding which information covered in the text is a "big idea" and which is a "supporting detail" that may or may not be critical to understanding, teachers can make critical decisions about which content in the text to emphasize, and how to emphasize important connections among key concepts.

By focusing on key ideas and connections among them instead of evenly treating a series of details as though all the information is equally

important, teachers would then be pursuing understanding versus content coverage. This pursuit makes activity and assignment selection critical. Since most of the written assignments in the "Activities of Green Plants" materials are focused on getting students to recall facts, teachers would need to be selective in deciding which worksheets are worthwhile in helping students reformulate and extend their knowledge. If worksheets were used, they would need to be followed up with group discussions or other activities that help students use the knowledge they have reviewed by completing the worksheet for a meaningful purpose. The learning log that is mentioned at the beginning of the text (but never included as part of the flow of activities) is a potentially useful tool for helping students go beyond factual recall called for in the written assignments. Writing regularly in the log to ask questions, review central concepts, or use information to explain or predict situations could supplement or even replace the worksheets. Thus, teachers need to weigh the value of assignments on the basis of what they are asking students to do with the knowledge being taught, and make decisions about what an appropriate use is at a particular point in the learning process.

Both sets of curriculum materials bypass opportunities to use extended writing assignments to develop understanding. Teachers could consider places in both lesson series where extended writing (e.g., essays, laboratory reports, research projects, interviews, letter-writing) would be an appropriate means of helping students construct understanding of a topic. Using extended writing assignments brings in additional instructional issues that must be considered, since students are still developing as writers and

need instructional support to complete the writing process as well (cf. Langer & Applebee, 1987; Rosaen, forthcoming; Scardamalia & Bereiter, 1986; Tchudi & Tchudi, 1983). Using extended writing in content areas as a means of helping students go beyond mere "knowledge telling" (Bereiter & Scardamalia, 1985) is fertile ground for improving learning opportunities, yet there is a great deal more to be learned about how to carry it out effectively.

In summary, the ideal is for texts to contain content that is well selected to treat key topics in depth, organized to help students understand concepts and interrelationships among them, and explicated to help students construct understanding that goes beyond recall. In addition, there would be a balance in assignments in texts that would appropriately elicit students' prior knowledge, get them to consolidate and review their knowledge at strategic times, and focus on helping students reformulate and extend their understanding of key issues. Until this ideal is met in texts that are typically available to teachers, the tasks of imposing coherence on the content and pursuing understanding over content coverage through appropriate assignments and activities that get students to use their knowledge for worthwhile purposes are left to teachers. Careful study of text materials can reveal what the materials have to offer, and then teachers must figure out ways to use the text effectively to teach for understanding.

Figure 1: Subject Matter Content in "Activities of Green Plants" Materials

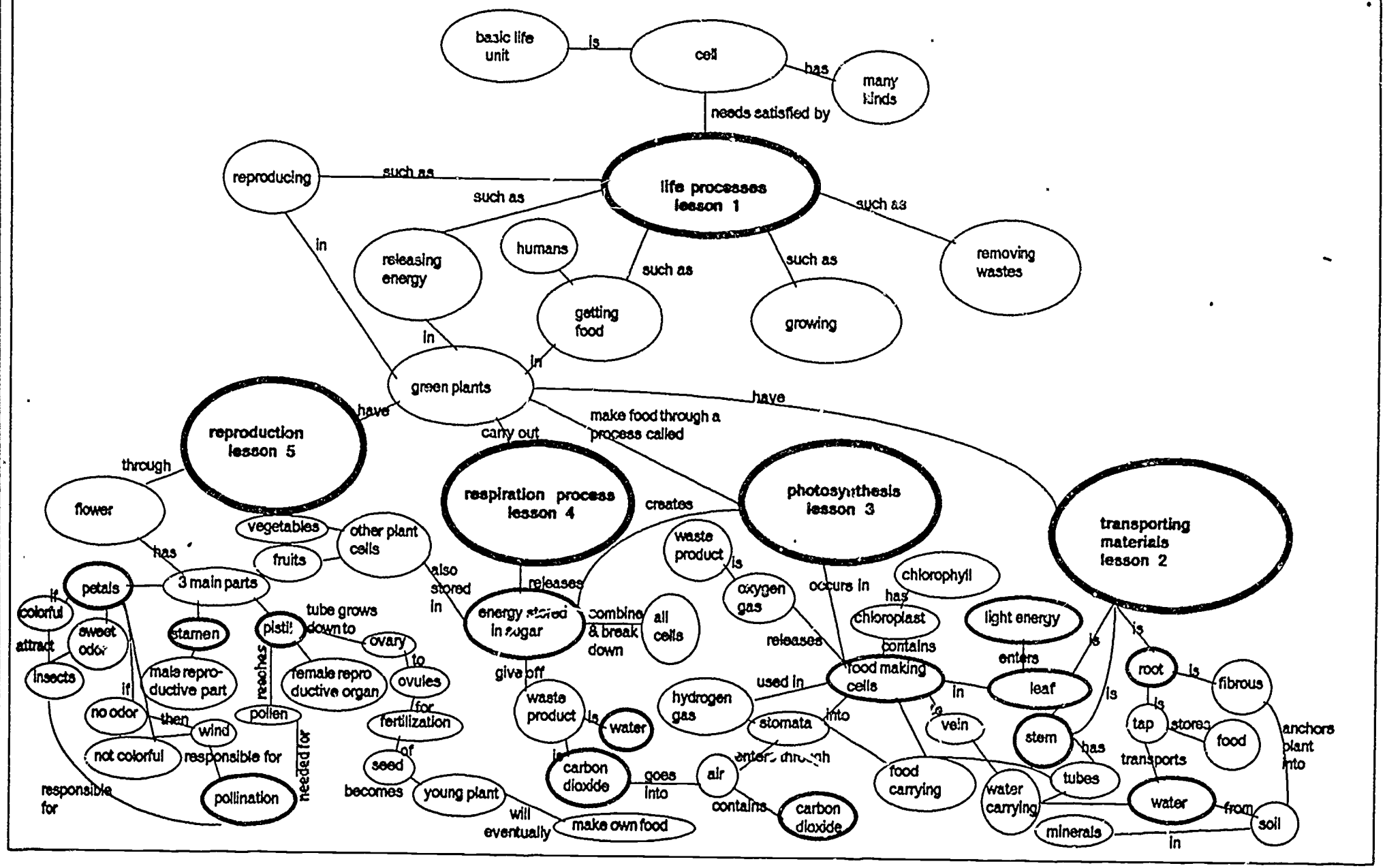


Figure 2: Subject Matter Content in "The Power Plant" Materials

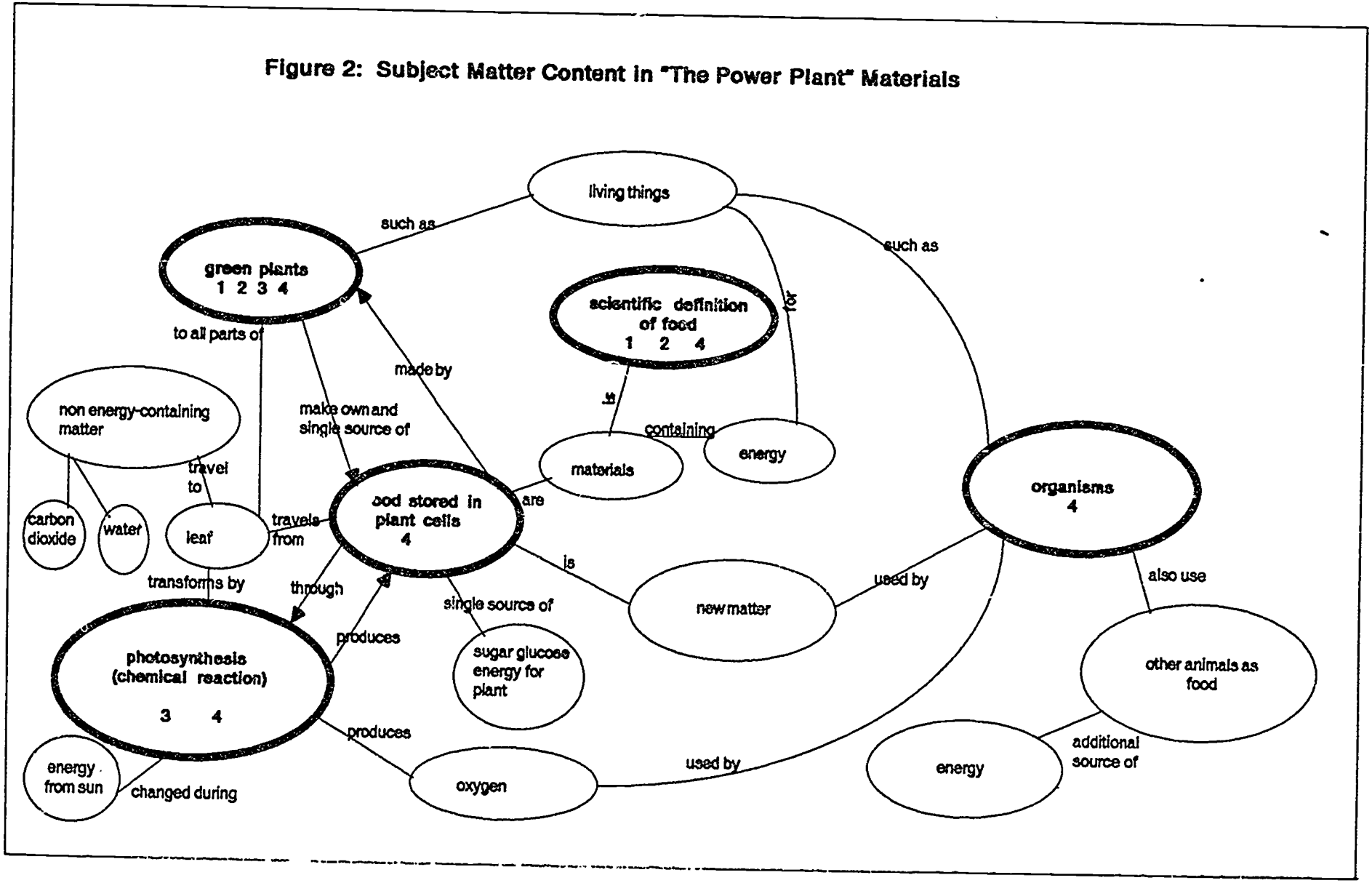


Table 1: Functions of Writing Assignments in "Activities of Green Plants"

Total: 15 required (4 optional)	1 required	11 required (2 optional)	3 required (2 optional)

Lesson	HOW KNOWLEDGE IS USED IN WRITING ASSIGNMENTS		
	Elicit Prior Knowledge	Consolidate & Review Knowledge	Reformulate & Extend Knowledge
1: Plants and Animals Are Alike		Reinforcement/Review: Chapter Checkup	Reinforcement/Review: Create list for survival kit
2: Transporting Materials	Motivation: Sketch of hypothysis describing how plants transport materials	Reinforcement/Review: Chapter Checkup Reinforcement/Review: Challenge/Critical Thinking Worksheet	Concept Development: (Optional) Research report on carnivorous plants
3: Food Making in a Leaf		Concept Development: (Enrichment) Draw & label slides of leaf cells Concept Development: Write photosynthesis formula on board in segments and explain Reinforcement/Review: Chapter Checkup Reinforcement/Review: Skills Worksheet--Sequence steps of photosynthesis Reinforcement/Application: (Optional) Find pictures, identify, label parts of a plant from which each food comes	
4: Using the Energy in Food		Concept Development: Write formula for respiration on board in segments and explain Reinforcement/Review: Chapter Checkup	Reinforcement/Application: Take-Home Science Worksheet
5: Producing New Plants		Concept Development: Draw & label pistil (flower examination activity) Reinforcement/Review: Chapter Checkup Reinforcement/Review: Vocabulary Worksheet	Concept Development: (Optional) Research report on hayfever Concept Development: Skills Worksheet--Observation and Inference

Note: Assignment labels (Motivation; Concept Development; Reinforcement/Review/Application) are those given in teacher's guide.

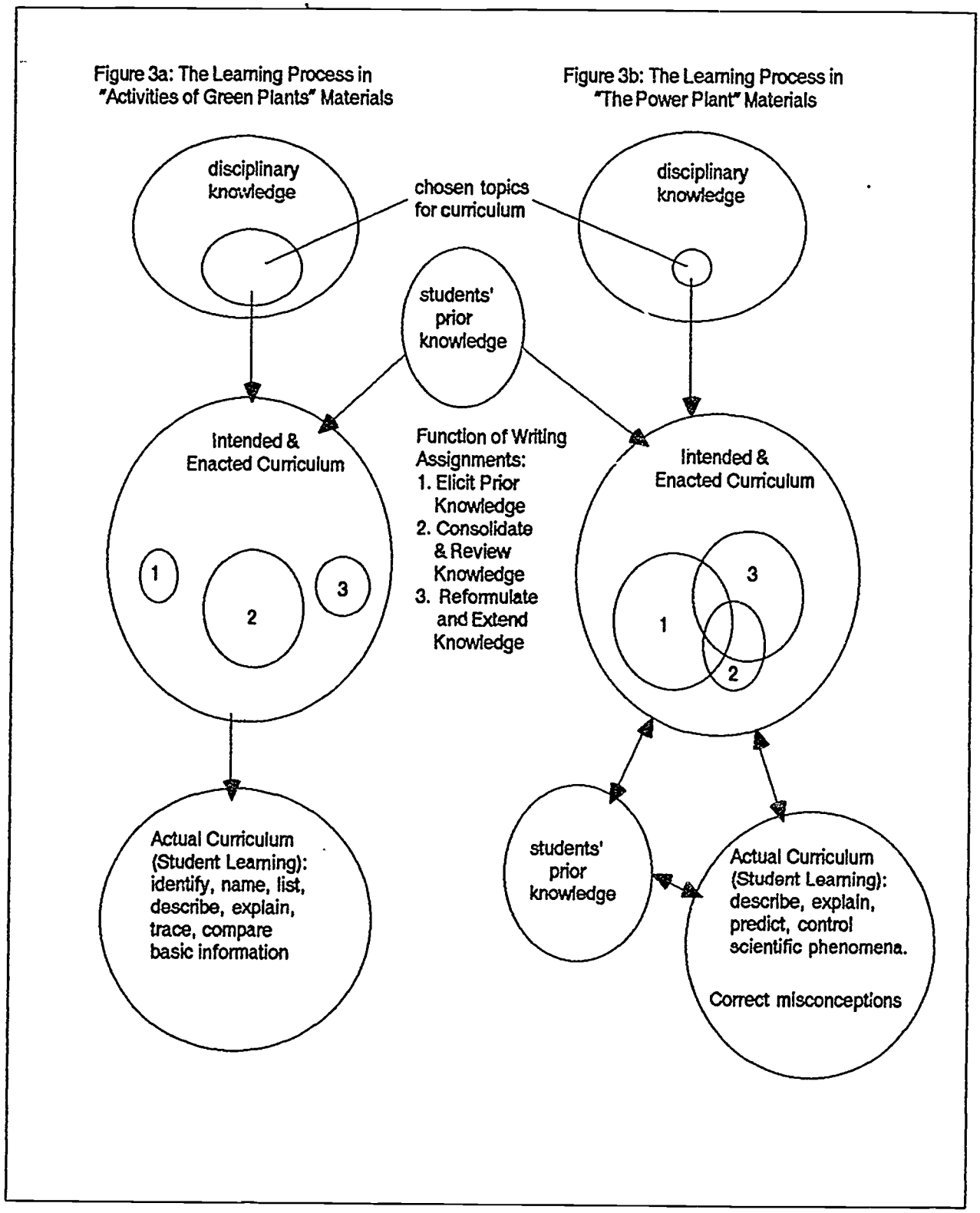
Table 2: Functions of Writing Assignments in "The Power Plant"

Total: 20 | 8 assignments | 2 assignments | 10 assignments

Chapter	HOW KNOWLEDGE IS USED IN WRITING ASSIGNMENTS		
	Elicit Prior Knowledge	Consolidate & Review Knowledge	Reformulate & Extend Knowledge
1: Introduction	**Write own definition of food. **Write down own ideas about how plants get food. **Write down own ideas about what kind of food plants use. **Draw arrows on diagram to show food movement in plant.		**How would you change your definition of food? **Use definition of food to explain why you could not live on water and vitamin pills alone. Use scientific definition of food to explain whether dirt is food for a baby if the baby eats dirt.
2: Using Experiments to Find Out About Food for Plants	**Make predictions about weight of child, food, and soil. **Predict what will happen to seeds planted in soil, given water, kept in dark. **Predict what will happen to grass plants in dark, in sun.		**Answer question about Van Helmont's experiment: Is soil food for plants? **Use the scientific definition of of food to answer the question: Are minerals food for plants? **When a plant is looking dry and wilted, what do you do to help it? Does this mean that the water is food for the plant? Explain.
3: How Plants Use Sunlight to Make Their Own Food	**Draw arrows on diagram to show food movement in plant.	**Fill in chart to check understanding of the leaf factory.	**Use the idea of photosynthesis to explain experiment with grass seeds. **Use the idea of photosynthesis to explain 3 situations.
4: Using Your Knowledge About Food For Plants		**Fill in chart comparing food for humans and food for plants.	**Use key concepts to explain 5 situations. **Review and change original definition of food (from chapter 1); add to explanation. **Draw arrows on diagram to show food movement in plant.

Key: ** Specific writing tasks students are directed to complete in workbook

Figure 3: Contrasting Learning Processes in Curriculum Materials



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Appendix A

Phase II Study 2: Curriculum Materials Analysis Framing Questions

A. GOALS

1. Are selective, clear, specific goals stated in terms of student outcomes? Are any important goals omitted? As a set, are the goals appropriate to students' learning needs?
2. Do goals include fostering conceptual understanding and higher order applications of content?
3. To what extent does attainment of knowledge goals imply learning networks of knowledge structured around key ideas in addition to the learning of facts, concepts, and principles or generalizations?
4. What are the relationships between and among conceptual (propositional), procedural, and conditional knowledge goals?
5. To what extent do the knowledge goals address the strategic and metacognitive aspects of processing the knowledge for meaning, organizing it for remembering, and accessing it for application?
6. What attitude and dispositional goals are included?
7. Are cooperative learning goals part of the curriculum?
8. Do the stated goals clearly drive the curriculum (content, activities, assignments, evaluation)? Or does it appear that the goals are just lists of attractive features being claimed for the curriculum or post facto rationalizations for decisions made on some other basis?

B. CONTENT SELECTION

1. Given the goals of the curriculum, is the selection of the content coherent and appropriate? Is there coherence across units and grade levels? (Note: all questions in this section should be answered with the goals in mind.)
2. What is communicated about the nature of the discipline from which the school subject originated?

   a. How does content selection represent the substance and nature of the discipline?

   b. Is content selection faithful to the discipline from which the content is drawn?

   c. What does the relationship among conceptual (propositional), conditional, and procedural knowledge communicate about the nature of the discipline?

3. To what extent were life applications used as a criterion for content selection and treatment? For example, in social studies, is learning how the world works and how it got to be that way emphasized?
4. What prior student knowledge is assumed? Are assumptions justified? Where appropriate, does the content selection address likely student misconceptions?
5. Does content selection reflect consideration for student interests, attitudes, dispositions to learn?
6. Are there any provisions for student diversity (culture, gender, race, ethnicity)?

C. CONTENT ORGANIZATION AND SEQUENCING

1. Given the goals of the curriculum, is the organization of the content coherent and appropriate? Is there coherence across units and grade levels? (Note: All questions in this section should be answered with goals kept in mind.)
2. To what extent is the content organized in networks of information structured in ways to explicate key ideas, major themes, principles, generalizations?
3. What is communicated about the nature of the discipline from which the school subject originates?

   a. How does content organization represent the substance and nature of the discipline?

   b. Is content organization faithful to the discipline from which the content is drawn?

   c. What does the relationship among conceptual (propositional), conditional, and procedural knowledge communicate about the nature of the discipline?

4. How is content sequenced, and what is the rationale for sequencing? For example, is a linear or hierarchical sequence imposed on the content so that students move from isolated and lower level aspects toward more integrated and higher level aspects? What are the advantages and disadvantages of the chosen sequencing compared to other choices that might have been made?

5. If the content is spiralled, are strands treated in sufficient depth, and in a non-repetitious manner?

D. CONTENT EXPLICATION IN THE TEXT

1. Is topic treatment appropriate?

   a. Is content presentation clear?

   b. If content is simplified for young students, does it retain validity?

   c. How successfully is the content explicated in relation to students' prior knowledge, experience, and interest? Are assumptions accurate?

   d. When appropriate, is there an emphasis on surfacing, challenging, and correcting student misconceptions?

2. Is the content treated with sufficient depth to promote conceptual understanding of key ideas?

3. Is the text structured around key ideas?

   a. Is there alignment between themes/key ideas used to introduce the material, the content and organization of the main body of material, and the points focused on in summaries and review questions at the end?

   b. Are text-structuring devices and formatting used to call attention to key ideas?

   c. Where relevant, are links between sections and units made explicit to students?

4. Are effective representations (e.g., examples, analogies, diagrams, pictures, overheads, photos, maps) used to help students relate content to current knowledge and experience?

   a. When appropriate, are concepts represented in multiple ways?

   b. Are representations likely to hold student interest or stimulate interest in the content?

   c. Are representations likely to foster higher level thinking about the content?

   d. Do representations provide for individual differences?

5. When pictures, diagrams, photos, etc. are used, are they likely to promote understanding of key ideas, or have they been inserted for other

reasons? Are they clear and helpful, or likely to be misleading or difficult to interpret?

6. Are adjunct questions inserted before, during, or after the text? Are they designed to promote: memorizing; recognition of key ideas; higher order thinking; diverse responses to materials; raising more questions; application?

7. When skills are included (e.g., map skills), are they used to extend understanding of the content or just added on? To what extent is skills instruction embedded within holistic application opportunities rather than isolated as practice of individual skills?

8. To what extent are skills taught as strategies, with emphasis not only on the skill itself but on developing relevant conditional knowledge (when and why the skill would be used) and on the metacognitive aspects of its strategic application?

E. TEACHER-STUDENT RELATIONSHIPS AND CLASSROOM DISCOURSE

1. What forms of teacher-student and student-student discourse are called for in the recommended activities, and by whom are they to be initiated? To what extent does the recommended discourse focus on a small number of topics, wide participation by many students, questions calling for higher order processing of the content?

2. What are the purposes of the recommended forms of discourse?

   a. To what extent is clarification and justification of ideas, critical and creative thinking, reflective thinking, or problem-solving promoted through discourse?

   b. To what extent do students get opportunities to explore/explain new concepts and defend their thinking during classroom discourse? What is the nature of those opportunities?

3. Who or what stands out as the authority for knowing? Is the text to be taken as the authoritative and complete curriculum or as a starting place or outline for which the discourse is intended to elaborate and extend it? Are student explanations/ideas and everyday examples elicited?

4. Do recommended activities include opportunities for students to interact with each other (not just the teacher) in discussions, debates, cooperative learning activities, etc.?

F. ACTIVITIES AND ASSIGNMENTS

1. As a set, do the activities and assignments provide students with a variety of activities and opportunities for exploring and communicating their understanding of the content?

   a. Is there an appropriate mixture of forms and cognitive, effective, and/or aesthetic levels of activities?

   b. To what extent do they call for students to integrate ideas or engage in critical and creative thinking, problem-solving, inquiry, decision making, or higher order applications vs. recall of facts & definitions or busy work?

2. As a set, do the activities and assignments amount to a sensible program of appropriately scaffolded progress toward stated goals?

3. What are examples of particularly good activities and assignments, and what makes them good (relevant to accomplishment of major goals, student interest, foster higher level thinking, feasibility and cost effectiveness, likeliness to promote integration and life application of key ideas, etc.)?

   a. Are certain activities or assignments missing that would have added substantially to the value of the unit?

   b. Are certain activities or assignments sound in conception but flawed in design (e.g., vagueness or confusing instruction, invalid assumptions about students' prior knowledge, infeasibility, etc.)?

   c. Are certain activities or assignments fundamentally unsound in conception (e.g., lack relevance, pointless busy work)?

4. To what extent are assignments and activities linked to understanding and application of the content being taught?

   a. Are these linkages to be made explicit to the students to encourage them to engage in the activities strategically (i.e., with metacognitive awareness of goals and strategies)? Are they framed with teacher or student questions that will promote development?

   b. Where appropriate, do they elicit, challenge, and correct misconceptions?

   c. Do students have adequate knowledge and skill to complete the activities and assignments?

5. When activities or assignments involve integration with other subject areas, what advantages and disadvantages does such integration entail?

6. To what extent do activities and assignments call for students to write beyond the level of a single phrase or sentence? To what extent do the chosen forms engage students in higher order thinking?

G. ASSESSMENT AND EVALUATION

1. Do the recommended evaluation procedures constitute an ongoing attempt to determine what students are coming to know and to provide for diagnosis and remediation?

2. What do evaluation items suggest constitute mastery? To what extent do evaluation items call for application vs. recall?

   a. To what extent are multiple approaches used to assess genuine understanding?

   b. Are there attempts to assess accomplishment of attitudinal or dispositional goals?

   c. Are there attempts to assess metacognitive goals?

   d. Where relevant, is conceptual change assessed?

   e. Are students encouraged to engage in assessment of their own understanding/skill?

3. What are some particularly good assessment items, and what makes them good?

4. What are some flaws that limit the usefulness of certain assessment items (e.g., more than one answer is correct; extended production form, but still asking for factual recall, etc.).

H. DIRECTIONS TO THE TEACHER

1. Do suggestions to the teacher flow from a coherent and manageable model of teaching and learning the subject matter? If so, to what extent does the model foster higher order thinking?

2. To what extent does the curriculum come with adequate rationale, scope and sequence chart, introductory section that provide clear and sufficiently detailed information about what the program is designed to accomplish and how it has been designed to do so?

3. Does the combination of student text, advice and resources in teachers manual, and additional materials constitute a total package sufficient

to enable teachers to implement a reasonably good program? If not, what else is needed?

a. Do the materials provide the teacher with specific information about students' prior knowledge (or ways to determine prior knowledge) and likely responses to instruction, questions, activities, and assignments? Does the teachers manual provide guidance about ways to elaborate or follow up on text material to develop understanding?

b. To what extent does the teachers manual give guidance concerning kinds of sustained teacher-student discourse surrounding assignments and activities?

c. What guidance is given to teachers regarding how to structure activities and scaffold student progress during assignment completion, and how to provide feedback following completion?

d. What kind of guidance is given to the teacher about grading or giving credit to participating in classroom discourse, work on assignments, performance on tests, or other evaluation techniques?

e. Are suggested materials accessible to the teacher?

4. What content and pedagogical knowledge is required for the teacher to use this curriculum effectively?

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