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ABSTRACT

This study is based on the premise that research on science textbook content has not specifically dealt with patterned class and grade level differences in how the organization of the content orients students to the cognitive and personality characteristics identified as precursors to scientific careers. The investigation analyzed the effects of social class and grade level on the content of science textbooks from middle- and working-class school districts and from upper and lower grades. Content was examined on the basis of six variables: (1) orientation to cognitive flexibility; (2) orientation to abstract thinking; (3) orientation to communicative fluency; (4) orientation to autonomy; (5) orientation to goal-achieving; and (6) orientation to positive imagery. The results indicated that while more science texts are available to children in middle-class districts than in working-class districts, availability of knowledge important for the development of a scientific role is, on the average, the same for both middle- and working-class districts. In addition, the data suggests that social class has a distinctive effect on orientation to cognitive flexibility. Comparisons are made, with research done on political science textbooks. (TW)

Universalism in Science:

The Social Organization of Textbook Knowledge

Lynn Mulkey

BACKGROUND

The socialization and recruitment of scientists are often combined as a single major topic in the theory of the sociology of science. The task of the sociology of science is to seek out the specific conditions under which each of several possible social factors or many of them together actually influence the course of science (Barber). For example, educational influences have an effect on the development of science. One such condition pertains to the norm, "universalism" and education. "Universalism" refers to the view that the scientific community flourishes when access to scientific careers is possible for all segments of the population. This implies that to restrict scientific careers on grounds other than lack of competence is to prejudice the furtherance of knowledge; "accumulation of advantage" or access to resources by special groups/individuals, could have the consequence of segments of the population gaining access to specialized knowledge and careers -- an advantage not attributable to demonstrated differences in capacity (Merton).

The textbook, a knowledge resource, affects learning and cognitive orientation to the world (Davie; FitzGerald; Kuhn). Availability of knowledge is affected by the organization and transmission of content (Bernstein; Dansereau; Field). Availability of knowledge is also affected by patterns of access. Although Dansereau and Field have shown that the organization of science textbook material contributes substantially to students' understanding of science, most previous content analyses of textbooks have not been concerned with patterned differences in access to knowledge. Harrington, however, analyzed political science textbook content (according to social class and grade level) and found that middle-class children in upper grades were provided with political science knowledge helpful in making them "participants" in a democratic social system in contrast to children in lower grades from working-class districts who were provided with knowledge conducive to their socialization as "subjects" in the system. The present interest is, however, with social class and grade level differences in science textbook content and potential consequences for scientific careers.

The organizational features of science textbook content conducive to building the attributes felicitous to "participation" in science, can be examined by using observational instruments which evaluate orientation to the attributes of the mature research scientist. The attributes selected for study, as deduced from studies of research scientists (Drevdahl, ; Eiduson), describe the intellectual and emotional resources of scientists as precursory behaviors, knowledge and skills which have become refined so that individuals meet levels of proficiency and sophistication required by the adult professional scientist role.

PROBLEM

Literature on science textbook content has not specifically dealt with patterned class and grade level differences in how the organization of science textbook content orients students to the cognitive and personality characteristics identified as precursors of scientific careers, or as the variables which predispose individuals to scientific roles. This investigation has therefore analyzed the effects of social class and grade level on the content of science textbooks from middle- and working-class school districts and from upper and lower grades. Content was analyzed for orientation to the characteristics predictive of scientist roles by documenting and explaining social class and grade level variations for six variables: 1) orientation to cognitive flexibility; 2) orientation to abstract thinking; 3) orientation to communicative fluency; 4) orientation to autonomy; 5) orientation to goal-achieving; and, 6) orientation to positive imagery. The results of the data analysis of content according to social class -- seven districts, four working-class districts, three middle-class -- and grade level -- grades 2, 4, 6, and 8 -- were based on the comparability of content for middle-class versus working-class districts and for upper and lower grades.

An analysis of variance (ANOVA) for social class and grade effects and their interaction was performed; that is, the effects of social class on science textbook content were assessed independently of the effects of grade level on content, and then the interactive effects of social class and grade level were determined. The following were the three hypotheses concerning the content of science textbooks: H_1: textbooks used in working-class districts will contain content organized with a non-participant orientation as opposed to middle-class districts which will provide content organized with participant orientation; H_2: textbooks from lower grades will contain content organized with a non-participant orientation as opposed to higher grade textbooks, which will provide content organized with a participant orientation; and H_3: textbooks from middle-class, upper grades will contain content organized with a participant orientation as opposed to textbooks from middle-class, lower grades and from working-class upper and lower grades, which will contain content organized with a non-participant orientation. That is, it was hypothesized that textbook content for middle-class districts and higher grades would be organized so that knowledge is more facilitative of the acquisition of the intellectual and emotional characteristics of scientists than for working-class districts and lower grades.[1] Consequences are, if children in working-class districts are being socialized into non-participant roles, they are less likely to contribute to scientific advancement than are those children in middle-class districts who are being socialized into participant roles.

METHOD

A content analysis (Holsti) of cross-sectional data (textbook content from texts reported as used for the school year September 1983 - June 1984) was performed.

Population and Sample

The population was science textbooks used in New York State public, middle (grade 8) and elementary (grades 2, 4, and 6) schools. The sample (N = 187) was drawn from 7 representative school districts. The textbook was the unit of analysis. Books reported used by several schools in one district were counted only once per district; 49 of the same books were adopted by different distrricts.

Independent Variables

The concept, "social class" was measured according to the definition of Harrington, the New York State Commission on the Quality, Cost and Financing of Elementary and Secondary Education, the New York State Department of Education, and the New York City Board of Education. Textbooks were categorized and enumerated on the basis of those books reported as "used," that is adopted, by "working-class" and "middle-class" districts. Social class categories were based on statistical reports of reading scores, percentages of children receiving free lunches, median teacher income, and ethnic breakdown of student population. There were four working-class districts; (1) a suburban working-class district, (2) a rural working-class district, (3) a suburban working-class district, and (4) a small isolated upstate working-class city district. There were three middle class districts; (1) an urban middle-class district, (2) a suburban upper middle-class district, and (3) a suburban middle-class district. The concept of "grade level," was stratified into two levels, "elementary school students" and "middle school students." Elementary school students and middle school students referred to those students grouped together according to chronological age. "Grade level" was operationalized on three dimensions for "elementary school students" -- grade 2, grade 4, and grade 6 -- and on one dimension for "middle school students" -- grade 8.

Dependent Variable

The concept, "textbook content" consisted of six dependent variables (see Appendix): (1) "orientation to cognitive flexibility" (knowledge supportive of the ability to make connections between ideas in novel ways), (2) "orientation to abstract thinking" (knowledge supportive of the ability to apply rational ideas to empirical ends to produce generalized and systematic conceptual schemes), (3) "orientation to communicative fluency" (knowledge supportive of the ability to acquire the social and cognitive conventions of science), (4) "orientation to autonomy" (knowledge facilitative of self-direction in new situations), (5) "orientation to goal-achieving" (knowledge supportive of the ability for personal mastery of an event), and (6) "orientation to positive imagery" (knowledge which influences the perceptions of students about scientists so that entry into the scientific professions results). The degree of "participant organization" (grouping of content conducive to the acquisition and development of the cognitive and personality precursors of scientific roles) versus "non-participant organization" (grouping of content that is not conducive to the acquisition and development of the cognitive and personality precursors of scientific roles) was measured on a 3-point scale[2].

Data Analysis

Descriptive Techniques

The differential use of textbooks by middle-class and working-class districts was determined by computing the number of textbooks reported used "extensively" and those reported used "occasionally." To determine the availability of text materials to students on a basis that controlled for district size, the ratio of the number of materials per student was computed. This ratio did not reflect the actual use of textbooks by individual students, but was rather used to convey the number of books potentially accessible to students. For example, in a middle-class district, one book might accommodate 50 students and in a working class district, for every science textbook title reported used by the district, there might be 300 students. Then to see if material was distributed evenly by grade level, available material for grades 2 and 4 was compared with grades 6 and 8.

Inferential Techniques

A two-way analysis of variance (ANOVA) was employed in this study to examine the relationship between the independent variables (social class and grade level) and the dependent variable (science textbook content). One frequently encounters relationships in social research in which it is not immediately possible to specify which is the independent (causal) and which the dependent (effect) variable. Certain important sociological variables are relatively, but not absolutely fixed properties of the individual ["age," "sex," "parental SES"/"social class," are of this nature]. The basis for deciding which is the determining variable and which the determined is the fixity or alterability of the variables (Rosenberg). The dominant direction of influence of variables was logical grounds for making "social class" the independent variable and "content" the dependent variable. The criterion level of significance, $p < .01$, was used to test $H_0: u_1 = u_2 = u_3$. The null hypothesis was tested at two levels; first the composite mean score for all indicators comprising each dimension and sub-dimension of the six content variables was determined; the grand mean for these composite means was reflected in the test of significance for the variable, "orientation to participation." The second level consisted of tests of significance for each precursor variable separately (the composite mean score for all indicators comprising each dimension and sub-dimension). Comparing the mean scores using both full-scale and collapsed versions provided a good summary of "orientation to participation." [3]

FINDINGS

The main research question is "Does selection of science textbooks deprive younger children in working-class school districts the benefits of perspectives that will potentially help to make them "participants" in science while simultaneously enriching the scientific preparation of older children in middle-class school districts?"

Not every New York State public school district has equal access to science textbooks. Of the total of 187 books reported used extensively and occasionally by middle- and working-class districts, the three middle-class districts accounted for 64% ($n = 119$) and the working-class districts only 36% ($n = 68$). The middle-class districts also reported more books used extensively and occasionally than did the working-class districts. The lower grades accounted for 40% ($n = 75$) of the 187 books reported used by all districts in contrast to the upper grades who reported using 60% ($n = 112$). The upper grades reported more books used extensively and occasionally than did the lower grades. Since frequencies of reported use might have varied because of gross differences in district size, comparisons were facilitated by computing a ratio of number of students accommodated per book on the basis of district enrollments. Examination of these results revealed that middle-class and upper grade students had potential access to more science texts than working-class and lower grade students; in fact, almost twice as many and this same pattern appeared consistent for books used on an extensive basis as well as on on an occasional basis. It appears, however, from Tables 1, 2, and 3, that despite differences in

Table 1 about here

Table 2 about here

Table 3 about here

the number of books reported used by middle- and working-class school districts, and upper and lower grades, children of middle- and working-class districts were, on the average, receiving essentially the SAME orientation to the precursors of scientific roles. The expectation that children in middle-class districts would have more "participant orientation" (overall orientation to cognitive flexibility, abstract thinking, communicative fluency, goal-achieving, autonomy, and positive imagery) was not confirmed; and social class effects were therefore surprisingly less predictive of variations in science textbook content than anticipated. That is, children in middle- and working-class districts were essentially getting the same orientation to cognitive flexibility, abstract thinking, communicative fluency, autonomy, goal-achieving, and positive imagery. To further understand this finding, it was necessary to look more closely at social class effects on each orientation separately. Table 1 shows that the hypothesis that middle-class students would have more "participant orientation" than working-class students was supported for only one aspect of "participant orientation" -- orientation to abstract thinking ($F(1,183) = 5.25$, $p < .05$. And even in this case, although a statistically significant finding occurred, it must be noted that the relationship accounted for only 2 percent of the variance and therefore, though statistically significant, it may not be substantivley highly significant. Science textbooks from middle- and working-class districts, were, on the average, similar in orientation to cognitive flexibility, abstract thinking, communicative fluency, goal-achieving, autonomy, and positive imagery. In other words, differences in content for middle- as compared with working-class textbooks were, on the average, very small.

The second hypothesis, that children in lower grades will receive less orientation to participation in science than will children in upper grades found the most support in the study. Relevant to grade level variations in content for overall "orientation to participation," from the data shown in Tables 1, 2, and 3, books from lower grades contained significantly less "orientation to participation" (the composite score for orientation to cognitive flexibility, abstract thinking, communicative fluency, autonomy, goal-achieving, and positive imagery) than books from upper grades ($F(1,183) = 59.35$, $p < .01$. Attempts to foster a general scientific literacy appeared to more often result in "depriving" the younger child (lower grades, 2 and 4) access to textbook features salient to socialization into scientific careers than the older child (upper grades, 6 and 8), regardless of whether they were in the middle- or working-class districts. For all six of the content variables analyzed, Tables 1, 2, and 3 show that being from upper (6 and 8) as opposed to lower (2 and 4) grades was the most predictive of "orientation to participation," the scores, on the average, being higher for upper grades (orientation to cognitive flexibility ($F(1,183) = 35.73$, $p < .01$); orientation to abstract thinking ($F(1,183) = 21.99$, $p < .01$); orientation to communicative fluency ($F(1,183) = 22.70$, $p< .01$; orientation to autonomy ($F(1,183) = 17.04$, $p < .01$); and, orientation to positive imagery ($F(1,183) = 39.10$, $p < .01$).

The results appearing in Tables 1, 2 and 3, provide minimal support for the third and central hypothesis set forth that middle-class, upper grades will have the most exposure to orientation to participation in science. Only one aspect of orientation to participation (orientation to cognitive flexibility) produced a significant interaction ($F(1,183) = 4.19$, $p < .01$), the difference in means being greatest for the middle-class district upper grades.

CONCLUSIONS AND THEORETICAL IMPLICATIONS

In sum, the data indicated that, 1) while more science texts are available to children in middle-class districts than in working-class districts, availability of knowledge important for the development of a scientific role is, on the average, the same for both middle- and working-class districts; 2) the relative availability of science vis-a-vis political science material is more constrained by the age-grade factor and was indicated by a consistent main effect of grade level on all aspects of orientation to participation; and, 3) social class has a distinctive effect on orientation to cognitive flexibility.

With respect to the first finding that science textbooks were more available in middle- than in working-class school districts, it seemed that a logical consequence was that a child in a middle-class district would have potential access to a greater variety of text materials than a child in a working-class district, regardless of the orientation to the features precursory to a scientific career. Yet interestingly, we found a different pattern than expected when we looked to see to what degree the hypotheses explained the variations in content. Orientation to participation in science perhaps approaches more of science's ideal of universalism than we anticipated. While for political science texts, the "lead-lag" phenomenon predominated, where children of middle-class, upper grades received the most participant-oriented material, in the science study, for only one of six aspects of participant orientation, orientation to cognitive flexibility, did this pattern emerge. Thus, the results did not lend support to the central hypothesis set forth, that the middle-class, upper grades will have the most exposure to orientation to the precursors of scientific roles. Rather a new hypothesis, concerning a patterned grade effect, has been generated for science textbooks. The finding that social class had a stronger effect on political science knowledge (Harrington) than on science knowledge suggests that science appears more resistant to threats to universalism (equal access to knowledge resources) than other disciplines. Scientific ideas retain a universality uncommon in other areas of human enterprise and are unprecedented except by mathematical ideas which are also related by a search for common, comprehensive, abstract structures (Lange). Or perhaps, the finding that social class had a stronger effect on political science knowledge than on science knowledge could be attributed to the fact that textbook writers have a very stylized and rather uniform approach to presenting science. Thus even if a bias were potentially present in textbook adoptions, there may not be sufficient variability to allow this bias to operate. Additional research is required to explore this question.

The second finding, a consistent main grade effect on all aspects of orientation to participation, was more pervasive than in the case of political science texts, and of no surprise, because of the complex cognitive skills and accompanying motivational factors that are required in order to do science. The variations found can be best attributed to beliefs about how learning takes place; changes in the strict hierarchy of developmental theory might be the most predictive of variations in science textbook content. This finding concerns support for the idea of "accumulation of advantage." The notion of "accumulation of advantage" is somewhat befitting because it suggests that those children who have the most exposure to the conventions are prepared to receive the most orientation to cognitive flexibility. The younger child is technically not "deprived" of knowlege; rather, conventional knowledge accrues as a function of cognitive development (reflected in years in school).

The third and last finding that social class had a distinctive effect on orient: tion to cognitive flexibility can perhaps be explained by some additional theoretical insight. Examination of the definition of "cognitive flexibility" shows its "cumulative" nature, but this quality allone does not suggest a particular predispositon to the impact of social class. For example, from Drevdahl's study about the factorrs of importance for creativity in science, there is considerable support fro the contention that non-conformity is desirable for creative effort. Several of the intellectual factors are, to a great extent, measures of the degree to which the individual avoids the usual, routine, conventional ways of doing and thinking of things. Creative individuals are conventional in accepting knowledge and methods; once these are accepted and internalized, unconventionality can be expressed within this framework by means of flexibility and fluency in approach. Compared to the art fields the creative artist is less dependent upon what has gone on before and may depend to a greater extent upon his/her personal unconventionality. So "cognitive flexibility," by definition, is a characteristic that can be fostered only after conventional knowledge has been acquired; there is clearly a cumulative quality to this resource -- one must already "have" to "get it." But, as in the case of the pervasive grade effects upon all other orientations, the idea of "accumulation of advantage" is only somewhat befitting because, while it suggests that those children who have the most exposure to the conventions are prepared to receive the most orientation to cognitive flexibillity, the younger child is technically not "deprived" of knowledge; rather, conventional knowledge accrues/accumulates as a function of cognitive development (reflected in years in school). While main grade effects reflect the general cumulative nature of scientific knowledge for all orientation variables, the middle-class is more likely to receive encouragement in developing cognitive flexibility (the privilege to be non-conforming). The "Matthew Effect" in science (Merton) refers to the idea that in science as in other areas of human life, those who are rich are likely to get richer Merton gets the idea for his paper form the Gospel according to St. Matthew: "For unto every one that hath shall be given, and he shall have abundance; but from him that hath not shall be taken aweay even that which he hath." (Cole). It's application to science concerns the accruing of greater increments of recognitiion for particular scientific contributions to those scientists of considerable REPUTATION and the withholding of such recognition from scientists who are less well know. The evaluation/reception of scientific papers in part dpends upon the reputation of the author; discoveries made by eminent persons are more likely to be quickly incorporated into the body of scientific knowledge. If two scientists independently make the SAME discovery, the considerably more eminent one will get the greater or all the credit. Although these ideas seem disjointed with the discussion of access to certain features in science texts, the distinctive theoretical contribution which is brought to bear is the aspect of speed or the time it takes for ideas to be recognized and diffused. While main grade effects reflect the general cumulative nature of scientific knowledge for all orientation variables, the MIDDLE CLASS IS MOST ENTRUSTED to receive more RAPIDLY, this feature (orientation to cognitive flexibility) -- the privilege to be non-coforming. The Matthew Effect (the accruing of greater increments of recognition for particular scientific contributions to those scientists of considerable reputation and the withholding of such recognition from scientists who are less well known) as it is used by Merton seems useful in the present situation, to refer to the middle-class, older child. "Class" acts as "eminence" does for the scientist. The middle-class child who is older may be assumed to have received conventional knowledge and therefore gets access to knowledge which fosters cognitive flexibility (non-conformity) faster than the older working-class child, when, in fact, both the child in the working-class and the child in the middle-class, are in the same grade. Textbooks appear to be written and selected for children who are perceived as, and perhaps actually are, prepared for orientation to cognitive flexibility. The middle-class child, has, in this case, "accumulated advantage" and the advantage is not necessarily attributable to demonstrated differences in capacity. Testing the Matthew Effect, where those who are perceived to "have more," "get more," by controlling for ability, could strengthen the reliability of this anomalous finding.

The generalization of the concept of the Matthew Effect as it applies to the educational context and science textbooks leads us to consider the functional consequences for the socialization of scientists, recruitment to scientific careers, and for science. While it is less worrisome that young children, in general, receive less "orientation to participation" (exposure to the knowledge precursory to scientific roles), when the assumption is made, by those selecting text material, that those students, particularly in the working-class, are less prepared to receive orientation to cognitive flexibility, then there is a "misallocation of credit" that is typical of the discovery phenomenon for scientists, and a temporary ignoring of some who are equally ready to receive more resources. Under these conditions the principle of the Matthew Effect is dysfunctional for scientific advance. Such a pattern would somewhat support the continuation of the working-class student's relatively lower social position while giving his/her more privileged peers an advantage in learning about science. A segment of the population has been deprived access to knowledge resources important for socialization into science, and, in praxis, the norm of universalism in science is not operating in this case. Ultimate outcomes are for the maintenance of science.

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Footnotes

1. While it might appear that this paper posits a connection between the content of science textbooks and the ability/proclivity to enter a career in science, the actual hypothesis for study is that children from working-class schools backgrounds are exposed to fewer and different textbook materials than children from middle-class schools with the implication that the former are less likely to enter scientific careers than the latter. The study does not attempt a prediction of scientific career aspirations; it does not determine how much of a structural effect of social class on scientific career aspirations is explained by the measures of "scientific materials exposure," it simply looks at the effects of social class and grade level on the context of science texts. Using students as the unit of analysis, additional data on social class background of students, curricula content, intention to pursue scientific careers, and other variables related to both exposure to scientific materials and career intentions (i.e., academic achievement, ability, curriculum placement, etc.), embedded in a design that controls for the potentially salient variables could contribute to a more predictive understanding of who becomes a scientist.

2. For the purpose of brevity, the coding instrument is not presented but may be obtained from the author.

3. Findings for only the first two of five levels of hypothesis testing have been reported in this article.

Appendix

DESCRPTION OF DEPENDENT VARIABLES

ORIENTATION TO COGNITIVE FLEXIBILITY refers to whether knowledge is supportive of the ability to make connections between ideas in novel ways. It will be assessed in terms of: 1) the appearance of separated/general knowledge structure vs. integrated/unified knowledge structure (book title indicates attention to only one discipline [i.e., biology, chemistry, physics, geology, etc.] and conceptual schemes/underlying themes are present [i.e., unit and/or chapter headings refer to concepts like "energy," "matter," "measuring," "observing," etc.]); 2) the absence of the relevance of science to other school subjects vs. the occurrence of intra-subject technological features (there are uses of science situations as in such a case as students are asked to observe photos of writing instruments and to classify them into groups of pens, pencils, crayons, etc.]; there are uses of science, in illustrations and in written explanations [not accompanied by photos] where knowledge of other school subjects is required. For example, an understanding of "types of air masses that effect North America." requires knowing geography. Other school subjects include math, literature, social studies, health, music, art, physical education, etc.]; 3) narrow scope vs. broad scope (the number of topics in the index of the book); 4) single sequencing scheme vs. multiple sequencing schemes (the number of sequencing schemes between units, chapters and within chapters [i.e., see Table of Contents for "simple-to-complex," such as one-celled to multi-cellular, "whole-to-part," such as humans to one-celled animals, "hierarchical," such as prerequisite knowledge needed to master a subsequent objective. To understand the idea of the bonding of atoms, students must have some understanding of electric forces as well as of magnetic and gravitational forces], "chronological" [historical], where early concepts of matter, for instance, are compared to the changing conceptions through time]); and 5) inconsistent repetition of concepts vs. systematic repetition of concepts ("unit simple repetitions" where words like "growth" or "how things grow" appear in the first chapter title following the introduction of a unit; "chapter simple repetitions" where exact concept word or similar concept words appear in chapter sub-headings or first paragraph of text following chapter title; "unit spaced repetitions" when the concept or practices ask students to simulate/approximate what is called for in a terminal behavior and equivalent practices ask students to do exactly the same thing as called for in terminal performance.

ORIENTATION TO COMMUNICATIVE FLUENCY refers to whether knowledge is supportive of the ability to acquire the social and cognitive conventions [content, methods, goals] of science. It will be assessed in terms of: 1) relative perceptual bases vs. common perceptual bases (action words are specified in objectives -- "name," "explain," "define," "list," "clarify," "observe," "measure," "identify,," etc.; action words appear in terminal behaviors at end of chapters and/or units; behavioral qualifiers are present in objectives -- a statement of how information will be reported, [orally or in writing]; behavioral qualifiers appear in terminal behaviors; quantitative/qualitative conditions are specified in objectives and in terminal behaviors, such as, "in three sentences," "in ten minutes," etc.; standards of performance, such as, "three out of five," etc., and appear in objectives and/or in terminal behaviors; 2) no specified norms of institutionalized idea system vs. defined conventions of science (attitude statements about organized skepticism and/or universalism/individualsm are present, i.e., remarks pertaining to respect for logic and empirical evidence, freedom of investigation, rejection of superstition, retesting, etc; attitude statements about communality/disinterestedness appear, i.e., those remarks pertaining to the findings of science as a product of social collaboration, findings are not private property, etc.; the basic processes of science are identified, i.e., measuring and quantitiative relationships [code the explicit use of the word, "measure," and/or any speciification for a mathematical computation, the explicit use of the words, "classify," and/or "observe"]; the integrated processes of science are identified -- the explicit use of "problem," "identify problem," "solve problem," "collect data," "analyze data," "conclude," "hypothesize," "predict," "control variables," etc.; recall tasks, such as, "naming,""defining,""remembering,""listing,""identifying," etc.; and the appearance of comprehension tasks such as translation [i.e., when presented with a relationship of two or more variables stated in mathematical terms, student will restate in a sentence]; interpretation [i.e., based on graphs of temperature, student will write a paragraph describing the weather], extrapolation [based upon a graph of average temperatures for the current month over the past thirty years, student will predict expected average temperature for a month]; and, 3) information constraints vs. various representations of reality similar words appear in following chapters; "chapter spaced repetition"s when the concept or similar words appear in following chapter sub-headings; "cumulative unit repetitions" [i.e., examine all preceding units for concept words coded and determine if next unit has a cumulative statement of the next unit]; "massed unit repetitions" such as summaries, questions atend of unit, further activities at end of unit, etc.; and "massed chapter repetitions" such as summaries, questions at end of chapter, further activities at end of chapter, etc.).

ORIENTATION TO ABSTRACT THINKING refers to whether knowledge is supportive of the ability to apply rational ideas to empirical ends to produce generalized and systematic conceptual schemes. It will be assessed in terms of: 1) impulsive-holistic framework vs. reflexive-analytical frameworrk (problem-solving situations appear, that is, statements which require student to explain, and/or to determine from direct sensory data -- "plants play a double role in the carbon dioxide-oxygen cycle; explain how this happens."); 2) memory/recall strategies vs. expository and discovery strategies (photographic examples are introduced before/after concepts are presented; illustrated examples and written examples [without accompanying photos and/or illustrations] also appear; other features are: activities where students have to ormulate their own examples, such as, "We have discussed three kinds of levers, can you think of two more?"; activities where students are required to apply a princple to a problem, such as, "How much potential energy does a book have if it is raised 2 m rather than 1 m?"; activites where students must discriminate examples from non-examples in photographs, illustrations, and in written descriptions [not accompanying photos and/or illustrations]; 3) unstructured mode of interrogations vs. a question typology (to figure out answers and to go beyond mere description or factual information; these are literal, not rhetorical questions, such as, "What are some of the abiotic factors in the ecosystem you live in?"; also the presence of "expansion-experimentation questions" such as "Why do guitar players put their fingers on the strings at different places?"); and 4) written accounts of experience vs. invitation to participation (demonstrations in photographs are present such as exhibitions of experimental procdedures; also demonstrations in illustrations occur; en route behaviors -- knowledge prerequisite to performing terminal behavior such as if students are asked to name and explain four properties of sound waves; analagous (specification for exploratory/field experiences -- statements that direct student to data gathering activity which allows exploration of phenomena in natural settings and/or in laboratory settings; specialized information displays where students are referred to graphs, charts, tables, formulae, in text; 2-dimensional static projections are referred to as supplemental to text -- students are directed to other references in the form of bibliographies, science-related journals, newspapers, slides, etc.; 2-dimensional dynamic projections appear where students are directed to supplemental films, videos, and/or computers; reporting activities where student is asked to communicate findings in the forms of pictures, graphs, and/or written explanation occur; and think-time activities are specified, where students are requested to stop and think [refer to explicit use of word, "think"].

ORIENTATION TO AUTONOMY refers to whether knowledge facilitates self-direction in new situations. It will be assessed in terms of: 1) <u>adoption of strict developmental scheme vs. adaptation for individual difference</u> (tasks in concrete operations stage are present -- those which require concrete materials for manipulation and/or photos and/or illustrations; tasks in formal operations stage are present -- thought does not depend on direct concrete reality, concrete materials are not needed and ideas can be manipulated abstractly; and 2) <u>the absence of criterion-referenced self-evaluation vs. provision for criterion-referenced self-evaluation</u> (when self-evaluation opportunities occur such as self-test questions at unit and/or chapter endings).

ORIENTATION TO GOAL-ACHIEVING refers to whether knowledge is supportive of the ability for personal mastery fo an event. It will be assessed in terms of: 1) <u>no perceived purpose vs. set-induction</u> (the appearance of set-inductions where simply identifying a learning task is not enough; photos, illustrations, and/or written material which introduces/presents ideas relevant to a desired outcome are observable at unit level and at chapter level); and 2) <u>low fate control vs high fate control</u> (the appearance of moral dilemmas [the social responsiblity of the scientist where the outcomes of science are considered and student is required to make a moral judgment/cholice concerning the uses and outcomes of science as in the cases of nuclear energy, pollution, conservation, etc. [comments on pros and cons of item]).

ORIENTATION TO POSITIVE IMAGERY refers to whether knowledge influences the perceptions of students about scientists so that entry into the scientific professions results. It will be assessed in terms of: **1)** eccentric scientist stereotype vs. positive projection (the scientist is portrayed as having no social life [no hobbies, no leisure activities, no friends, no relaxation, etc.] the scientist is conveyed as being neglectful of family life [not marrying, having children, or being home] and/or only males appear in text); and **2)** ritual display absence vs. typification by public pictures (photographs of research scientists appear; instructional pictures of research scientists [line drawings/illustrations] appear and, personal publicity photographs and/or instructional pictures of notable research scientists] appear).

Table 1. Analytical Model and Summary of Statistically Significant Findings: Social Class (controlling for grade level); Grade Level (controlling for social class); and Social Class and Grade Level by Science Textbook Content ($N = 187$)

		Social Class (controlling for grade level)		Grade Level (controlling for social class)		Social Class			
		Middle	Working	Upper	Lower	Middle		Working	
	Science Textbook Content					Up	Low	Up	Low
Level II	Orientation to Cognitive Flexibility			b		c			
	Orientation to Abstract Thinking	a		b					
	Orientation to Communicative Fluency			b					
	Orientation to Goal-Achieving			b					
	Orientation to Positive Imagery			b					
Level I	Orientation to Participation								

[a]Significant social class differences found ($p < .05$).
[b]Significant grade level differences found ($p < .01$).
[c]Significant social class by grade level interaction found ($p < .01$).

Table 2. Means and Standard Deviations of Scaled Codings of Orientation to Cognitive Flexibility, Abstract Thinking, Communicative Fluency, Autonomy, Goal-Achieving and Positive Imagery for Social Class and Grade ($N = 187$)

	Orientation to Participation	
	Mean	SD
Middle Class	2.34	.39
Upper Grade	2.60	.26
Lower Grade	2.09	.35
Working Class	2.34	.39
Upper Grade	2.43	.39
Lower Grade	2.08	.23
Upper Grade	2.52	.33
Lower Grade	2.09	.32

Table 3. Means and Standard Deviations of Scaled Codings of Orientation to Cognitive Flexibility, Abstract Thinking, Communicative Fluency, Autonomy, Goal-Achieving and Positive Imagery for Social Class and Grade (N = 187)

	Orientation to Cognitive Flexibility		Orientation to Abstract Thinking		Orientation to Communicative Fluency	
	Mean	SD	Mean	SD	Mean	SD
Middle Class	3.23	1.02	2.31	.33	1.87	.33
Upper Grade	3.85	.62	2.42	.30	2.02	.32
Lower Grade	2.61	.98	2.20	.31	1.72	.27
Working Class	3.17	1.01	2.27	.31	1.91	.33
Upper Grade	3.30	1.05	2.34	.30	1.95	.36
Lower Grade	2.74	.72	2.07	.25	1.76	.15
Upper Grade	3.59	.89	2.38	.30	1.99	.34
Lower Grade	2.64	.93	2.17	.30	1.73	.24

	Orientation to Autonomy		Orientation to Goal-Achieving		Orientation to Positive Imagery	
	Mean	SD	Mean	SD	Mean	SD
Middle Class	2.50	.48	1.79	.41	2.34	.66
Upper Grade	2.69	.38	1.89	.46	2.69	.52
Lower Grade	2.31	.50	1.69	.33	1.99	.60
Working Class	2.60	.41	1.79	.49	2.33	.70
Upper Grade	2.65	.42	1.85	.52	2.47	.67
Lower Grade	2.42	.33	1.59	.30	1.90	.66
Upper Grade	2.67	.40	1.87	.48	2.59	.60
Lower Grade	2.34	.46	1.67	.32	1.97	.61