1996

Is there time for elementary school science?

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Abstract

I was made acutely aware of the lack of science education in the elementary grades during a spring, 1995, class at the University of Northern Iowa, entitled Analysis and Improvement of Science in the Elementary Classroom. Currently in American schools, elementary science classes receive a mere 10% of the instructional time (Abell & Roth, 1992). As an elementary teacher of 25 years in second, third and fourth grades, I know this was true in my classroom as well as being a generally accepted practice among other elementary teachers. During my preservice preparation the emphasis of college training and student teaching was in the reading/language arts areas. It was possible to graduate in 1960 in a two-year teacher training program at my junior college without a single course in the teaching of science, but several reading/language courses were required. In the three elementary schools where I have taught, reading/language arts was the main focus of the academic day.

IS THERE TIME FOR ELEMENTARY SCHOOL SCIENCE?

A Graduate Review

Submitted to the Division of Elementary Education

Department of Curriculum and Instruction

in Partial Fulfillment

of the Requirements for the Degree

Master of Arts in Education

UNIVERSITY OF NORTHERN IOWA

by

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May 11, 1996

This Review by: Sharon K. Coltvet

Titled: Is There Time for Elementary School Science?

has been approved as meeting the research requirement for the

Degree of Master of Arts in Education.

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Is There Time for Elementary School Science?

Introduction

I was made acutely aware of the lack of science education in the elementary grades during a spring, 1995, class at the University of Northern Iowa, entitled Analysis and Improvement of Science in the Elementary Classroom. Currently in American schools, elementary science classes receive a mere 10% of the instructional time (Abell & Roth, 1992). As an elementary teacher of 25 years in second, third and fourth grades, I know this was true in my classroom as well as being a generally accepted practice among other elementary teachers. During my preservice preparation the emphasis of college training and student teaching was in the reading/language arts areas. It was possible to graduate in 1960 in a two-year teacher training program at my junior college without a single course in the teaching of science, but several reading/language courses were required. In the three elementary schools where I have taught, reading/language arts was the main focus of the academic day.

Teachers receiving this language arts focus lack confidence in their ability to teach science and are uncomfortable doing it. Weiss (1993) found that 76% of elementary teachers felt very well qualified to teach reading/language arts compared to 28% for teaching life science. Also this limited amount of time spent on science often occurs in classrooms of teachers who sincerely believe that a major emphasis on reading is in the best interest of the child. "If you teach them to read they will have all the tools they need to study or pursue whatever they want to," is a familiar adage from highly respected teachers in the elementary school field. It has been my experience that reading is the main focus of instruction and has primetime placement in the elementary school day. In the 1970s the right to read was recognized as a national educational goal and therefore, reading was given priority in our schools (Neuman, 1974).

The language arts area is often scheduled for big blocks of time for instruction. Weiss (1993) reports an average of 70 minutes per day is spent on the teaching of reading/language arts

compared to an average of 30 minutes per day spent on science instruction. Elementary teachers defend this amount of time spent in the language arts area as a must for every child to learn how to read; if a child masters the skills of reading he can better read about science. Martin Haberman (1989) argues that this school reading machine has helped to establish mediocrity in our nation's schools.

The problem of finding time for doing science is a glaring and real concern. Children in the elementary schools are being deprived; science can be a viable and valuable way of learning. Stiles (1995) suggests that science is the basis for all activities in our lives; however, science is not emphasized in the elementary classroom (Rowe, 1980). A 1990 National Assessment of Educational Progress (NAEP) survey found that fewer than one-half of the fourth grade students attended schools which gave special priority to science, compared to three-fourths or more who attended schools which gave special attention to mathematics, reading, and writing.

Alexander (cited in Butzow & Butzow, 1989) found that many of the strategies employed in learning to read and learning science are often very similar, e.g. observing, comparing, using time/space relationships, interpreting, communicating, predicting outcomes, making judgments and evaluation. Goodman (1985) believes that language is perfect for a dual curriculum, giving authenticity to writing and speaking. Also, a hands-on, multidisciplinary science program such as Biological Sciences Curriculum Study-Elementary School Sciences Programs (BSCS-ESSP) can enhance skills associated with language arts and listening (Barufaldi & Swift, 1980). A place must be found for an exemplary science program in the elementary classroom. The world has changed in such a way that science literacy has become necessary for everyone, not just the privileged few: science education will have to change to make that possible (AAAS, 1990).

Purpose

The purpose of this paper is to provide a rationale for teaching science in the elementary classroom. This paper will provide a rationale to suggest science and reading as an integrated curriculum.

The problems that this paper will address are:

Do science and reading as a dual curriculum have validity in the elementary classroom?

How can science and reading be integrated effectively in the elementary classroom?

Methodology

To find answers for these questions, in the school year 1994-1995, four inservice meetings at Iowa's Area Five Education Agency in Fort Dodge, Iowa, provided information on the status of science, mathematices and technology in our schools and what plans are in progress to address these areas. Benchmarks (AAAS,1990), also referred to as science standards, is a National Science Teachers Association guide explaining the educational goals that each child should achieve in mathematics, science, and technology at different levels in their education. Along with Benchmarks, the book, Science for All Americans by James Rutherford (published by the American Association for the Advancement of Science, 1995) was given to each participant. As one response to the challenge of reforming science, mathematics, and technology education, the American Association for the Advancement of Science has initiated Project 2061, a long-range, multi-phase effort designed to help the nation achieve scientific literacy (AAAS, 1990). An ERIC search of studies showed many relationships between reading and science to suggest integration. In the search for information the North Central Regional Educational Laboratory Resource Center in Oak Brook, Illinois, was contacted and information received regarding the integration of science and reading.

A Review of the Literature

A Basis for Integrating Science and Reading

In many elementary school science classrooms science equipment can be found stored in a closet or resting on a shelf in the classroom too high to be reached by teachers and students. Bringing the science equipment to the students is not a daily occurrence in most elementary classrooms. Science is often part of the scheduled day of instruction but left until last and the day is over and there has been no time to do science. A 1990 National Assessment of Educational Progress (NAEP) survey indicates that science is not taught frequently in many schools. Twenty-eight percent of the fourth graders reported having science instruction about

once a week or less frequently, and only about one-half reported having science instruction every day (NAEP, 1990). Science may often be treated as an incidental event when a child brings in an insect or an interesting artifact and a science lesson may appear spontaneously.

In addition, the teaching of science may be impeded by teacher anxiety, lack of knowledge, and time. Many elementary teachers have anxiety concerning their knowledge of science and therefore do not feel comfortable teaching it. While two out of three elementary science teachers have the very minimal recommended college course work in science, only 28 per cent feel very well qualified to teach life science (Weiss, 1993). Yager (1987), however, held that those teachers with the least knowledge may be the better science teachers because they also are exploring and discovering and are more willing to allow this process to occur in their classroom.

In 1992, at The University of Iowa, College of Education, one-third of the elementary teaching students chose reading/language arts as a major. Of the remaining students 4% chose a science emphasis (Stiles, 1995). At the University of Northern Iowa, spring, 1995, 7.9% of the elementary education graduates chose science as an emphasis. In the past science has not been emphasized for elementary preservice teachers (Abell & Roth, 1992).

This heavy emphasis on reading in the elementary curriculum (Haberman, 1989), oftentimes is justified by the assumption that learning to read will give the child the key to all other areas of the curriculum. On the contrary, (Haberman, 1989) contends, that this emphasis on reading has not provided the results that would be expected considering its heavy emphasis. Many poor readers have been known to have highly developed skills in such areas as logical thinking. The value of logical thinking, the importance of problem-solving skills, and the significance of perseverance in the face of adversity often go unrecognized in schools where the primary concern is bringing children up to grade level on standardized reading tests (Neuman, 1974).

Another problem is allowing time for the teaching of science. When it is suggested that an elementary teacher expand an existing program, a common response questions where to put it

in the ever expanding curriculum. Even when teachers see and agree with research showing the need and value of an exemplary science program, it is likely that nothing will change. Teachers may be aware of recent research on the teaching of science but opinions about science education are not significantly influenced by contemporary research findings. Rather the influence is established by curriculum frameworks, instructional objectives and assessment programs (Shymansky, Yore & Good, 1991). Another concern of elementary teachers is covering the content. They do see a need and understand the rationale for hands-on problem solving of relevant, everyday science, but might be unwilling to sacrifice content coverage to achieve such goals (Shymansky, Yore & Good, 1991). Weiss (1993), however, asserts that 90% of elementary teachers support hands-on instruction, indicating that activity-based experiences are worth the time and expense for what students learn.

Stiles (1995) asserts that all of the activities in life revolve around science, and yet less than 10% of the school's instructional day is spent on science (Abell & Roth, 1992). Children start out as natural scientists instinctively eager to investigate the world around them (Rowe, 1980). Dewey once stated, "No one has ever explained why children are so full of questions, outside of school "(cited in Neuman, 1974). Elementary science education is a key to the basics because science promotes the development of the thinking skills, learning processes, and positive attitudes required for lifelong learning (Mechling & Oliver, 1983).

The Reading Science Connection

As Alexander (cited in Butzow & Butzow, 1989) stated: the strategies employed in learning to read and learning science are often very similar, e.g. observing, comparing, using time/space relationships, interpreting, communicating, predicting outcomes, making judgments and evaluation. This information suggests that the integration of science and reading should be given serious thought. Skills in science, reading and listening share many commonalities. The inquiry skills of science such as observing, identifying, naming, classifying, predicting, inferring and communicating are similar to those processes and skills inherent in reading and listening (Barufaldi & Swift, 1977). Simon (1980) suggests that science experiences can serve as

motivators, to enhance writing ability. Each discipline could continue to argue for its share of the now bulging school day or its proponents could form a partnership for the benefit of the students and satisfy each subject's goals and objectives. Kovalik and Olsen (1994) contend that science, when used as a beginning point for integration, allows the focus to be on the experienceable world of children and that the real world naturally integrates the sciences. Next, is to integrate the application of (but not the teaching of) the language arts (reading, writing and speaking, listening) with the research skills and mathematics problem-solving skills. This would extend the range and depth of science exploration and it would also increase the amount of time for science.

Ken Goodman (1985) says this about content area integration with whole language:

> If language is learned best and easiest when it is whole and in natural context, then integration is a key principle, for, language development and content become a dual curriculum. For learners it's a single curriculum focusing on what is being learned, maximizing opportunities for pupils to engage in authentic speech and literacy events while they. . . carry out a scientific study. The teacher evaluates both linguistic and cognitive development. Speaking, listening, writing and reading are all happening in context of the exploration of the world of things, events, ideas, and experiences. The content curriculum draws on the interests and experiences children have outside of school, and thus incorporates the full range of oral and written language functions. It becomes a broad, rich curriculum that starts where learners are in language and knowledge and builds out from there (p. 30).

Typically, elementary teachers have used basal reading activities to focus on isolated reading skills. If the emphasis and importance of the reading/language arts curriculum remains the same, could science become the vehicle to teach reading? A year-long study with fourth graders implemented a curriculum strategy that increased the time allocated for in-depth science teaching by replacing the district-adopted basal reading program with science-content-based

instruction that concomitantly facilitated reading comprehension skills (the time allotted for science was 30 minutes per day and the time allotted for language arts was 90 minutes per day). Teachers in both the experimental and the control classrooms taught the same district science and reading/language arts curriculum and used the same science textbook. However, by not using the basal reading series, the experimental-group teachers had far more time to teach science in-depth, even while using science-content-based strategies and materials to teach the reading (and language arts) objectives. District-wide-skills based curriculum objectives were referenced to specific science activities. The study investigated the combined effect of these curricular components (i.e., in-depth science and science-content-based reading instruction) upon student achievement, attitude and self-confidence in both science and reading. The results were astounding! Students in experimental groups performed significantly better in both reading and science (as measured by the Iowa Test of Basic Skills and the Metropolitan Achievement Test) than the control group (Romance & Vitale, 1992).

What student can resist a good adventure with some puzzle to be solved or mystery to be unraveled? The elementary school science classroom is a natural setting for adventure because so much in the immediate environment is a mystery to young students. In the Science, Parents, Activities and Literature (PALs) program students' ideas are used to focus on science enhancement activities. The science activities are combined with a language arts component to capitalize on the power of children's literature and uses parents as partners to promote science in the elementary school curriculum (Shymansky & Dunkhase, 1994). The Science PALs approach has several strengths. By using student ideas about science to focus on enhancement activities, attention is shifted from what teachers don't understand about specific science topics to what their students don't understand. By using language arts and children's literature to pique students' interest and access their ideas, new instructional time for science is gained in combination with language arts in the primary grades. PALs plays to the instructional strengths of the majority of teachers in K-6 (language arts). Shymansky and Dunkhase (1994) also contend that young students need to learn how to think about, work with, and express science ideas through a variety

teachers in K-6 (language arts). Shymansky and Dunkhase (1994) also contend that young students need to learn how to think about, work with, and express science ideas through a variety of language, visual and tactile modes; and they need to do these things early and often. The Mid-California Science Improvement Program uses a science-oriented year-long theme based on a physical location which provides being-there experiences for teaching your curriculum and an agreement among teachers as to what each level will teach. In an evaluation assessing the program's impact on the science achievement Okamoto (cited in Greene, 1991) found that the participating students showed substantial and statistically significant gains.

Integrated Science and Reading

Can a single teacher make a difference in dealing with the deficit that exists in the teaching of elementary school science? An elementary teacher can be a leader in science instruction by demonstrating that it is a priority in the classroom. Penick (1983) states that leadership and commitment are common elements in schools having exemplary science programs.

Project 2061 (AAAS, 1985) is a long term effort of science educators on behalf of all children to help transform the nation's school system so that all students become well educated in science, mathematics and technology. A teacher who is committed to the teaching of reading and also understands and recognizes the need for strengthening science education in the United States might choose to integrate science and reading. Integrated curriculum as expressed by Pappas, Keifer & Levstick (1990) is an organized framework which blends the teaching of listening, speaking, reading and writing with the content areas. Of course integrated curriculum is not a new concept in education. Vars (1991) reports philosophical and psychological antecedents dating back to writings of Herbert Spencer in the 1800s. Dewey (cited in Ryan & Cooper, 1988) felt that science should be integrated with other subjects to show relevance and connections to real-life experiences.

Dedicated teachers of reading need not give up minutes needed to spend on reading instruction but can use a new vehicle (science) with which to teach reading. Merrick and

Crocker (cited in Mishler, 1982) found that perceptual skills and logical thinking played the role of prerequisites in reading. Motivation through concrete experiences helped children in first and third grades expend more effort in reading.

A way to excite a learner about the printed page is to read something in which he has invested his experiences and or his ideas. A student learns to read by reading. Reading does not happen in the abstract; one always reads and comprehends some content (Schmidt, 1985). Science experiences could be the key to unlocking the reluctant reader's door. Kovalik & Olsen (1994) assert that science provides the most powerful context for learning all the other subject areas. Science as a content area provides the playground for exercising all the basic skills. An appreciation of what is learned in real-life situations is built into the curriculum (Kovalik & Olsen, 1994). Some children's unwillingness to participate in ritualized reading lessons becomes confused with their willingness to read (Haberman, 1989). Kovalik and Olsen (1994) state that we could greatly enhance learning--motivation to learn and ability to extract meaning--if we focused our curriculum in subject areas (science) that the brain is already genetically wired to perceive and understand. Neuman (1984) asserts that science can serve as as a vehicle for providing children with unique and highly valuable school experiences, because it appeals to the basic curiosity that youngsters feel about the natural and manmade world around them. Teachers don't have time not to teach science.

Hands-on science and reading.

In some reading classes do we have too many sit down, feet on the floor, written activities which are abstract in nature and very boring while all the fun learning takes place outside of school? Hands-on activity-based learning can enhance both science and reading. If a picture says a thousand words, then a child touching, handling and manipulating objects would be worth much more. Howe & Vasu (1988) conclude that images formed from observation of an object with all its confusing detail will be remembered better than an image constructed from words. It would be helpful to replace the incidental and offhand use of materials and methods that encourage imagery with an effort to encourage the use of imagery in concert with language.

Imagine an elementary student bent over a worksheet trying to guess which word goes in the blank by the process of elimination. Compare this to another student looking at his bean plant through a magnifying glass touching, measuring, and manipulating it; searching his vocabulary bank for words to describe the phenomena that has taken place that week. Hands-on activities allowing students to do science also contribute toward a more effective learning environment for the construction of meaning from written material by providing concrete reference for the learner (Staver & Bay, 1989). Merrick & Crocker (cited in Mishler, 1982) also found that meaningful science activities would provide the basis for purposeful writing and Kishta (cited in Mishler, 1982) found that fourth, fifth and 6th graders who performed Piagetian tasks successfully also scored higher on the language portion of the Iowa Test of Basic Skills (ITBS). Burafaldi and Swift (1980) discovered that a hands-on, multidisciplinary science program could enhance skills associated with language arts and listening. The number of experiences a student has must continuously increase so that the student will have a basis for relating and applying new information (Kovalik & Olsen, 1994).

What is the teacher's role in the science/reading classroom when students are involved in hands-on activities? Penick (1976) found that in a class where students have manipulative materials available to them, a teacher 's interference in the child's naturalistic learning should be minimal. These interferences, as stated by Penick, are: telling students what to do and how to do it, praising, and rejecting/discouraging students' behaviors. More figural creativity was found in students who directed their own learning a majority of the time. Also, when doing hands-on activities, discussion is vital. A child's misconceptions about science cannot be clarified with hands-on science alone. A discussion component must follow every hands-on activity. Discussion time and hands-on time are equally essential to a conceptual change in science when using the predict-observe-explain approach (Woods, 1994). Powell and Hornsby (1993) found that interesting content generates authentic oral language in children.

Writing.

Just after a hands-on science activity, children usually bubble over with enthusiasm. They want to tell others about what they have seen and found out. When children are engaged with interesting content they generate written language. This language is not frills on the edge of the program; it can be the core of the program if the teacher knows how to harness it (Powell & Hornsby, 1993). Donald Graves (1971) states that for many children, writing simply has no connection with everyday events. We need to show children why writing matters in our lives and how we draw writing ideas from everyday events. Graves (1971) calls this reading the world. Simon (1980) suggests that science experiences can serve as motivators, to enhance writing ability. He found that expressing ideas and observations in written form helps students analyze and clarify concepts that need to be communicated clearly. In turn, the mental processes developed through writing clearly helps students observe more astutely and to think more logically about science phenomenon. Kovalik and Olsen (1994) state that the primary purpose of schooling should be to help students understand their world.

Speaking, listening and group learning.

In a science/reading classroom there are opportunities for speaking and listening. Learning is a collaborative effort between teacher and students, between students, between members of the class and the people in the community. The community and the school can provide firsthand, being- there experiences (Kovalik & Olsen, 1994). The team approach would be emphasized and memorizing technical vocabulary is de-emphasized (AAAS, 1990). With the knowledge that all of us can contribute to learning and can do science and reading, students can work in groups to provide academic and social support to each other (Johnson & Johnson, 1986). Students need to be encouraged to share observations or experiences of everyday phenomenon with the class. Using a team approach helps students see that everyone can contribute to the attainment of common goals and that progress does not depend on everyone's having the same abilities (Jones & Steinbrink, 1989). The teacher needs to be a facilitator, equipped with an understanding of how knowledge develops in children. Dillon (cited in Pizzini & Shephardson,

1991) found that the teacher's role is critical in structuring appropriate experiences and asking encouraging and probing kinds of questions. In a science/reading classroom students need to be encouraged to raise questions about the material being studied, and learn to frame questions clearly enough to begin their search for answers. Marzano (cited in Pizzini & Shephardson, 1991) found that students become actively involved in their learning when they formulate and ask questions.

Speaking, sharing and listening are vital in a science/reading classroom. Students should be encouraged to work together, to share ideas and information freely with each other, or to use modern instruments to extend their intellectual capabilities (AAAS, 1990). Weiss (1993) reports that 91% of elementary teachers in grades 1-4 support the idea of having students work in cooperative learning groups for science instruction. Suchman (1977) contends that unstructured observations increase the number of questions that students ask. Watson (1992) found that the number of questions that students ask among themselves (in groups) exceeded the amount asked when directed by the teacher. This suggests there should be less and less of the teacher's interference in the child's learning process. Tischer (1977) revealed that low levels of questioning and explaining on the part of the pupils are negatively correlated to pupil's achievement. The teacher needs to create situations where the spirit of peer questioning prevails. Parker (1985) found that when students work together in small co-operative groups, their problem solving skills are enhanced, social relationships improve, and they have more positive attitudes towards school. Students are often able to translate the teacher's language into "kid" language for one another; this is, however, possible only within groups. According to Watson (1992), a student who explains to another learns by doing; this is similar to how teachers learn by teaching.

Conclusions

Teachers will find it hard to give up the minutes spent on reading instruction to make room for an exemplary science program. But must they? Discovering a new vehicle (science) with which to teach reading will not be giving up reading instruction but gaining science

instruction time. There is no doubt that science instruction time is needed in the elementary schools (AAAS, 1990; Abell & Roth, 1992; NAEP, 1990; Rowe, 1980; Weiss, 1993).

When reading is taught separately, science is not necessarily a part of the lesson. But when science is taught, it usually involves reading. Rather than teach reading and then science, it makes more sense to teach science, incorporating reading, from the beginning (Stiles, 1995). Many of the strategies in learning to read and learning science are often similar (Alexander, 1985; Burafaldi & Swift, 1980; Mechling and Oliver, 1983; Simon, 1980).

The Science PALs Program (Shymansky & Dunkhase, 1994) helps teachers gain confidence in science plus piques children's curiosity about science to read about it. The Mid-California Science Improvement program uses science as a logical choice for integration to show relevance and connections to real-life experiences (Kovalik & Olsen, 1994). Romance and Vitale (1992) suggest that district-wide language arts skills can be referenced to specific science activities to benefit both science and reading objectives.

Dewey (cited in Ryan & Cooper, 1988) believed that science can and should be integrated to show relevance and connection for real-life experiences. Goodman (1985) contends that language is learned best and easiest when it is whole and in natural context. Students cannot learn to think critically, analyze information, communicate scientific ideas, make logical arguments, work as part of a team, and acquire other desirable skills unless they are permitted and encouraged to do these things over and over in many contexts (AAAS, 1990).

Most Americans are not science-literate (AAAS, 1990). Writing this paper has created an opportunity to develop a rationale about what is valuable for students in the elementary classroom. Changes are not easy to make. They come about very slowly. Changing old habits is hard. The first step is wanting to change, not for the sake of change but because of the realization that what is being done will improve the learning that takes place in the classroom.

Recommendations

One need not be intimidated by volumes of science objectives plus language arts skills to teach simultaneously. Schools do not need to be asked to teach more and more content, but to

teach less in order to teach it better. The problem for curriculum developers, therefore, is much less what to add than what to eliminate (AAAS, 1994).

The teacher is instrumental in carrying through with a science/reading integrated curriculum. Elementary teachers are fully aware of the fact that they are not involved in an exemplary science program but are doing nothing about it but experiencing pangs of guilt. Ninety-nine per cent of elementary teachers believe science is best taught by hands-on activities and that it should have application in real-life (Weiss, 1993). What then is the problem? Weiss (1993) concludes that lack of content preparation, inadequate facilities and equipment, plus lack of money to purchase consumable supplies are barriers for teachers.

The Science PALs program (Shymansky & Dunkhase, 1994) builds its program on the strong reading/language arts background of the teacher and enables the teachers to learn through the students. Programs such as these need to be followed closely.

Without a science-literate population, the outlook for a better world is not promising (AAAS, 1994). We need to find a way to include a hands-on exemplary science program in the elementary classroom. Integrating science and reading may be a way to do it.

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