ED 387 327 SE 056 645

AUTHOR Rice, Diana C.; Corboy, Margaret R.

TITLE Elementary Science Instruction: Are Teachers Prepared To Teach What Their Students Must Master?

PUB DATE Apr 95

NOTE 13p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (San Francisco, CA, April 22-25, 1995).

PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.

DESCRIPTORS Elementary Education; *Elementary School Science; Higher Education; *Preservice Teacher Education; *Science Instruction; *Science Teachers; *Scientific Concepts

ABSTRACT

Research findings indicate that the elementary school is the most effective level for intervention leading to improved attitudes, higher achievement, and increased access in science. Yet, deficiencies in elementary teachers' interest in science, in their confidence in their ability to teach science, and in their pedagogical and content preparation present obstacles to such intervention. The objectives of this study were: to explore the knowledge of a group of preservice (N = 109) and inservice (N = 57) elementary teachers on a set of sample items from the South Carolina Basic Skills Assessment Program (BSAP) Science Test and to identify variables related to scores on these items. The study identified two variables significantly affecting performance on the BSAP questions: type of education major and developmental level. Results showed that those participants characterized as "formal" thinkers scored significantly higher on the BSAP items than the "transitional" thinkers who, in turn, scored significantly higher than the concrete thinkers. Also, the secondary education majors scored significantly higher on the measure of content knowledge as well as on the measure of developmental level than did elementary or early childhood majors. Contains 17 references. (JRH)

Elementary Science Instruction: Are Teachers Prepared to Teach What Their Students Must Master?

Diana C. Rice

and

Margaret R. Corboy

School of Education
University of South Carolina-Aiken
Aiken, South Carolina 29801

Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, San Francisco, CA, April 22-25, 1995

Background.

The many problems plaguing science education in the United States are well documented. Results of a number of studies show American students lagging behind students in many other nations in science and math achievement (Linn, 1987; International Association for the Evaluation of Educational Achievement, 1988). In general, students' interest in science and science-related careers declines between ages 9 and 17 (Johnson & Johnson, 1982), and this is trend is particularly strong for girls (Kahle & Lakes, 1983). Women and minorities continue to be underrepresented in science and science-related careers and, despite interventions, African-Americans and Hispanics score below the national norm on science and mathematics achievement tests (Beane, 1988).

In South Carolina, the need for good science instruction parallels or exceeds the need demonstrated so clearly at the national level. Data from the Basic Skills Assessment Program, the mandated statewide testing program, indicate that 45% of students in grades 3, 6, 8 failed to meet minimum standards in science (South Carolina State Department of Education, 1993)).

Objectives and Significance.

The importance of quality K-12 science education cannot be underestimated. The experience in elementary science classes is of particular concern. Research findings indicate that the elementary school is the most effective level for intervention leading to improved attitudes, higher achievement and increased access in science (Beane, 1988). Yet, deficiencies in elementary teachers' interest in science, in their confidence in their ability to teach science, and in their pedagogical and content preparation present obstacles to such intervention (Jungwirth, 1994; Melchat, 1993; Sherwood & Gabel, 1980). "Poor preservice teacher preparation is often cited as a prime contributor" to these problems (NSTA, 1983, p.65).

Over twenty years ago, Bryant (in Blosser & Howe, 1969) found evidence that there were "discrepancies between what children are expected to learn in science and the science education of preservice teachers to prepare them to facilitate this learning" (p. 56). Has the situation changed, at least in South Carolina? Are future elementary teachers acquiring the content and pedagogical content knowledge necessary to teach elementary students the content and skills prescribed by state curriculum and which will allow them to compete nationally and internationally?

A recent study involving a group of elementary education majors at a 4 year institution in South Carolina indicated that these students did not feel adequately prepared in science content (Rice & Roychoudhury, 1994). Though they had completed their science content requirements and the science methods course, over half indicated that they felt that their preparation in science content was inadequate. Their remarks also supported the contention that there is a strong link between levels of teachers' confidence in their ability to teach science and the degree to which they feel they understand science content (Abell, 1990; Rice & Roychoudhury, 1994)).

If one applies the logic prescribed by recent trends toward "authentic" assessment to the preparation of elementary teachers, it would seem logical that, at a bare minimum, curricular goals for elementary teacher preparation should meet the standards for science content and processes to which the state holds its elementary students accountable. What do preservice teachers know relative to what their students will need to know?

The objectives of this study were (1) to explore the knowledge of a group of preservice elementary teachers of a set of sample items from the South Carolina Basic Skills Assessment Program (BSAP) Science Test; (2) to identify variables related to scores on these items.

Participants.

Two student cohort groups at a 4-year institution in South Carolina participated in the study: 35 students enrolled in one of the pre-professional education courses (PP) and 74 student teachers who had completed coursework (including science methods and 12 hours of laboratory science (ST). In addition, a sample of 57 inservice teachers from an area elementary school (IT) provided another contrast with the student teachers.

Methods.

A 27-item instrument was developed which included nine sample items included in the BSAP Science tests administered to school children in grades 3, 6, and 8 during Spring, 1992. These items reflect content and science process skills which South Carolina students in these grades are expected to have mastered. A "BSAP" score of 0-9 was therefore possible. The other items included in the instrument constituted a measure of formal reasoning ability, the Test of Logical Thinking (TOLT) (Tobin & Capie, 1981). Tolt scores of 0-1 represent concrete reasoning ability; 2-3, transitional; and 4 or more, formal reasoning. The TOLT has an internal consistency coefficient of 0.85 (Roadrangka & Yeany, 1985). Reliability of TOLT for a similar group of preservice elementary teachers was 0.74 (Rice, 1990).

Demographic data such as age, education major, number of science courses taken, grades taught, and years of teaching experience were also collected.

Results.

The following designations are used to identify groups of students or teachers: IT=Inservice Teachers; ST=Student Teachers; PP=Students in preprofessional course; EE=Elementary or Early Childhood major; SE=Secondary Education Major; OE=Other Education majors such as special education, art or music. Tables 1-4 summarize some of the descriptive data obtained in the study. Comparisons were made utilizing analysis of variance. Scheffe post-hoc tests were used to identify sources of difference for multiple comparisons. Those comparisons which indicated significant differences are described below.

TOLT:

1. IT > PP and ST ($F=4.20$), $p < 0.05$
2. SE>EE and OE ($F=6.20$), $p < 0.01$

BSAP:

1. PP>ST sig. ($F=6.18$), $p < 0.01$
2. SE>EE sig. ($F=6.22$), $p < 0.01$
3. Formal>Transitional>Concrete sig. ($F=9.78$), $p < 0.01$

No other comparisons of BSAP and TOLT scores relative to these groups were significant. Correlation between BSAP and number of science courses taken was not significant.

Discussion.

In general, all study participants performed reasonably well on the nine BSAP items. Only the preprofessional students scored significantly higher on the

BSAP items than student teachers (see Table 1). This result is perhaps because the former have, in general, had more recent exposure in high school and college science courses than the student teachers who were completing their college studies. Secondary education majors scored significantly higher than elementary and early childhood majors on the BSAP items.

As one might expect, the older inservice teachers exhibit higher reasoning levels (Tables 1 & 3). Still, some 42% of student teachers and about 35% of the inservice teachers were below formal operational level. Results (Table 3) support earlier findings that many college students have not achieved formal operations (Anderson & Mitchener, 1994).

Of particular interest is the finding of a strong relationship between reasoning ability and BSAP scores (Table 5). When this relationship is considered in concert with the high number of non-formal thinkers identified in the study, there is some reason for concern given that formal reasoning has been found to be related to "preservice teachers' achievement, aptitude, attitude and knowledge of science processes (Anderson & Mitchener, 1994). This problem seems particularly important for preservice elementary teacher education as TOLT scores for elementary and early childhood majors were significantly lower than for secondary education majors.

Certification of elementary teachers in South Carolina requires three laboratory science courses, representing both biological and physical sciences. In this study, the number of science courses taken was not significantly related to BSAP success. This result implies that the number of science courses may not be a factor related to content knowledge. Examination of the preservice teachers' applications for graduation indicated that 42% of the group had taken courses in three areas of science; 27% had taken courses in biology and geology only; 34% had had at least one chemistry course; and 19% had completed a course in physical science. Perhaps there is a need for a closer examination of the range of science courses taken and of the depth and breadth of the content of these courses, rather than an increase in number of science courses required.

Conclusions.

The inferences drawn from this study are limited to the groups participating in the study. However, other researchers and science educators might benefit from knowledge of the results, particularly given that questions persist about the success of elementary education programs in their preparation of effective elementary science teachers.

The results of the study raise no serious concerns about the performance of the preservice or inservice teachers on the BSAP items, material which elementary students are expected to master. The study did identify two variables significantly affecting performance on the nine BSAP questions: type of education major and developmental level. Results showed that for all participants in the study, those characterized as "formal" thinkers scored significantly higher on the BSAP items than did the "transitional" thinkers who, in turn, scored significantly higher than the concrete thinkers on these elementary science items (see Table 5). In this study, secondary education majors scored significantly higher on the measure of content knowledge (BSAP) as well as on the measure of developmental level

(TOLT) than did elementary or early childhood majors.

If we expect our children to learn science and to develop better attitudes toward science, they must be taught by teachers who exhibit an understanding of science concepts and positive attitudes toward science. Given the relationship between formal reasoning ability and the science achievement and attitude of preservice elementary teachers described by Anderson and Mitchener (1994), the results of this study would encourage elementary teacher education programs to be very deliberate in their establishment of standards. The study suggests that if we are to improve the quality of elementary science instruction preservice elementary teachers capable of high-level reasoning should be recruited and nurtured.

TABLE 1: Means (S.D.) -- Selected Variables

	N	TOLT	BSAP	#Science Courses
IT	57	5.0 (1.0)	7.7 (1.0)	5.6 (4.9)
ST	74	3.9 (2.3)	7.1 (1.2)	3.3 (1.7)
PP	35	3.9 (2.9)	7.7 (2.9)	1.8 (1.2)

TABLE 2: Means (S.D.) BSAP and TOLT by Education Major

	N	BSAP	TOLT
EE	120	7.3 (1.1)	4.06 (2.5)
SE	20	8.3 (0.8)	6.09 (2.2)
OE	23	7.5 (1.2)	3.99 (2.3)

TABLE 3: Developmental Levels --Frequencies (%)

	N	Concrete	Trans.	Formal
IT	57	1(1.8)	19(33.3)	37(64.9)
ST	74	11(14.8)	20(27.0)	43(58.2)
PP	35	8(22.9)	10(28.6)	17(48.6)

TABLE 4: BSAP Scores -- Frequencies (%)

	N	4	5	6	7	8	9
IT	57			10(17.5)	10(17.5)	22(38.6)	15(26.3)
ST	74	7(1.4)	7(9.5)	14(18.9)	19(25.7)	24(32.4)	9(12.1)
PP	35		1(2.9)	4(11.4)	7(20.0)	14(40.0)	9(25.7)

TABLE 5: BSAP (S.D.) by Developmental Level

	N	BSAP
Concrete	20	6.7 (1.4)
Transitional	49	7.2 (1.4)
Formal	97	7.8 (1.1)

References

Abell, S.K. (1990). A case for the elementary science specialist. School Science and Mathematics, 90(4), 291-301.

Anderson, R. & Mitchener, C. (1994). Research on science teacher education. In D. Gabel (Ed.), Handbook of Research on Science Teaching and Learning. New York, NY: National Science Teachers' Association.

Beane, D.B. (1988). Mathematics and science: Critical filters for the future of minority students. Washington, DC: The Mid-Atlantic Equity Center, The American University.

Blosser, P. & Howe, R. (1969). An analysis of research on elementary teacher education related to the teaching of science. Science and Children. January/February, 50-60.

International Association for the Evaluation of Educational Achievement. (1988). Science achievement in seventeen countries: A preliminary report. Oxford, England: Pergamon Press.

Johnson, R. & Johnson, D. (1982). What research says about student-student interaction in science classrooms. In M. Rowe (Ed.), Education in the 80's: Science. Washington, DC: National Science Teachers Association.

Jungwirth, E. (1994). Science teachers as uncritical consumers of invalid conclusions: Incompetence or just poor performance? Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, Anaheim, CA, March 26-29.

Kahle, J.B. & Lakes, M.K. (1983). The myth of equality in science classrooms. Journal of Research in Science Teaching, 20, 131-140.

Linn, M. (1987). Establishing a research base for science education: Challenges, trends, and recommendations. Journal of Research in Science Teaching, 24, 191-216.

Melchat, S. (1993). Identification of informed, partially informed, misinformed and uninformed conceptual science knowledge of rural idaho elementary teachers. Doctoral dissertation, University of Idaho, Moscow, ID.

National Science Teachers Association (1983). Science preparation for preservice elementary teachers. Science and Children. September, 65-70.

Rice, D.C. (1990) Cooperative learning in a college laboratory science course for preservice elementary teachers (Doctoral dissertation, Indiana University, 1989). Dissertation Abstracts International, #9030392.

Rice, D.C. & Roychoudhury, A. (1994). An exploratory study of how one science educator contributes to preservice elementary teachers' confidence in their science teaching abilities. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, Anaheim, CA, March 26-29.

Roadrangka, V. & Yeany, R. (1985). A study of the relationship among type and quality of implementation of science teaching strategy, student formal reasoning ability, and student engagement. Journal of Research in Science Teaching, 22(8), 743-760.

Sherwood, R. & Gabel, D. (1980). Basic science skills for prospective elementary teachers: measuring and predicting success. Science Education, 64(8), 749-778.

South Carolina State Department of Education (1993). Report of BSAP results for 1993.

Tobin, K. & Capie, W. (1981). The development and validation of a group test of logical thinking. Educational and Psychological Measurement, 41(2), 413-423.

* Sample BSAP Items

OBJECTIVE: Science Process Skills
SUBSKILL: Integrated Science Process Skills

GRADE: 6

Some students thought that the amount of moisture in the air affects how fast something dries. Each day, the students measured the moisture in the air. Then, they wet a paper towel and measured how long it took to dry.

Which **hypothesis** did the students investigate?

(A) Paper towels dry faster when the size of the towel is smaller.

(B) Paper towels dry faster when there is more water in the towel.

(C) Paper towels dry faster when there is less moisture in the air.

(D) Paper towels dry faster when the temperature of the air is higher.

OBJECTIVE: Nature of Science
SUBSKILL: Nature of Science

GRADE: 8

Mark is drawing diagrams to show a salt marsh ecosystem. He is trying to explain the cycling of food through the marsh.

Which of the following **best** describes what Mark is doing?

(A) gathering evidence to answer questions about an ecosystem

(B) doing an experiment to investigate an ecosystem

(C) developing a theory to describe an ecosystem

(D) making a model to represent an ecosystem

* South Carolina State Department of Education