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DISCIPLINARY VIEWS OF CORRESPONDING
ELEMENTARY SCHOOL SUBJECTS

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Center for the Learning and Teaching of Elementary Subjects

The Center for the Learning and Teaching of Elementary Subjects was awarded to Michigan State University in 1987 after a nationwide competition. Funded by the Office of Educational Research and Improvement, U.S. Department of Education, the Elementary Subjects Center is a major project housed in the Institute for Research on Teaching (IRT). The program focuses on conceptual understanding, higher order thinking, and problem solving in elementary school teaching of mathematics, science, social studies, literature, and the arts. Center researchers are identifying exemplary curriculum, instruction, and evaluation practices in the teaching of these school subjects; studying these practices to build new hypotheses about how the effectiveness of elementary schools can be improved; testing these hypotheses through school-based research; and making specific recommendations for the improvement of school policies, instructional materials, assessment procedures, and teaching practices. Research questions include, What content should be taught when teaching these subjects for understanding and use of knowledge? How do teachers concentrate their teaching to use their limited resources best? and In what ways is good teaching subject matter-specific?

The work is designed to unfold in three phases, beginning with literature review and interview studies designed to elicit and synthesize the points of view of various stakeholders (representatives of the underlying academic disciplines, intellectual leaders and organizations concerned with curriculum and instruction in school subjects, classroom teachers, state- and district-level policymakers) concerning ideal curriculum, instruction, and evaluation practices in these five content areas at the elementary level. Phase II involves interview and observation methods designed to describe current practice, and in particular, best practice as observed in the classrooms of teachers believed to be outstanding. Phase II also involves analysis of curricula (both widely used curriculum series and distinctive curricula developed with special emphasis on conceptual understanding and higher order applications), as another approach to gathering information about current practices. In Phase III, models of ideal practice will be developed, based on what has been learned and synthesized from the first two phases, and will be tested through classroom intervention studies.

The findings of Center research are published by the IRT in the Elementary Subjects Center Series. Information about the Center is included in the IRT Communication Quarterly (a newsletter for practitioners) and in lists and catalogs of IRT publications. For more information, to receive a list or catalog, or to be placed on the IRT mailing list to receive the newsletter, please write to the Editor, Institute for Research on Teaching, 252 Erickson Hall, Michigan State University, East Lansing, Michigan 48824-1034.

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Abstract

This report summarizes the findings of Study 2 of Phase I of the Center's research, in which professors representing eight academic disciplines were asked to report historical trends and current thinking in their disciplines about how the disciplines should be represented in the elementary school curriculum, and then to present their own personal recommendations. The papers reveal that some disciplines have a long history of policy statements about elementary education, others have made statements only recently, and still others have not yet addressed the topic. The statements of disciplinary organizations, and especially the statements of the authors of these eight papers, tend to emphasize the teaching of school subjects in ways that will encourage development of interest in the subjects and acquisition of values and dispositions emphasized in their underlying disciplines (rather than formal courses in disciplinary knowledge). Recommended curriculum and instruction practices are similar to those currently being recommended by educational psychologists and subject-matter curriculum and instruction specialists who are concerned about the teaching of school subjects with an emphasis on understanding, thinking, and authentic applications.

DISCIPLINARY VIEWS OF CORRESPONDING ELEMENTARY SCHOOL SUBJECTS

Jere Brophy¹

This is the report of Study 2 of Phase I of the research agenda of the Center for the Learning and Teaching of Elementary Subjects. Phase I has involved surveying and synthesizing the opinions of various categories of experts concerning the nature of elementary-level instruction in mathematics, science, social studies, literature, and the arts, with particular attention to how teaching for understanding and for higher order thinking and problem solving should be handled within such instruction.

Study 1 of Phase I involved preparation of review and synthesis papers describing what the literatures in each of these school subject areas have had to say about teaching the subjects with an emphasis on understanding and thinking. These papers have been completed and released through the Center's Report Series (Brophy, 1988; Cianciolo, 1988; May, 1989; Putnam, Lampert, & Peterson, 1989; Roth, 1990). Although each of them addressed a broad range of literature, the views that they represent are primarily those of educational psychologists and of curriculum and instruction specialists in each of the subject areas. Other Center studies have focused on the views of elementary teachers (through questionnaires sent to a large sample of teachers and interviews of a small sample) and of selected states and school districts (as communicated through their policy documents supplemented by interviews with key spokespersons).

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Procedures for Study 2

Study 2 of Phase I complemented this work by investigating the perspectives on ideal elementary subject-matter teaching that have been offered by the academic disciplines that inform these school subjects. For this study, Michigan State University faculty members, representing eight disciplines, were asked to prepare papers representing the positions of their respective disciplines concerning what ought to be included in the elementary school curriculum. Papers have been completed for the disciplines of science (written by Professor Martin Balaban, 1990), mathematics (written by Professor David Blair, 1990), political science (written by Professor Cleo Cherryholmes, 1990), music (written by Professor Robert Erbes, 1988), literature (written by Professor William Johnsen, 1989), history (written by Professor Peter Levine and Peter Berg, 1989), geography (written by Professor Bruce Pigozzi, 1990), and the visual arts (written by Professor Linda Stanford, 1990).

Instructions to Authors

The authors were asked first to review and synthesize historical developments and current thinking expressed by professional organizations and intellectual leaders in their discipline concerning how the discipline should be represented in the elementary school curriculum and then to outline their personal views on the topic. In the first parts of their papers, in which they addressed historical and current thinking expressed by their disciplines, the authors were asked to address the following topics: (a) the knowledge, skills, and dispositions that students should acquire in elementary education in their subject area; (b) the degree of emphasis that should be placed on problem solving and higher order thinking; (c) the degree of emphasis that should be placed on the structure of knowledge in the field, both as something to be

learned and as a guide to thinking about desirable content; (d) distinctions in content across grade level; and (e) distinctions in content taught to different types of students. They also were invited to speculate about probable future developments in their disciplines' views on these issues.

For the second parts of their papers, the authors shifted from acting as a reporter for their disciplines to communicating their personal views. They were asked to identify what they thought should be the primary goals of elementary-level instruction in their discipline and to identify key topics that would be appropriate for addressing these goals. Recognizing that authors were likely to mention more content than could be covered feasibly within typical time constraints, we asked the authors to differentiate the recommended content into three levels of importance. We also invited them to comment on such issues as appropriate sequencing of content, whether different content should be taught to different types of students, whether the elementary curriculum should be designed to build toward preparation for the secondary curriculum (and if so, how), what content currently taught in their area could be reduced or eliminated, what advice they had for teachers about methods of instruction or approaches to assessing learning, and what teachers would need to know in order to be able to represent the discipline appropriately.

Authors' Responses

The authors varied considerably in their responses to these guidelines for preparing the papers. Variation in the first parts of the papers reflects differences among disciplines in the attention they have paid to elementary education. Some disciplines have had a long history of interest in the topic and have developed detailed position statements, but others have given it little or no attention at all. Variation in the second parts of the papers

reflects the authors' different levels of involvement with elementary education. Several authors were unfamiliar with elementary students and classroom processes and thus declined to make suggestions or else limited themselves to a few very general guidelines. Other authors were more familiar with elementary-level teaching in their disciplinary area and were able to make more detailed comments and suggestions.

Typically, the papers addressed issues relating to goals, content selection and representation, general approaches to teaching, and teacher preparation in some detail, but said little or nothing about the relationship between the school subject curriculum and the structure of knowledge in the discipline, distinctions in content across grade levels or types of students, or methods of evaluation. A few authors listed key goals or content, but none attempted to suggest a detailed scope and sequence, let alone to distinguish among three levels of importance.

Summaries of Papers

Additional analysis of the papers considered as a set will be given following brief summaries of each paper considered individually.

Art

Stanford (1990) begins by noting that modernist thinking, emphasizing attempts at "objective" analysis of artistic creations, is being replaced by postmodernist ideas about examining art works within the context of time, place, and culture. A related theme is re-viewing--looking back at earlier developments not only to understand them within the context of their time and place but also to consider their meanings with the benefit of hindsight and within the contemporary context. She argues that issues of art education need to be considered within the context of these developments in the underlying

discipline. She organizes her treatment of these issues with reference to a set of four questions.

1. What is art and art education? Are they the same or different? Should we care? Here, Stanford notes that how one defines art has implications for what one teaches about art. She rejects a narrow definition of art as art making, preferring a broader definition that includes not just art making but also art history, art criticism, and aesthetics. Besides providing a foundation for an appropriately broader view of art education, this definition renders moot any attempt to artificially separate art from art education, because the two are seen as inexorably related.

2. What is the relationship of the discipline to the school subject of art? Given the already-mentioned intimate connection between art and art education, current debates no longer center on distinguishing the two but instead on how much emphasis should be given to the four major components of art education (art making, art history, art criticism, and aesthetics). Stanford argues for a balance, rejecting extreme approaches such as an exclusive emphasis on self-expression through art making or a discipline-based approach that is limited to teaching art as academic content. Her envisioned approach would teach about cultural contributions of art through the ages but would also balance creativity and serendipity with history and aesthetics, individual values with shared values, and emphasis on each of the four components.

3. What constitutes the most worthwhile content? What can students learn from art that will be useful and relevant in later life? Here, Stanford endorses the recommendations of the National Art Education Association that call for a general, integrated approach incorporating strands based on the four components rather than separate courses in separate art disciplines. She views

the latter approach as based on an invalid identification of the arts with the sciences that leads to forced attempts at conceptual structuring and sequential ordering of content. She calls for a broadly inclusive curriculum that would include deliberate representation of female and minority art. Art would be taught in the context of values and its connections to other cultural influences of the time and place, using a discursive approach featuring open-ended discourse. Learning would be active and often collaborative, and it would include keeping sketch books and developing portfolios.

To accomplish multiple goals, students would study art in three ways: (1) as an independent form structured according to its own laws and systems of relationships (this lends itself to investigation of formal properties and their aesthetic impact); (2) as a form belonging to a history of similar forms (this is useful for developing perceptual skills regarding the elements of art, symbols, themes, and moods); and (3) as a form belonging to the intellectual history of a given period (this is useful for encouraging students to ask and investigate "why" questions concerning such issues as what themes the artists were trying to communicate and why they used the methods and materials that they did).

Taken together, these approaches would make art a multicultural learning arena. Teachers would draw not only on classical works discussed in textbooks but also on art that they were interested in personally or that represented local interests and creativity. The definition of art would be broad enough to include all kinds of aesthetic creations as well as innovations, such as computer art. Students would study and create art forms that would be valued not only for their independent form but also for their membership in one of many histories of similar forms and for their contributions to the multicultural intellectual history of a given period. Gradually, students

would develop the behavior and perceptual skills for learning to see visually and culturally.

4. Are most art educators progressing toward the formulation of answers to the above questions? Stanford believes that they are. She sees value in current debates but cautions against misguided attempts to apply definitions of sequential learning as it is known in the sciences to the arts. She would like to see students learn to see and appreciate the artistic in all aspects of their lives and environments and to think about art not just as creation of a product but as communication of meaning. Students should come to appreciate that art, including design and architecture, is all around them.

Stanford places emphasis on development of key values, appreciations, and dispositions drawn from the disciplines of art making, art criticism, art history, and aesthetics. She gives a few examples of content representations, questions, and activities that might be used with an emphasis on helping children to learn about and to create art in a multicultural context that includes the well-known and the little known, the elite and the vernacular. She discusses teacher preparation by inference and she portrays teachers as knowledgeable curriculum makers, thus implying that they are capable of making decisions regarding their use of the visual arts curriculum.

Geography

Pigozzi (1990) begins by noting that recent status reports paint a dismal picture of the geography knowledge of American students. He agrees that factual ignorance is a problem but argues that a more fundamental weakness in current geography teaching is the failure to help students to understand why place is important, or more broadly, to appreciate that geography is a useful discipline and not just a collection of facts about places.

Pigozzi believes that the Association of American Geographers and the National Council for Geographic Education have taken important steps to address these problems by developing recommendations for geography teaching that center around the five central themes of location, place, relationships within places, movement, and region. He elaborates on these five themes and provides examples of how they can be used to teach students worthwhile geographic content. However, he also suggests two changes in the ways that these themes might be presented to teachers and students so as to further reinforce a switch in geography teaching from emphasis on information and data to emphasis on process and function.

First, he would exclude location from the list of central themes--not because it is unimportant but because it is a fundamental, primitive concept that is not so much a part of geography as it is a conceptual underpinning of it. Pigozzi views location as a primitive concept that needs to be developed before geography as such is taught, just as the alphabet and spelling are primitive concepts that precede the teaching of reading and notions of time and sequence are primitive concepts that precede instruction in history. If location and related cartography concepts involved in understanding and making maps were viewed as primitive foundational concepts rather than as a central theme of geography itself, there would be less temptation to equate learning geography with learning place names.

Pigozzi's second recommended change would be to reorder the presentation of the remaining four central themes, or at least to present them in ways that place more emphasis on the themes of movement and relationships within places than on the themes of place and region. This is because emphasis on the themes of place and region tends to lead to a travelogue version of geography that emphasizes the exotic but does not promote appreciation of the usefulness of

geographic analysis for understanding human-environment interactions. Thus, students should learn not just about the physical characteristics of places but about their implications for human adaptation. Furthermore, coverage of human adaptation should include not only cases of human adaptations to geography (e.g., location of cities along fall lines; fall line cities developed on navigable rivers at the first rapids encountered by shallow draught vessels of the colonial period), but also cases of human impact on geography as a result of cultural developments (e.g., deforestation of Britain during the early industrial revolution). Teaching about relationships within places should include analyses of why things are like they are in particular places and what this might imply about problem solving elsewhere. Teaching related to the theme of movement should emphasize not just macro issues, such as historical immigration and cultural diffusion patterns, but also micro issues, such as the spatial arrangements of aisles and shelf displays in the supermarket or the planning of traffic control mechanisms in the local community. Again, the emphasis should be on how geographic knowledge can be useful in solving real-world problems. Geography should be presented as useful as well as interesting.

Figozzi concludes that geography needs to be taught (preferably as a subject separate from social studies) by teachers who have developed knowledge and appreciation of its usefulness as a discipline. He doubts that a single geography course is enough to prepare teachers to do this, especially if it is a world geography course that focuses on a global scale and reinforces the exotic place tradition, rather than equipping teachers to teach about geographical ideas that elementary students need to know.

History

Levine and Berg (1989) note that historians have had a great deal to say about K-12 history teaching through the years, although more about secondary than about primary education and more in the first half of the 20th century than in the second half. Many of the ideas that have been included in various reports appear to be good ones, but others could be characterized as racist, sexist, or narrow in their views about good citizenship.

Early reports emphasized giving history equal time with other subjects and stressed its value for educating citizens, broadening perspective, or developing judgment. To the extent that these reports said anything about the elementary grades, they usually emphasized "great man" biography and mythology as preparation for more systematic work in history that would be taught later, focusing on critical thinking and judgment rather than facts. In an appendix to one early report, Lucy Selmon recommended introducing history in Grades 3 and 4 through stories from mythology and biography that would be aimed mostly at arousing interest in history among students whose ideas of time and place were "imperfectly developed." The students then would study history more systematically in Grades 5 and 6 (early Greek and Roman history, medieval and modern European history). The emphasis would be on the roots of American democracy.

A subsequent committee made similar recommendations, emphasizing that young minds were not yet ready for systematic history instruction but would respond to colorful treatment of limited material. Guidelines for Grades 1-3 emphasized story telling supplemented with picture drawing, construction of wigwams, and other hands-on activities designed to stimulate imagination and interest. Instruction would begin to capitalize on children's ability to read by third grade, but the emphasis would remain on heroic stories (although

stories of real people rather than myths). The guidelines for Grades 4-6 called for full-scale chronological study of American history, integrated with literature and geography, but with continued strong emphasis on heroes and "great men." It was thought that students not only would find such material interesting but also would be inspired to ideals through reading about heroes and other role models.

In general, early reports stressed stimulation of interest in history and inculcation of values, without saying much about skills or about teaching history as a discipline. After World War I, history became subsumed within social studies, taught with an emphasis on relevance to contemporary life and on inculcating citizenship values. Subsequent recommendations mostly came from the National Council for the Social Studies rather than from historians' organizations, and they gradually coalesced around the expanding communities approach for Grades K-6. Gradually there was more emphasis on understanding general trends and less on stories of great men portrayed as models of ideals and "American" values. This trend was interrupted briefly during World War II, but after the war, the "social studies" approach gradually reassumed dominance. Historians' groups have been silent about elementary education since World War II, although the American Historical Association did cooperate with the National Council for the Social Studies and other groups in forming the National Commission on the Social Studies that released a report recently (after Levine and Berg completed their paper).

Looking back, Levine and Berg find several ideas emphasized in various reports that they believe should characterize teaching of history in elementary school classrooms: emphasizing a critical reading of history, developing appreciation of connections between students' own lives and the past, using an integrative approach that combines history with English and geography (but does

not submerge it within social studies to the point that its integrity gets lost), and teaching history not just as a discipline but as citizen education. In the latter area, however, they emphasize the need to replace inculcation of unquestioning patriotism with a more critical approach to citizen education, as well as to replace narrowly ethnocentric views with a more multicultural and global perspective. They would like to see history taught in ways that would take advantage of children's natural curiosity and imagination to stimulate interest in the past and in learning about history. They also would like to see it taught in ways that would produce appreciation of cultural diversity, an understanding of citizenship that does not deny other peoples or cultures their own definitions, the breaking down of racial and sexual stereotypes, and at least initial development of skills involving use and appreciation of evidence for developing interpretations of events and questioning what one hears and reads. This implies a critical, rather than an unquestioningly celebrative, approach to American history and values.

The authors identify two overriding principles for elementary history teaching. First, they believe that an integrative approach to learning should dominate in the early grades. By this they do not mean the substitution of social studies for history but instead the blending of material and approaches from history, English, geography, art, and music in ways that bring the past alive and encourage the skills and independent learning habits that can be accomplished in the lower grades. Second, they believe that the K-6 grades should be a time for encouraging the kinds of attitudes about learning and people and the development of important basic skills that are needed for an appreciative and critical study of history, rather than a time for systematic content coverage (which can occur in Grades 7-12). As an example of the kind of teaching they have in mind, they cite Myra Zarnowski's program that

integrates history with literature instruction by focusing on biography (Zarnowski, a professor at Queens College, worked with a fourth-grade teacher in a New York City classroom with a heterogeneous student body).

To prepare elementary teachers to teach in this manner, the authors suggest a required minor that would encompass a core of courses in history, language arts, art, music, and geography. This core would include four-six courses in history, and would be taught with emphasis on the key values, ideas, and skills that teachers would need to acquire in order to teach in the ways that the authors envision.

Literature

Johnsen (1989) focuses on developing a rationale for the teaching of literature in its own right rather than merely as a vehicle for teaching language arts, social studies, or other school subjects. He notes that although literary works can be used as grist for teaching language arts or social studies and for developing higher order thinking and problem solving skills, literary studies is an area that has its own knowledge base and analytic procedures. The best defense of the "canon," the works usually taught in college literature courses, is their ability to serve as models of research, and as sites for further research, into fundamental human behavior. The necessary revision of this canon to include the "voiceless" should likewise follow this criterion.

University literature courses, where this canon is taught, are not especially helpful preparation for future elementary teachers because they seldom study texts that they will be teaching to their own students later. Meanwhile, in their pedagogy courses, future teachers learn a great deal about teaching students language arts, but not much, if anything, about teaching them

literature. Consequently, they are likely to omit literature from their curricula or to teach it in ways that neglect its integrity as a discipline.

To the extent that literature is currently taught at all at the elementary level, the teaching tends to focus on affective response (or occasionally, aesthetic appreciation). Although recognizing that these approaches have value, Johnsen laments that they do not prepare students for studying literature in the ways that are emphasized in later curricula influenced by university English departments.

Johnsen notes that Northrop Frye established a basis for an independent discipline of literary studies by identifying recurring elements (symbols, archetypes) that reflect the structure or tonality of literary works. Frye believed that the structures of literature were the structures of the imagination itself. Frye then proposed a larger paideia, which he envisioned as a liberating preparation for the study of all expressions of a verbal culture, not a more narrow refinement approach designed to educate the taste of a dominant social class.

Johnsen proposes to revise Frye's theory of archetypes, while saving his essential contribution to an education in literary studies. He notes that the literary structures isolated by Frye can themselves be the subject, and not the final, irreducible building blocks of literary works. Literary thinking is never simply thinking "in" archetypes but also thinking "about" them. Literature does not simply give us examples of bourgeois sensibility, genres, and so forth, but mimics them and "minds" them (thinks about them, cares for them, attends to them, is critical of them, meditates on their consequences). Literature is a form of research into the fundamental aspects of all human behavior, but especially mimetic behavior.

Johnsen argues that, to exploit this research potential of literary study properly, we will need a renewed interest in the content of literature instruction. Current elementary curricula tend to focus on skills and processes without much attention to what literature is taught. Some current textbooks suggest concentrating on myths, but they regard myth as just another kind of literature whose content can never give us anything that we don't already know from some other discipline: history, psychology, or one of the other social sciences.

Johnsen then suggests what a work like Shakespeare's King Lear knows that is not already known, by comparing the play's research into the motives and consequences of rule-governed behavior to current research in the social sciences often used to construct elementary curricula.

He concludes with a single example for a coherent curriculum, from kindergarten to the graduate seminar, by suggesting that simple stories like Cinderella embody the kinds of cultural stereotypes that complex works like King Lear modify. Myth puts the blame for everything on stepsisters and mothers, but certain canonical works know that no one is uniquely responsible for everything that goes wrong. Johnsen urges long-range cooperation of those who teach literary study in the university with elementary English teachers.

Mathematics

Blair (1989) notes that a number of references to elementary education have been made through the years by basic mathematicians. Rather than attempt to cover all of these in his paper, he cites some histories of the subject and concentrates on relatively recent reform efforts. The School Mathematics Study Group (SMSG) was a post-Sputnik reform effort that initially concentrated at the secondary level but eventually yielded textbooks for the lower grades as

well. It took a top-down approach, working backwards from the idea that high school seniors should be prepared to take calculus in college. The recommended K-6 content was still arithmetic, but it was to be taught with an emphasis not just on skill mastery but on learning "what was going on" when arithmetic operations were performed (learning that subtraction is the inverse of addition and that division is the inverse of multiplication, understanding the reasons for--rather than just memorizing the answers to--arithmetic facts and calculation problems). The SMSG curriculum had many positive features, but with hindsight we can see that the content was too formalized--it attempted to teach about laws as abstractions without giving sufficient attention to rationales and applications. The "working backwards" approach led to attempts to spiral curricula around key ideas, to introduce terms early for use later, and to teach arithmetic in ways that helped prepare the way for algebra. As operationalized, however, these features contributed to the problems of abstractness and lack of application value that limited SMSG's acceptance and led eventually to a call for return to basics.

Blair emphasizes the importance of viewing mathematics as a discipline that is continuously being developed, not as a fixed body of knowledge or set of procedures for solving problems. Although mathematics does offer problem-solving tools, its practitioners emphasize development of its knowledge base and thus engage in problem solving only within that context. Thus mathematics should not be equated with problem solving independently of the development of mathematical knowledge.

The Comprehensive School Mathematics Project (CSMP) developed an approach to elementary mathematics teaching that embodied these notions of mathematics as a developing discipline (in contrast to SMSG, which treated it as a closed system). CSMP is notable for its innovative content representations and for

its emphasis on class discussion, in which children contribute ideas and work together to solve problems. It is currently in use in many schools.

Additional contemporary trends include adjustments to the computer (which has raised new questions, made old ones more tractable, and rendered certain previously stressed skills obsolescent), attempts to integrate different aspects of the math curriculum more effectively, attempts to eliminate unnecessary repetition of material across years, attempts to embed more practice within application contexts, and greater emphasis on nonartificial applications. Curriculum developers now are concentrating on identifying worthwhile problems to have students solve, not on trying to teach problem-solving skills independently of content and context.

Concerning content selection, Blair notes that the intersection of all suitable curricula is not a suitable curriculum itself. He also is skeptical of attempts to identify minimal core content that everyone should know and then attempt to teach only that content in situations where the students are low achievers or the teacher's mathematics knowledge is limited. He argues for a broadened, yet better integrated, curriculum that would continue to focus on arithmetic but also include topics from other areas of mathematics. The curriculum would feature small groups of key ideas developed in depth and within the context of natural applications. The core would be arithmetic and "what goes with it" (counting, place value, measurement, etc.), but taught with emphasis on understanding rather than hand algorithms or fast mental arithmetic. Students would get considerable experience with hand-held calculators and would work on problem solving, estimation, probability, statistics, informal geometry, and spatial visualization along with arithmetic. Instead of an exclusive emphasis on preparing students for higher work in mathematics,

there also would be emphasis on general problem solving and preparation for everyday living.

The program also would attempt to convey the beauty of mathematics as a discipline, in addition to emphasizing its utility for purposes such as balancing checkbooks or building better bridges. The similarity of mathematics to music might be noted in this regard, along with some of the subject's historical and cultural aspects.

Preparation for such teaching would require not only solid mathematics knowledge but experience in teaching problem solving and other nontraditional topics to elementary students. Ideally, mathematics consultants would be available to assist ordinary classroom teachers in planning their curriculum and instruction. The paper concludes with guidelines for a sample unit on area to be taught to fifth or sixth graders. Its content is built around a set of related key ideas about mathematics, and the recommended instructional methods feature teacher-led group discussion of realistic problems.

Music

Erbes (1988) endorses and elaborates on the guidelines developed by the Music Educators National Conference (MENC) in suggesting goals and content guidelines for elementary music education. He recommends that music should be treated as an art and that students should not only learn facts about music but learn to think intelligently (critically and creatively) about it. In this regard, he believes that higher order thinking can be integrated into elementary music education through selection of appropriate musical topics.

Erbes notes that until the progressive education movement, music education emphasized performance, rote learning, and passive participation in musical activities. Since then, there has been more emphasis on playing

instruments, moving to music, and creating music. Later infusion of ideas from Bruner and Piaget led to an interest in higher order thinking and learning as applied to music, and more recent conferences have emphasized the processes of learning in music and the need for stimulating instructional and motivational techniques. Erbes believes that the field is currently in a refinement phase in which ideas contributed by Orff, Kodaly, Dalcroze, and Gordon are being synthesized. He calls for continuation of these refinement and synthesis efforts but with greater attention given to higher order thinking skills.

Concerning incorporation of higher order thinking (especially critical and creative thinking) into music instruction, Erbes recommends the skills approach outlined in the book Dimensions of Thinking (Marzano, Brandt, Hughes, Jones, Presseisen, Rankin, & Suhor, 1988), although he calls for couching it within an attempt to make students better appreciators and consumers of music throughout life. This implies interactive approaches to instruction that provide students with many opportunities to express opinions and develop arguments about music.

Erbes lists goals and content for elementary music programs, subdivided by grade level and categories of objectives (performing/reading, creating, listening/describing, and valuing). Plans for the early grades focus on group activities designed to develop students' interest in music and competence and confidence in their participation skills. Plans for the later grades emphasize more individual experiences, exploration, and creativity. These guidelines for elementary music are intended for all students (in contrast to expectations for the secondary grades, where music is seen as becoming an individual elective). They are intended to expose the students to a broad variety of forms (including the music of all of the major cultures included in the school) and to build a basis for lifelong appreciation and enjoyment. The primary grades would

emphasize breadth and exposure; Grades 4-6 would get into more depth and specialization, with more emphasis on developing higher order thinking skills.

Erbes argues the need to devote more curricular time to music, to treat it as a basic subject rather than just a frill, and to provide more thorough teacher training (or, alternatively, more frequent and reliable student exposure to music specialists). He also calls for treating music as a continually developing art rather than a static endeavor and for keeping up with developments, such as electronic music and computerized music.

Recommendations concerning objectives and content coverage are given at two levels: a minimal level to be taught by regular classroom teachers and an enriched level to be used if the class is taught by a specialist frequently enough to provide continuity and thrust to the curriculum (he recommends 150 minutes of music instruction per week). Content would include the great master works of past and present music, supplemented by music of major cultural groups, folk music, jazz, etc. Elementary general music would be taught primarily to develop lifelong understanding and appreciation of music rather than more narrowly to prepare students for secondary performance programs. Diversity would replace the current overemphasis on singing, and an emphasis on understanding would replace rote learning.

In describing what teachers should know in order to teach music effectively, Erbes lists instructional competencies, musical competencies, and personal competencies. Few elementary teachers would have the recommended musical competencies without significantly enhanced musical preparation.

Erbes also lists various ways to evaluate accomplishment of knowledge, skill, and attitude objectives, emphasizing that such evaluation should be done as an aid to program development and not just as a basis for grading. In an appendix, he provides an outline of a unit on recognizing instruments. Along

with a great deal of listening to and discussing music, the recommended instructional strategies include the SQ3R (five steps in systematic study: survey, question, read, recite, review) and reciprocal teaching methods that have been developed for teaching reading comprehension and study skills.

Political Science

Cherryholmes (1990) notes that political science organizations have had nothing to say about elementary teaching, partly because school curricula already were established before political science became well organized as a field, and partly because political scientists have been preoccupied with their own scientific activities. This silence is fitting, he argues, because it would be inappropriate to attempt to use the factual, descriptive, and explanatory scientific theories of politics developed by political scientists as a basis for deriving evaluative, normative, and prescriptive guidelines for civic education in elementary schools. It is for society at large, and educators in particular, to decide what should constitute elementary civic education.

Having established that political scientists' disciplinary activities do not entitle them to any privileged position in debates about civic education, Cherryholmes offers four guidelines. In doing so, he speaks not so much as a political scientist but as an individual interested in curriculum and civic education who is "guided by commitments to human dignity and community, to social justice and equality, and to liberal democracy."

The four guidelines call for students to (1) learn important characteristics of liberal democracy and its historical development, carefully reading the texts of their society and of other societies; (2) learn that the development of liberal democracy in the United States has been flawed and oppressive as

well as liberating and enlightening, although generally evolving in the direction of greater social inclusion; (3) learn important political scientific knowledge that will help them to develop authoritative descriptions and explanations of the structure and operations of our social and political system-- knowledge about the operations of our government, relations among nations, comparative political systems and political thought, and so on; and (4) learn that social and political life and practices are complex, contradictory, and transitory, and thus in need of constant recreation. If these guidelines are followed successfully, students will come to think of themselves as critical pragmatists who are building communities and ways of living where human dignity is privileged. For examples of curriculum and instruction that embody these guidelines, Cherryholmes refers to the 1979 McGraw-Hill elementary social studies series, of which he was a principal author.

Science

Balaban (1990) did not write a full paper reporting historical and current trends in the discipline's views on elementary education. Having seen Roth's (1990) coverage of these topics in the literature review and synthesis paper that she wrote for Study 1 of Phase I of the Center's research, Balaban believed that there was no useful purpose in him writing a review of the same literature because it would simply repeat what Roth already had said. Instead, he confined himself to a few pages of commentary on issues raised in Roth's paper.

Balaban's notes are thoughtful and interesting, and his endorsement of Roth's work is encouraging. However, Roth is a senior researcher in the Center and a science educator by discipline, and we still wanted a more complete statement representing the views of scientists written by one or more

scientists (i.e., not science educators) who were not part of the Center's core group of researchers. There was no need to recruit one or more additional scientists to write such a paper, however, because the American Association for the Advancement of Science (1989) had recently released the report Science for All Americans: A Project 2061 Report on Literacy Goals in Science, Mathematics, and Technology. Commissioned by the major professional organization representing disciplinary scientists and representing the distilled consensus achieved after months of work by several committees, this report is the most definitive statement that exists on scientists' views about K-12 education. Consequently, we used this report, supplemented by Balaban's notes, as our statement of scientists' views on science education.

In about 200 pages, the report lays out key ideas about what the scientists consider to be basic literacy across several topics (the nature of science, mathematics, and technology; the physical setting; the living environment; the human organism; human society; the designed world; the mathematical world; historical perspectives; common themes; and habits of mind), then finishes with chapters on effective learning and teaching and on reforming education. It is a statement of goals and key content rather than a curriculum document or outline. Follow-up plans call for working with six school districts to develop representative curricula. The report refers to K-12 education in general without speaking of particular grade levels or courses.

Content guidelines were developed with the intention of reducing the sheer amount of material covered, weakening or eliminating rigid subject-matter boundaries, paying more attention to connections across science, math, and technology, presenting science as a social enterprise that both influences and is influenced by human thought and action, and fostering scientific ways of

thinking (attitudes and values as well as skills). The instructional suggestions call for conveying the spirit and character of scientific inquiry and values by starting with questions about phenomena rather than with answers to be learned; engaging students actively in the use of hypotheses, the collection and use of evidence, and the design of investigations and processes; and placing a premium on student curiosity and creativity. The report also mentions the need for better teacher preparation, more realistic teaching loads, and curriculum materials that would focus more on key ideas and understanding and would be compatible with teaching that featured discourse and inquiry rather than recitation and seatwork.

Although there is great emphasis on socialization into science as a discipline, the report adopts a broad definition of scientific literacy and thus can be said to foster citizen science rather than just specialist science. The recommendations are meant to be minimum ones that apply to all students (without distinctions among types of students, except for mention of the need for special encouragement of girls and minorities). Criteria for inclusion of selected content were (a) utility (will enhance job prospects or be useful in making personal decisions), (b) social responsibility (will help one make good policy decisions relating to science and technology), (c) intrinsic value of knowledge (it is historically important, pervasive in the culture, and essential to general education), (d) philosophical value (it will help one ponder enduring questions of life and death, perception and reality, good, etc.), and (e) childhood enrichment (it will increase children's understanding of phenomena that they are interested in at their own levels).

The report is well written in clear and mostly nontechnical terms. In addition to descriptions of key content to be covered in the areas listed above, the report calls for encouraging and reinforcing key values, attitudes,

and other habits of mind (curiosity, openness to new ideas, skepticism, and interest and confidence in science) and skills (computational, calculator, estimation, manipulation and observation, communication, and critical response).

The chapter on effective learning and teaching mentions the following principles of learning: Learning is not necessarily an outcome of teaching (it is difficult and takes time, thus underscoring the need to go into depth on fewer items); what students learn is influenced by their existing ideas; progression is usually from the concrete to the abstract (although concrete experiences are most effective when they occur in the context of some relevant conceptual structure); practice is needed to ensure learning (especially practice in realistic or authentic contexts); effective learning requires feedback; and expectations affect performance. The report also lists the following principles of teaching as being consistent with the nature of scientific inquiry: start with questions about nature (and in particular, about things that are familiar and interesting to students rather than abstractions or phenomena outside their range of understanding); engage students actively (in observing, measuring, etc.); concentrate on the collection and use of evidence (in the process of seeking answers to questions or solutions to problems); provide historical perspectives (to reinforce the notion of science as a human enterprise conducted with purposes in mind); insist on clear expression (because this is essential to clear debate and resolution of issues on the basis of evidence); use a team approach (most science is collaborative); do not separate knowing from finding out; and deemphasize memorization of technical vocabulary.

The report also suggests reinforcing scientific values by welcoming curiosity, rewarding creativity, encouraging a spirit of healthy questioning,

avoiding dogmatism, and promoting aesthetic responses. Finally, it recommends that teachers counteract learning anxieties by building on success, providing abundant experience in using tools (so that this will not feel foreign or threatening to students who are not familiar with tools), support the role of girls and minorities in science, and emphasize group learning. The chapter ends with a reminder that teaching can be expected to take time (including time spent doing hands-on activities).

These recommendations comprise a tall order for both teachers and students. Even though they were developed with a conscious effort to reduce breadth in order to allow for development of key ideas in depth, the guidelines subsume a great deal of content. They are written at a relatively high level of abstraction that masks a great deal of time-consuming development that would have to occur in order to produce true understanding of the topics and mastery of the skills that are included. Teachers would have to have much more highly developed and integrated scientific knowledge than most of them have now, and student mastery of the goals laid out in this report would require a great deal more time devoted to science than is devoted now.

Balaban's notes emphasize many of the same themes stressed in the AAAS report. He begins with the assumption that students are naturally curious and seek to regulate their lives through understanding and controlling their environments. This implies that the role of teachers is to create an environment that supports such curiosity and inquiry by modeling and rewarding these traits themselves and by affording students opportunities to make many observations and develop schemas to integrate their knowledge.

Balaban stresses that good teachers wonder about the mystery of things and continually model an attitude of inquiry. They also have deep subject-matter knowledge that includes the ability to give good, spontaneous answers to

questions about matters that were not specifically prepared in advance. He sees this as important not only to supply the requested information but also to allow students to see the joy of developing new thought relationships at the moment of their creation. Teachers also should know how to listen and to guide their students in their studies in ways that are adapted to the students' abilities and interests.

As a zoologist, Balaban responded to questions about teacher preparation and school curriculum content with a specific focus on biology. He believes that in order to teach biology effectively, about half of the program of teacher preparation should be in biological subjects, and the work should include a hands-on research project that would be presented as an undergraduate thesis (so that the teacher would understand what goes into the art of discovery). Balaban believes that the key to good science is asking meaningful questions that can be tested through some systematic collection of evidence. There is no fixed method or set of rules.

His recommendations about content coverage include (a) probability theory and its applications to predicting and controlling the environment, (b) genetics, (c) evolutionary biology, and (d) systems of social behavior that allow for and affect adaptation.

Discussion

The papers are too varied to allow for point-by-point comparison across a set of common dimensions, but considered as a set, they suggest several noteworthy observations. Several of these concern the images that the authors project of their respective disciplines and their visions of how these should be represented to elementary students. At least implicitly, and often explicitly, the authors conveyed images of their disciplines as vibrant, growing,

human enterprises that are engaged in for a variety of purposes and that offer opportunities not just to generate information but to experience joy, beauty, self-actualization, and other intrinsic rewards. In articulating goals and guidelines for instruction, the authors typically expressed the hope that these humanistic aspects of their disciplines would be appreciated by teachers and communicated effectively to students. Goals statements typically emphasized values and dispositions at least as much as knowledge and skills, and teaching suggestions typically emphasized discourse, collaborative inquiry, and hands-on activities over traditional recitation and seatwork. The authors typically emphasized the importance of helping students learn to think like disciplinary specialists think, as well as avoiding representations that would tend to make students think of their disciplines merely as fixed and static collections of information.

A related common theme was the importance of developing appreciation of the full breadth and richness of the discipline. Various authors wanted to make sure that students learned about the beauty and cultural aspects of mathematics in addition to its usefulness in solving problems, the usefulness of geographical principles in addition to the interest value of geographical facts, the knowledge about the human condition that can be learned along with knowledge about genre or technique in studying literature, and so on. The authors tended to define their disciplines broadly and to call for curricula and instructional methods that would communicate this richness and diversity to students rather than create one-dimensional or otherwise distorted images of their disciplines.

In part because of their concerns about these issues, and in part because most of them were relatively unfamiliar with elementary-level curriculum and instruction, the authors tended to place more emphasis on encouragement of

interest in the school subject and development of values and dispositions that are stressed in their disciplines than on coverage of particular content. They typically emphasized depth over breadth, calling for development of basic concepts and skills (along with key values and dispositions) in the elementary grades but being content to leave systematic coverage of disciplinary knowledge to the secondary grades. Most of them distinguished, at least implicitly, between elementary school subjects and their underlying disciplines. They wanted the school subjects taught in ways that represented disciplinary knowledge and values appropriately, but they viewed the elementary subjects as drawing selectively from the disciplines to provide basic general education and life preparation for students, not as courses in the disciplines as such.

Several authors advocated integrated approaches that would minimize artificial barriers between school subjects and attend to across-subject connections in addition to within-subject content. At the same time, however, several authors (including those who advocated integrated approaches) warned against approaches that would have the effect of eliminating or distorting the integrity of their disciplinary perspective and the educational benefits that it can bring. Thus, concerns were expressed that literature not be so submerged within language arts instruction that no true literary study occurs, that geography not be so submerged within social studies that no true geographic analysis occurs, and so on.

The authors usually did not have much to say about teaching and learning at different grade levels or about adapting instruction to individual or group differences in students (other than to suggest that teachers use examples and activities that would connect content to students' interests and to the local context). However, they were effective in communicating the richness and application and appreciation value of their respective disciplines, as well as

in suggesting potentially powerful examples and activities. Thus, even though disciplinary specialists, such as these authors, typically lack sufficient knowledge about elementary classrooms and students to be able to develop elementary curricula on their own, those who have interest in doing so could be valuable contributors to curriculum development teams. This is especially true given their tendency to emphasize the humanistic, motivational, and affective aspects of their disciplines--a tendency that would have more appeal to teachers and elementary education specialists and would likely lead to more rounded curricula than the "structures of the disciplines" emphasis that drove curriculum reform in the 1960s.

The curriculum and instruction ideas suggested by the authors also fit well with the current thinking of educational psychologists and subject-matter curriculum and instruction specialists concerning teaching school subjects with an emphasis on understanding, thinking, and authentic applications (as described in the literature review and synthesis papers prepared for Study 1 of Phase I of our work [Brophy, 1988; Cianciolo, 1988; May, 1989; Prawat, 1988; Putnam, Lampert, & Peterson, 1989; and Roth, 1990] and also in Brophy, 1989, and Prawat, 1989). Themes stressed in both sets of papers include balancing breadth of coverage with depth of development of key ideas; emphasizing the connections between ideas in addition to teaching the ideas themselves; emphasizing teacher-student discourse that features dialogue or discussion, not just recitation; and activities that offer students opportunities to process information actively and engage in authentic applications.

The visions of good discipline-based subject-matter teaching advanced by these authors are inspiring, but they also raise issues of feasibility. If the recommended goals and related curriculum and instruction suggestions were taken seriously, they probably would require significant increases in the time that

students spend in school, and they certainly would require significant increases in the length of and changes in the nature of teacher preparation. Changes of a magnitude implied in these papers do not seem forthcoming even in this time of emphasis on reform, and in any case there are reasons to question whether even substantial enhancement of teacher preparation programs could succeed in turning out many elementary teachers who had the levels of expertise in each of the disciplines that is envisioned by these authors. One could eliminate the need for such multiple expertise by extending the departmental approach downward to include the elementary grades, of course, but this would entail trade-offs that might not be acceptable to very many elementary teachers or others concerned about elementary education. Another possibility would be increased availability of subject-matter teaching specialist/consultants, as suggested by Blair. In any case, full realization of the visions put forward in at least some of these papers may not be feasible. The visions stand as challenging ideals, however, and are best viewed with an eye toward identifying ways to actualize them as fully as possible within the prevailing constraints.

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