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Elementary Science: Where Are We Now?

Barbara R. Sandall, EdD
Western Illinois University

"Elementary Science: Where are We Now?" is a review of Elementary Science Education from the 1960s to 1999. Curriculum moved from uniform programs in the 1960s based on two assumptions to a wide diversity of goals, philosophies, and types of materials in the 1970s. The two assumptions behind the elementary science curriculum programs of the 1960s included (1) If science is presented as scientists would do it, it will be interesting to all students; and (2) Any subject can be taught to any child at any stage of development. Project Synthesis was a discrepancy study of data collected from three earlier studies on the state of science education in the 1970s. The programs of the 1970s varied in student outcomes, learning/teaching styles, cost, format, and content. The goal for science education for the 1980s was scientific and technological literacy (Staver & Bay, 1987). National Science Foundation funds were invested in developing new curriculum materials in the 1980s to reach this goal (Harms & Yager, 1981).

This article will focus on the answers found from a small sample of teachers representing multiple districts. What criteria are being used to select science curriculum materials? The first part provides a historical perspective of elementary science education, and the last part presents the results of where elementary science education was in the late 1990s. This discussion begins with the Project Synthesis, which was a discrepancy study of data collected on the state of science education in the 1970s. The rest of the article examines the literature from 1981 to 1999 and research conducted by the author. The author found that educators wanted to use the inquiry-based science curriculum materials recommended by the standards but were restricted by non-academic considerations such as funding.

Problem

Educators are in the process of creating a plan for combining state learning standards with local district goals, national standards, and the needs of the learner and community to create an effective curriculum. How can curriculum be selected to meet all of these needs? All of these issues must be synthesized into practice, so educators need the knowledge and skills set forth in the research and standards to be able to transfer knowledge and skills into practice.

Design

In 1999, a study was conducted by Sandall to evaluate a professional development program for teachers in Illinois. This professional development program would (1) introduce teachers to the Illinois Learning Standards and the National Science Education Standards, (2) identify school goals and needs and apply Illinois Learning Standards, National Science Education Standards, and local school goals in the curriculum selection process.

Objectives

Participants in the professional development program will be able to . . .

- Describe the standards.
- Describe how the implementation of the standards would be shown in the classroom.
- Demonstrate the ability to use the standards to select science materials.
- Demonstrate the ability to use the standards to select curriculum.
- Select curriculum which meets the needs of the school and the standards.
- Compare standards with the school goals.

Purpose of the Study

To evaluate the components of a professional development design created for K-8 educators in Illinois who are in the process of selecting science curriculum materials.

Questions to Be Answered

- What criteria are being used to select science curriculum materials?
- What professional development materials would be most effective to develop the skills necessary for a critical selection of standards-based science curriculum materials?
- How can educators be encouraged to select or adapt existing standards-based science curricula?
- Do participants apply the process modeled in the professional development program to select science materials?

This article will focus upon the answers of a small sample of teachers representing multiple districts to the question, "What criteria are being used to select science curriculum materials?" The first part provides a historical perspective of elementary science education, and the last part presents the results of where elementary science education was in the late 1990s. This discussion begins with the Project Synthesis, which was a discrepancy study of data collected on the state of science education in the 1970s. The rest of the article examines the literature from 1981 to 1999 and research conducted by the author.

Historical Perspective

Curriculum moved from uniform programs in the 1960s based on two assumptions to a wide diversity of goals, philosophies, and types of materials in the 1970s. The two assumptions behind the elementary science curriculum programs of the 1960s included (1) If science is presented as scientists would do it, it will be interesting to all students; and (2) Any subject can be taught to any child at any stage of development. Project Synthesis was a discrepancy study of data collected from three earlier studies on the state of science education in the 1970s.

The programs of the 1970s varied in student outcomes, learning/teaching styles, cost, format, and content.

The Project Synthesis team identified four goal clusters:

- Goal Cluster 1: Academic Preparation
- Goal Cluster 2: Personal Needs
- Goal Cluster 3: Personal Needs
- Goal Cluster 4: Societal Issues (Harms & Yager, 1981)

The goal for science education for the 1980s was scientific and technological literacy (Staver & Bay, 1987). National Science Foundation funds were invested in developing new curriculum materials in the 1980s to reach this goal (Harms & Yager, 1981).

In the 1970s, elementary students typically had limited experiences in science. In many cases, it was taught at the end of the day, if there was time, by a teacher with little interest, experience, or training to teach science. Equipment available was limited and seldom used. The lessons came from a textbook and consisted of reading and memorizing facts that were in the book (Pratt, 1981).

In elementary science, student outcomes should be based on the knowledge of how students learn and their needs. Concepts should broadly sample all content areas, support all four Project Synthesis goal clusters, develop skills in the processes of science, and be interesting. Elementary science should encourage curiosity, build interest in the student's world and themselves, and provide opportunities to practice methods of science and communicate. Students should be actively involved in data collection and planning investigations. Information presented should be clearly articulated in a variety of ways. What is taught should be age appropriate and reflect how it was developed. Science programs should be interdisciplinary in nature (Pratt, 1981).

An examination of the actual state of elementary science revealed that textbooks and other published materials determined student outcomes (Pratt, 1981). Teachers, who were often not confident in science, selected the curriculum programs, and the majority of the teachers used textbooks. Pressure from the public, local educational climate, and desire for inquiry also affected how programs were selected. Principals believed science was important, but the three Rs had a higher priority. Socialization influenced what and how things were taught which led to an emphasis on extrinsic motivation, attention to directions, homework, and testing. Professional development is also affected by socialization. If the professional developers do not come to the classroom, work with the teachers' students, use materials in the classroom, and demonstrate a positive student response, the innovation did not succeed (Stake & Easley, 1978).

Program implementation barriers identified in Project Synthesis included the following: Science was difficult to teach, required more time and work, and it was not fun; most science programs were text-based, and most teachers were not aware of alternative science programs. There was a decline in the number of science supervisors to provide support, no funds or facilities and teachers did not value and were not prepared to teach in the content, methodology, or goals of exemplary programs of science instruction (Pratt, 1981).

The Project Synthesis report identified the following needs for improving science education:

- Major redefinition of goals and a new conceptualization of science curriculum

- New programs and procedures for teacher preparation and new materials development
- A means for translating research into practice
- A renewed attention needed to be paid to the evaluation of science education
- Development of systems for implementation and support (Harms & Yager, 1981)

How Far Have We Come Since 1980?

So how far have we come since the early 1980s? The National Assessment of Educational Progress (NAEP) showed a decline in science and mathematics scores from 1970-1977. Trends in all levels of performance in science increased between 1977-1996, and there was an increase in the percentage of students taking more challenging mathematics and science courses (Campbell, Voelkl, & Donahue, 1996). Kamens and Benavot (1991) found an increased emphasis on science and mathematics in school curricula worldwide in the late 1980s and early 1990s.

Kendall and Marzano (1995) found that teachers relied heavily on textbooks to determine what is important to teach in each discipline. Their study showed that textbook manufacturers and companies creating standardized tests were, in effect, determining the standards for content and setting performance standards. Kendall and Marzano found that these companies had different standards and assessments, so there was a need for unified standards. The structure and organization of current standards and benchmarks were also very different, so there was a need to make them more uniform. Without this uniform format, curriculum and assessment issues become difficult and do not allow for subject integration.

There was a difficulty in creating national standards due to disagreements on the scope, purpose, and nature of the standards. In this study, questions were identified which needed to be resolved. Are standards for subject literacy or expertise? The literacy versus expertise issue was not a major issue. Literacy meant that standards could be described as minimum requirements of knowledge and skills. Expertise meant someone had the knowledge and skills that, once acquired, would give them expertise in the field. Can thinking skills be separated from content, and should standards be formed as content or performance standards? There was agreement on the importance of enhancing thinking and reasoning skills but not on which skills should be addressed in the standards. Should there be content or curriculum standards? There should be a uniform set of standards for all subject areas. How are benchmarks defined and at what level of generality are benchmarks and standards stated? Most content areas recognize a need to identify benchmarks and understandings at different grade levels (Kendall & Marzano, 1995). Teaching methodology also needed to be examined. This will be discussed in greater detail in the section on the National Science Education Standards.

National Standards

What are National Standards? What is the purpose of National Standards? Should the United States have National Standards? Some of the answers to these questions follow.

The National Science Education Standards (NSES) were developed in 1996 by the National Research Council. These standards show the need for changes in science education. Both of the major science education reform documents, NSES and the Project 2061 benchmarks (AAAS, 1993) require systemic changes in science education. Some of the recommendations include selection and use of materials aligned with the standards, reflection on teaching practice, and a variety of assessment tools to improve teaching and student achievement.

These documents encourage scientific literacy. Scientifically literate students have the ability to apply scientific knowledge to aspects of their own life. This includes understanding of the basic concepts of science and the principles, laws, and theories that organize the body of scientific knowledge. It includes understanding the varied applications of science and modes of reasoning of scientific inquiry. Understanding the nature and history of the scientific endeavor, including its relationship to technology and other disciplines, are also needed to understand the world around us (NRC, 1997).

Scientifically literate students are those who are familiar with the natural world and recognize its diversity and unity. They understand key concepts and have an awareness of ways in which science, mathematics, and technology depend upon one another. Scientifically literate students know that science, mathematics, and technology are human enterprises. They know what it can imply about science, mathematics, and technology's strengths and limitations. They have a capacity for scientific ways of thinking and use scientific knowledge and ways of thinking for individual and social purposes (AAAS, 1993).

Common recommendations in both of these documents include the following:

- Scientific literacy is for all students.
- Science is active, hands-on learning and in-depth study of fewer topics.
- Science should emphasize critical thinking, problem solving, and developing mathematics and science as a way of thinking and reasoning.
- Science should emphasize integration and interdisciplinary activities.
- Science should emphasize application of science, mathematics, and technology to real-life situations.

NSES encourages cooperative and collaborative activities among students and more team teaching. Collaboration facilitates change because teachers learn content and pedagogical knowledge from one another. It encourages teachers to take more risks in implementing innovative strategies and provides needed support. It is a way to sustain the processes of individual change in science teaching. Collaboration helps teachers reflect on practice and is essential in overcoming barriers to change (Briscoe & Peters, 1997).

The NSES and 2061 benchmarks place more emphasis on alternative assessments and multiple kinds of assessments for teachers and students. Teachers become facilitators of learning, change agents, and decisionmakers. Exemplary teachers are used as mentors or role models, exemplary classrooms are used as models, and teachers develop exemplary curriculum models. Alternative curriculum models, development of new materials and technologies for teaching, and assessment are required for the implementation of the new standards. Criteria for identifying the curriculum most effective for individual schools are also required. These criteria may require changes in the organization of schools, educational policies, and educational research. NSES requires changes in how we think about how science is taught; it also requires ongoing professional development.

Most of the reformers studied in this analysis agree that standards should be set for content and assessment. Standards are needed to make the U.S. education more equitable to students in all areas, socioeconomic levels, and cultural backgrounds. Standards are necessary but they should allow autonomy for local districts or teachers to decide how it should be taught and allow some variation for local needs. These standards are based on the schools mission to stimulate a desire to learn, create a community of lifelong learners, inspire innovation, as well as teaching content and process. The development of the standards requires new materials and strategies for assessment.

Now that standards have been developed, there are many issues that need to be addressed. One issue is how to determine if the students meet the standard. NSES recommends that multiple assessment strategies need to be used (NRC, 1996). Standardized tests and letter grades cannot give a full picture of what the student has learned. The aim is that students should reach most standards by the end of the benchmark grade levels given in most standards documents.

Many systemic changes will have to take place in schools to implement the standards. The change needs to come over time and from within the schools and communities with a focus on improving teaching and learning. All parts of the educational system should agree on and be working toward the changes. Teachers, administrators, parents, and other members of the educational community may need assistance in understanding the need for the standards. Teachers are the change agents; therefore, work needs to be done to help them see why the change is needed and how they can change their part of the system. They have to be given the time and resources needed to make the changes. The larger educational community needs to be involved in awareness sessions as well as in creating a support system for the teachers and students throughout the change process.

Some implementation issues that need to be resolved include what and how many benchmarks should be articulated, how student performance is reported and if students should be required to meet all standards. It has been found that grades were used to rate performance, however, this does not necessarily mean that two students receiving the same grade covered the same content. There was therefore a need to look at different assessment strategies such as weighting the standards identified in a systematic way or reporting student progress by benchmarks. The students should then be required to meet a core set of the benchmarks, not all of them (Kendall & Marzano, 1995).

Assessment aligned with the standards provides opportunities for students to develop their ability to assess their own learning. The assessment is consistent with the principles for sound assessment practices in the NSES. Developers supply evidence that the curriculum provides adequate opportunity for students to achieve the curriculum's content goals (Champagne, 1996).

Change is a slow process, and it will not happen without support at all levels. Creating standards and imposing them on teachers will not bring about the necessary changes (Richardson, 1990). The quality of elementary science instruction has been studied and shows that the way science is being taught must be changed (Morey, 1990). Changes which must occur involve restructuring fundamental beliefs that teachers have about what is important for students to learn and the methods to use to achieve learning (Fullan, 1993). The new ideas and experiences need to be tested and interpreted based on their current understanding of teaching and what works in the social and cultural mix in the classroom. If change does not take into consideration teachers' concerns about how the changes will affect them, it will not be successful (Briscoe & Peters, 1997).

There is a debate throughout the United States about the need for national standards, curriculum, and assessment for all students. The discussion centers on the need to make what is taught more equitable throughout the country and the need to compete in a global economy.

Part of the problem lies in variance of academic requirements in schools. Throughout the U.S., schools have been setting their own standards, curriculum, and assessment. When students transfer from one location to another, there is an inconsistency in what they have learned so that they may be ahead or behind students in their new school. This has been brought to the forefront because of our increasingly mobile society. In the past, families lived in the same location most of their lives. The students attended the same school district kindergarten through twelfth grades, so that there was coordination in their education. Now that many families are so mobile, there is a need for a more universal curriculum and, therefore, standards.

Another problem arises, especially in the elementary schools, with what is being taught in each grade level. For example, elementary teachers have multiple subjects to teach, and one teacher may put more emphasis on a particular subject area than another. Some teachers teach what interests them or the subject matter which they feel most comfortable teaching, so that the academic backgrounds of the individual students vary greatly, even within the same district.

Many feel that because of this wide range of curriculum across the country, there is a need for national standards and a national curriculum framework. There are also many who disagree and see no need for national standards. Debates center on many issues, some of which include the following questions: Should there be national standards, curriculum, and assessment? What is the purpose of national standards? Who should decide what the standards are? Would standards be mandated federally and the schools therefore lose their local autonomy? Would assurance be given that the standards had no bias toward gender, ethnic, or cultural group? Would standards be set so high and mandate so much that monetarily poorer urban and rural areas would not be able to afford to meet all the goals and objectives? Would the curriculum be so narrow that it excluded fine arts, Tech Prep, etc.? How would schools determine if the students met the recommended standards? How much will it cost in staffing and other resources to make the necessary changes to our current school system? Some of these questions have been answered, and some remain unanswered.

The national standards efforts are very complex, and there are many issues that still need to be resolved. There is a need to recognize the research being done in regards to the national standards, so a summary of research on the National Science Education Standards follows.

"Current proposals for a uniform national curriculum reflect ignorance of our schools' real problems. If America is to have the kind of schools it needs, we will need to face up to deeper structural issues" (Eisner, 1991). As Eisner points out, a national curriculum is needed but it is not a simple task, and it should not neglect the deeper mission of the schools. This mission is the stimulation of curiosity, cultivation of intellect, refinement of sensibilities, growth of imagination, and a desire to use all of these things.

There are five dimensions of schools that need to be addressed in changing the educational system: (1) the intentional, (2) structural, (3) curriculum design, (4) pedagogy, and (5) evaluation. The intentional dimension is a serious examination of what really matters (e.g., characteristics of curriculum, features of our teaching, forms of evaluation, and the nature of the workplace). Structural dimensions cover the structures, roles, and time of students and teachers. Designs of curriculum were described as ideas that matter, needed skills, and the means through which students and programs interact. Under the dimension of pedagogy, Eisner (1991) suggests that the teacher is the key to change. The quality of teaching and attention to role and time are needed to treat teaching as an art. He also suggests that the primary location for teacher growth is in the workplace. Finally, Eisner states that evaluation defines what really matters.

A national curriculum would help organize a common knowledge base for teachers around which teacher education programs, licensing, and inservices could be created. This step would create a richer curriculum and add needed performance incentives. In their study of the national curriculum of other countries, they found a wide variance in the curricula. The differences were in curriculum specificity, the quality and variety of curriculum materials, the role of national exams, and the quality and effectiveness of teacher preparation. Principles for designing an American model included that the purpose for the standards should be to improve teaching and learning. This model would coordinate systems of assessment, teacher training, instructional materials, resources, and policies which affect learning. It would promote systemic coherence and local flexibility, and it would preserve the American system of second chances (Smith & Cohen, 1991).

Smith and Cohen (1991) suggest the elements of design include specificity of content, sequence and timing, and depth and breadth. The design would provide local flexibility, stress common curriculum and resources, give equal support to all, and would balance national curriculum and local discretion. In creating a national curriculum, there is a need for . . .

- High-quality instructional materials.
- Some form of assessment which would reflect the content being taught and carry institutional and professional consequences.
- Teacher opportunity to learn and develop expertise in the content areas they are teaching.
- Concepts being taught chosen by agencies interested in improving education.

In the *American 2000, The President's Education Strategy Fact Sheet* (Office of the Press Secretary, 1991), four themes for improving education are cited. One theme is, "creating better and more accountable schools based on world class standards." This can be done by developing and assessing new voluntary national standards, using the school as the site of reform, and promoting and providing school choice. It also requires citing exemplary teachers and administrators, encouraging alternative certification, and providing governors academies in all states.

The second theme is "creating a new generation of American schools which involve research and development." These schools would also have educators, businesses, and communities participating in the development of materials and the curriculum and in the creation of charter schools (Office of the Press Secretary, 1991).

The third theme involves "transforming all Americans into lifelong learners." This would require improving literacy for all Americans and establishing standards and school-to-work transitions. Creating lifelong learners would also mean enhancing job training opportunities and creating business and community skill clinics (Office of the Press Secretary, 1991).

Finally, the President recommends making communities places where learning happens. This would mean greater parent and community involvement and better coordination of programs. It would also necessitate a review of eligibility requirements to streamline or reduce red tape (Office of the Press Secretary, 1991).

In order to accomplish these recommendations, the U.S. Department of Education (1991) established six national goals:

1. All children will start school ready to learn.
2. The high school graduation rate will increase at least 90%.
3. Students will leave grades four, eight, and twelve having demonstrated competency in challenging subject matter.
4. U.S. students will be first in the world in science and mathematics achievement.
5. Every adult will be literate and possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship.
6. Every school will be free of drugs and violence and will offer a disciplined environment conducive to learning.

As a part of Goals 2000 (U.S. Department of Education, 1991), the governors met to define the standards, develop voluntary national tests, and encourage parental choice. They agreed to challenge communities to embrace the national goals, create local strategies for meeting the goals, and devise report cards. The governors also agreed to support charter schools and to foster and support educational innovation.

A Summary of the National Scene

Teachers rely heavily on textbooks to determine what is important to teach in each discipline. The textbook manufacturers were, in effect, determining the standards for content and companies creating standardized tests, and setting performance standards. There is, therefore, a need for national standards. The structure and organization of current standards and benchmarks across subject areas are very different. There is a need to make them more uniform. Without this uniform format, curriculum and assessment issues become difficult and do not allow for the possibility for subject integration (Kendall & Marzano, 1995).

Kendall and Marzano (1995) cited that the difficulty in creating national standards was due to disagreement on the scope, purpose, and nature of the standards. They identified questions which needed to be resolved: (1) Are standards for subject literacy or expertise? Literacy vs. expertise issue was found not to be a major issue. Literacy meant that standards could be described as minimum requirements of knowledge and skills that students should know and be able to do. Expert knowledge and skills that were once acquired would give students expertise in every field. (2) Can thinking skills be separated from content and should standards be formed as content or performance standards? There was agreement on the importance of enhancing thinking and reasoning skills, but not on which skills should be addressed in the standards. (3) Should there be content or curriculum standards? There should be a uniform set of standards for all subject areas. (4) How are benchmarks defined and at what level of generality are benchmarks and standards stated? Most content areas recognize a need to identify benchmarks and understandings at different grade levels (Kendall & Marzano, 1995).

There were three implementation issues identified in the Kendall and Marzano (1995) report. What and how many benchmarks should be articulated? How should student performance be reported, as standards or grades? Should students be required to meet all standards? Their findings indicated that there were two basic formats for standards. One was to list the knowledge or skills needed, and the other was to list the standards as application tasks. Six hundred benchmarks were manageable for grades K-12. These were divided into 75 for grades K-2, 125 for grades 3-5, 150 for grades 6-8, and 250 for grades 9-12. The report indicated that grades are most commonly used to determine performance. This does not mean that two students receiving the same grade covered the same content, however. There was a need to look at different kinds of assessment strategies such as weighting the standards identified in a systematic way or reporting student progress by benchmarks. Finally, the students should then be required to meet some of the benchmarks but not all of them.

The disagreement over the need for standards has changed since the school reform movement began. Originally, on one end of the school reform spectrum, people envisioned nationally mandated curriculum, instruction, and assessment which took away all local autonomy of what needed to be taught. At the other end of the spectrum, people saw the standards as something which allow schools to teach everything and anything. As time has progressed, most realized that the standards were not just another added mandate. The standards in most cases actually reinforced what they were already doing. The other discovery made was that the textbook companies and publishers were already, in a sense, mandating what was taught and making a profit doing it. A federal list of recommended standards were created by nonprofit organizations such as the National Science Teachers Association, National Council for Teachers of Mathematics, U.S. Department of Education, AAAS, etc. This started to eliminate part of the publisher profit and school cost dilemma.

So Where Are We Now?

As a part of a larger study conducted with teachers from multiple school districts in Illinois in 1999, a needs assessment survey was created to determine what criteria were used to select curriculum materials. The survey can be found in Appendix A. Most cited the use of a curriculum selection committee which identified possible materials available, selected their top choices, and presented them to the rest of the faculty. Criteria used for selection of curriculum varied from school to school. Seventy-five percent of the respondents identified state and national standards as part of the criteria currently being used to select new curriculum (Sandall, 1999).

The curriculum that was being used by some of the groups was dated; some of it was from 1986 and 1989. Most of the schools found that their current curriculum was not aligned with all of the standards, and they wanted to learn how to address all of the standards.

Some respondents to the survey said they did not know how their current curriculum was selected. Some of the schools had curriculum selection forms with criteria for textbook selection; these included space for publisher, grade level, positive and negative comments, and the overall impression. Another sample selection criteria asked for the reviewer name, publisher, series title, text content, dates, and if the materials were aligned with the district science philosophy. Other questions on the survey included, “Did it provide adequate focus on major skill areas at my grade level and academic achievement standards?” They were also asked if the series provided enrichment and reinforcement activities, technology, alternative assessment opportunities, and critical thinking. Finally, the survey asks if the assessments evaluate students' competency in reading skills. The third document was an evaluation checklist with a Likert Scale being used, with one being low and five being high. On this third document, they were looking for clear instructions, adequate reading and writing responses, interdisciplinary connections, adequate drill, a focus on the state goals, clearly set objectives, varied strategies for addressing special needs students, critical thinking, alternative assessment, review and lesson extensions, and real-world applications (Sandall, 1999).

What criteria are recommended by the literature and National Science Education Standards (NSES) to select K-8 science curriculum materials? The NSES recommendations for elementary science include the following:

- Inquiry base
- Understanding and using scientific knowledge, ideas, and inquiry
- Continuous assessment of student learning
- Integration
- In-depth study of fundamental concepts
- Development of scientific community

NSES and other literature recommendations include the following:

- Coherent, consistent, and coordinated framework for science content
- Systematic approach to instruction, providing different forms of interaction
- Variety of teaching strategies
- Adequate time allowed to formulate knowledge, skills, and attitudes
- Integration cognition, motivation, development, and social psychology
- Varied curricular emphasis and opportunities to develop knowledge, understanding, and abilities
- Teaching methods and assessment strategies consistent with goals of science literacy
- Professional development provided
- Educational technologies
- Curriculum field tested and reviewed for scientific accuracy and pedagogical quality (Bybee, 1996)

Standards Alignment (topic corresponds with content standard) issues include the following:

- Outcomes of the series of activities or units the same as fundamental concepts of standards
- Learning strategies are sufficient in variety and quality for outcomes to be achieved by most students
- Assessments are provided in the curriculum along with scoring criteria or rubrics which clearly define the performance level expected
- Data are available to document that most students have been able to achieve the level of understanding expected (King, Pratt, & Foster, 1996)

What criteria are being used to select K-8 science curriculum materials? In the past, criteria included the following:

- Positive and negative comments, overall impression
- Aligned with science district philosophy
- Adequate focus on major skills

- Focus on academic standards in science
- Enrichment and reinforcement activities provided
- Critical thinking
- Technology-integrated activities
- Alternative assessments
- Clear instructions
- Adequate reading and writing responses
- Drill/review
- State goals
- Lesson objectives
- Strategies for special needs
- Real-world application
- Two of the three workshop groups were based on NSES and ILS

In the Sandall (1999) study, the elementary science curriculum selection criteria used at that time included

- NSES.
- Benchmarks.
- ILS.
- District goals, including inquiry, technological design, and spiral subject matter.

Progress has been made in the selection of curriculum materials. Even so, more needs to be done in helping educators select or adapt existing standards-based, nationally recognized science curriculum materials. Shymansky, Kyle, and Alport (1982) analyzed 34 studies of standards-based programs available in 1982 and found that students in these programs had

- higher student achievement.
- a more positive attitude toward science.
- improved skills.

In order to encourage educators to select or adapt existing standards-based, nationally validated curriculum materials, several issues must be addressed. One issue was to create awareness that these materials are available. A professional development session was created and implemented to address this issue. Some of the participants in these workshops realized the value of the materials that were examined and were ready to recommend these materials to their district. It was brought to the attention of the group, however, that these programs were not currently on the Illinois State Textbook Adoption List. This means that schools cannot purchase these materials with state textbook funds. One of the big changes that needs to be made is that these programs need to be added to state textbook adoption lists (Sandall, 1999).

A major issue seemed to be the need for funds to purchase the materials since state textbook funds could not be used. One addition which needs to be made to this workshop is to examine alternative sources of funding to purchase materials (Sandall, 1999).

In this study, 24 teachers representing multiple districts were asked how science was currently being taught. Teacher responses varied, including those whose classes were text-based with additional resource materials, hands-on program based on a textbook, and textbook based but with more activity and experimentation. Teachers in this study seemed to be adapting the texts to fit the standards (Sandall, 1999).

Conclusions

Based on this small sample, most teachers in the current study seem to be still using a text-based curriculum. Further study needs to be done on this topic to get the national picture of the state of elementary science education. Some progress has been made since the 1981 curriculum study; teachers are now examining the way they teach. Most of the reformers reviewed agree that standards should be set for content and assessment. The standards are needed to make education in the United States more equitable to students in all areas, socioeconomic levels, and cultural backgrounds. Standards are necessary but they should allow autonomy for local teachers or districts to decide how it should be taught, and they should allow some variation for local needs. These standards should be based on the schools' mission to stimulate a desire to learn, create a community of lifelong learners, inspire innovation, and teach content and process. In implementing the new standards, new materials and strategies for assessment must also be developed.

Creating and implementing national standards is a very complex issue. Development is only part of a broader issue. Now that standards have been developed, there are many issues that need to be addressed for their implementation. One issue is how to know if the students meet a standard. Multiple assessment strategies need to be used. Standardized tests and letter grades cannot give a full picture of what the student has learned. The aim is that students should reach most standards by the end of the benchmark grade levels given in most standards documents.

Many changes have already taken place, but still more will have to take place in schools to implement the standards. These changes need to be systemic. We have proven the band-aid approach of fixing one small piece at a time to try to fix the whole does not work. The change needs to come over time and from within the schools and communities with a focus on improving teaching and learning. All parts of the educational system should agree on and be working toward the changes. This means that teachers, administrators, parents, and other members of the educational community may need assistance in understanding the need for the standards. Teachers are the change agents; therefore, work needs to be done to help them see why the change is needed and how they can change their part of the system. They need to be given the time and resources to make the changes. The larger educational community needs to be involved in awareness sessions as well as in creating a support system for the teachers and students throughout the change process.

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Appendix A

Open-Ended Needs Assessment Survey

Organizational-Level Questions

1. In what professional development activities have you participated to implement the Illinois Learning Standards (ILS) in your school? Please describe.
2. What is included in your current school improvement plan for science?
   - Short-term goals
   - Long-term goals
3. What is currently being used for science curriculum materials?
4. Are the science curriculum materials you are currently using standards-based? Explain.
5. What criteria were used for selection of the current curriculum?
6. What criteria are you using to select your new science curriculum materials?
7. Do you feel that it is important to implement the ILS and the National Science Education Standards (NSES)? Explain.

Individual-Level Questions

1. How are you currently implementing the above ILS for science? (Attached is a copy of a summary of the ILS for Science.)
2. Are you aware that there are nationally validated standards-based curriculum materials available? If so, which programs?
3. How did you find out about the standards-based materials available?
   - Awareness workshop?
   - Training?
   - Observation of use in the classroom?
4. What professional development would help you implement the ILS and select standards-based curriculum materials?
5. Please describe how science is currently being taught.
6. Do you feel that it is important to implement the ILS and NSES in the classroom? Explain.
7. Describe the ideal science classroom.

Summaries of the ILS for Science (ISBE, 1998) and the NSES for Teaching and Assessment (NRC, 1996) were given to participants with the surveys.

Likert Scale Needs Assessment

Grade Level: K-3 4-6 7-8 9-12

Position: Teacher Student Parent Community Member Administrator

Number of Years in Position: ________

Teaching Area:

Mathematics Science Technology Language Arts
Social Studies Self-Contained Other ____________________

Please circle the most appropriate answer on both the organizational-level and individual-level questions.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
ORGANIZATIONAL LEVEL					
1. I have participated in some type of staff development to implement the Illinois Learning Standards in my school.	1	2	3	4	5
2. My current school improvement plan includes a plan for science.	1	2	3	4	5
Describe your Short-Term Goals for Science: ____________________ ____________________ ____________________					
Describe your Long-Term Goals for Science: ____________________ ____________________ ____________________					
3. The science curriculum materials we are currently using are standards-based.	1	2	3	4	5
4. Criteria for the selection of our current curriculum was based on the Illinois Learning Standards.	1	2	3	4	5
5. Our current curriculum materials are based on the National Science Education Standards.	1	2	3	4	5
6. Our current curriculum materials are based on the Illinois Learning Standards.	1	2	3	4	5
INDIVIDUAL LEVEL					
7. I am currently implementing the Illinois Learning Standards for science in my classroom.	1	2	3	4	5
8. I am aware that there are nationally validated standards-based curriculum materials available.	1	2	3	4	5

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
9. I found out about the standards-based curriculum in an awareness workshop.	1	2	3	4	5
10. I have had training in a standards-based science program. Please list which programs: ______________________________	1	2	3	4	5
11. I have observed the use of one of the standards-based programs in the classroom.	1	2	3	4	5
12. My selection of science curriculum materials will be based on recommendations of the Illinois Learning Standards and the National Science Education Standards.	1	2	3	4	5
13. I believe that it is important to implement the Illinois Learning Standards.	1	2	3	4	5
14. I believe it is important to implement the National Science Education Standards.	1	2	3	4	5

15. Please describe how science is currently being taught.
____
____
____
____
____

16. Describe the ideal K-8 science classroom.
____
____
____

Correspondence regarding this article should be directed to

Dr. Barbara R. Sandall
Department of Curriculum and Instruction
Horrabin Hall 48B
Western Illinois University
1 University Circle
Macomb, IL 61455
(309) 298-1411
BR-Sandall@wiu.edu

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