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Science Interest and Confidence Among Preservice Elementary Teachers

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Abstract

Research on science teaching in the elementary school indicates that science is often taught "little and poorly" by teachers who lack confidence in their subject matter. The purposes of this study of prospective teachers were to (1) examine the effect of elementary, high school, and college science experiences as well as informal science (play, museums, and hobbies) on interest in science and confidence in teaching science and (2) determine the effect of an inquiry-based science methods course on interest and confidence. The subjects were three groups of students in an initial certification master's program who were studied during a field-based science methods course. Their own experience with science when they were in elementary school, followed by informal experiences and high school experience, predicted initial interest in science. Elementary school experience, followed by the number of science courses taken in college, predicted initial confidence. The inquiry-based science methods course increased both interest and confidence.

At a time when national reform focuses on science for all children (Rutherford & Algren, 1990), it is disturbing that very little science is taught in the elementary school (Silvertsen, 1993). What little science is taught is done so primarily through lecture and textbooks rather than through exploration and experimentation (Weiss, 1994). Many teachers are neither interested in science nor confident in teaching science. A 1993 survey of elementary teachers indicated that 76% felt competent to teach reading/language arts, while only 28% felt competent to teach science. Although 99% of the respondents asserted that hands-on/manipulative activities should be an important aspect of science instruction, about 25% felt "less than well-prepared to use textbooks as a resource rather than as the primary instructional tool" (p. 9).

Many teachers avoid inquiry science because their own experiences did not stimulate their interest in science. The effect of poor science preparation in school on current teaching of science was described by Hawkins (1990) as "a loop in history by which some children grow to be teachers, taught science little and poorly, they teach little and poorly" (p. 97). Research with a previous generation of prospective teachers found that lack of interest in science was the primary reason given by elementary education majors for not electing to take science in college (Soy, 1967). Perkes (1975) found that decisions on how much science to take in high school and college and "sensed adequacy" to teach science were shaped in a vicious circle by prospective teachers' prior associations and experiences with science. If each generation of teachers is shaped by previous experience with science, less than adequate teachers may be powerful role models for the next generation of teachers.

Research on interest suggests that: (1) "interest is a phenomenon that emerges from an individual's interaction with his or her environment" (Krapp, Hidi, & Renninger, 1992, p. 5), (2) interest is an enduring "disposition" (p. 7), and (3) interest motivates behavior (Deci, 1992). If the above connections are accurate, the following might be said about interest in science. Science interest can be developed through interaction with fascinating phenomena. Once an interest in science is developed, people voluntarily seek out additional scientific information and science related experiences, thus further deepening science interest. Teachers who enjoy and appreciate science are motivated to do science with their children. If this hypothesized connection between interest and action is accurate, a key to the effective science education of children may be to ensure that those who teach science are interested in science. Interest may be critical if teachers are to stimulate children's curiosity, foster and preserve a sense of wonder in children (Latham, 1996), capture teachable moments, and ask probing questions.

Confidence, a self-assuredness that arises out of competence in subject matter, knowledge of young children, and practice in "what works," is also important. According to McDiarmid, Ball, and Anderson (1989), "considerable evidence suggests that many prospective teachers, both elementary and secondary, do not understand their subjects in depth" (p. 199). Grossman, Wilson, and Shulman (1989) suggest that weakness in science content can undermine the confidence of the teacher, causing him or her to avoid teaching science or to teach it strictly from the textbook. Unfortunately, according to Reynolds (1995), "beginning teachers often do not know the subject in ways that allow them to teach it" (p. 216), causing the learner to be shortchanged. Over-reliance on lecture and textbooks may reflect a lack of confidence in the use of inquiry approaches, which stimulate children to ask questions and which may require special attention to classroom management. Bird and Weller (1997) referred to teachers' "own sense of personal and professional fragility" that promoted worries "that they didn't know enough science to anticipate where students' questions might lead, that they did not possess the management skills to organize and conduct successful lessons, that they were too ignorant or inarticulate to counter challenges" (p. 9).

Teacher preparation programs which model the way teachers are encouraged to teach science (Glass, Aiuto, & Andersen, 1993: Stake, Raths, St. John, Trumbull, Foster, Sullivan, & Jennesse, 1993) and which give students strategies for identifying and mastering content knowledge (Smith & Lloyd, 1997) may be a way to break the loop in which insecure teachers who do not like science prepare the next generation of teachers. According to the *National Science Education Standards* (NRC, 1996), "If reform is to be accomplished, professional development must include experiences that engage prospective and practicing teachers in active learning that builds their knowledge, understanding, and ability" (p. 56). Teacher education programs should provide preservice teachers with hands-on experiences that promote positive attitudes toward science (Marcuccio & Marshal, 1993) and demonstrate that curiosity is the basis of science (Bunce, 1995/1996).

The present research was designed to study childhood and young adult influences on the initial interest and confidence of prospective elementary teachers and to evaluate the effect of a science methods course on enhancing that interest and confidence. Specifically, the purpose of this study was to answer the following research questions:

- What background experiences predict initial interest in science and confidence in teaching science?
- Do students increase in interest and confidence during the course?
- How are background experiences, interest, and confidence related at the end of the course?

Method

The research was conducted over a three-year period. Subjects were students in a field-based science methods course at a southern university. The course is required for students in an initial certification master's program designed for people with bachelor's degrees in fields other than education. The subjects in this research were 112 students who completed the program from 1995 through 1997. While taking the course, the students were in ten-week K-5 field placements: the 1995 group was placed in classrooms four days a week; the 1996 and 1997 groups were placed in classrooms three days a week. These field experiences were in a variety of school settings: urban, suburban, and multicultural. Most of the supervising teachers were selected by their schools. Generally, they were seasoned teachers who either volunteered or were requested by their principals to supervise students. They might have been chosen because of their excellence or merely because it was their turn to have a student teacher. A subset of urban teachers was selected by the university in collaboration with the school system because of their effectiveness in high-poverty schools.

According to the course syllabus, the course was designed "to teach science content and inquiry methods in such a way that those teaching children K-5 will feel confident, skilled, and motivated to integrate inquiry science into the curriculum." The number of class hours varied from year to year but averaged at about 45 hours. The course was designed to (1) provide participants with content information on science topics relevant to their teaching; (2) model developmentally appropriate inquiry teaching methods as recommended by the *National Science Education Standards;* (3) model methods of integrating science with other areas of the curriculum; and (4) introduce students to the materials and resources of science, where to obtain them, and how to use them. A variety of instructional strategies were employed including the following: modeling, lecture/discussion, videotapes of classrooms doing hands-on science, labs, projects, centers, field trips, use of dialogue journals, experience with computer software, and collaboration with peers. Mini-lectures on such topics as implications of child development theories, assessment, science standards, and women and minorities in science were interspersed throughout the course. The majority of the class time was spent doing hands-on activities designed to model good inquiry teaching, clarify important concepts and scientific processes, and spark the interest of the prospective teachers. Consistent with the constructivist philosophy of the professor, hands-on experiences varied somewhat from quarter to quarter, based on the interest of the students. Topics which were always included were science processes (observing, classifying, communicating, predicting, drawing inferences, and experimenting), electricity and magnetism, light and color, air pressure and flight, living things, inventions, and design technology. Class experiences included data collection using instruments (such as thermometers, balances, stopwatches, sound level meters, and rulers), field trips, discovery with an electricity and magnetism kit, design of paper helicopters and aluminum foil boats, cooking experiences, a creek study, and centers about trees. Students were shown ways to increase their content knowledge through experimentation, use of the Internet, and readings from text material and children's literature. Where possible, real materials rather than simulations, were employed. For example, in studying the food chain, students dissected owl pellets and fed mealworms to a toad. More detailed descriptions of the class activities are found in Jarrett (1996, 1998).

Students were expected to carry out the following assignments in their field placements: (1) set up two discovery centers; (2) do at least five activities with their children, including a simple controlled experiment, a design-technology activity, a lesson with living things, and an adaptation from a textbook lesson; (3) have the children keep science journals; and (4) produce a parent newsletter with the children based on their science journal entries. Due to differences in classroom requirements and the interests of the supervising teacher, some students had difficulty completing the assignments while others were able to do more science teaching than required.

In a survey they filled out at the beginning and end of the quarter, all students were asked to rate their interest in science on a five-point Likert Scale. Specifically, they were asked the following question:

What is your overall interest in science?
(low) 1 - 2 - 3 - 4 - 5 (high)

Students completing the program in 1996 and 1997 were also asked to rate their confidence in teaching science on a five-point Likert Scale. Specifically, they were asked,

Are you confident in your overall ability to teach science?
(not very) 1 - 2 - 3 - 4 - 5 (very)

To measure test-retest consistency, 24 students, similar to those in the study, were asked these same two questions twice, ten weeks apart, while student teaching. On both "interest" and "confidence," 71% of the students gave identical answers both times. The other 29% varied their answers by not more than one point (higher or lower).

The subjects in the study also answered the following questions about their science background:

- List science college courses taken.
- What did you think about how your elementary school science teacher(s) taught science?
- What did you think about how your high school science teacher(s) taught science?
- What did you enjoy most about science when you were in elementary school?
- What did you enjoy most about science when you were in high school?
- Did you have science-related hobbies as a child (such as rock or insect collecting)? Describe.
- Did you play with scientific toys as a child (such as Legos, chemistry sets, erector sets, etc.)? Describe.
- Can you remember science experiences you had as a child outside of school (such as visits to science museums, nature hikes with your family, etc.)? Describe.

In answer to the questions about elementary school science experiences, the responses were coded as "1," at least partially positive; or "0," if they made a negative comment ("boring") or could remember nothing. High school experiences were coded as "0," mainly negative; "1," partially positive; or "2," enthusiastic. Answers to questions about childhood hobbies, science toys, and field trips were combined into one variable, "informal experience," which was coded on a three-point scale. The percentage of agreement between the primary coder and an assistant who was unaware of the respondents' other scores was 96% for elementary school experience, 87% for high school experience, and 83% for informal experience. The number of university science courses taken was coded on a three-point scale: no courses (0), one or two courses (1), and three or more courses (2).

Results

All of the following analyses were computed using SPSS for Windows 6.1.

Predictive Value of Background Experiences of Students

Percentages were calculated to describe the background experiences of the students. In answer to the questions about elementary school science experiences, 37% of the responses were at least partially positive whereas 63% of the students felt negative ("boring") or could remember nothing. High school experiences were coded as mainly negative (32%), partially positive (31%), or enthusiastic (37%). In answer to questions about childhood hobbies, science toys, and field trips, 11% had almost no informal science experience, 30% had moderate experience, and 59% responded enthusiastically about science hobbies, toys, and field trips. Eighteen students (16%) had taken no science courses in college, 54 students (49%) had taken only one or two courses, and 37 students (33%) had taken three or more courses. Five students (5%) had majors or minors in a science related field.

At the beginning of the quarter, there was a relationship between students' ratings of their interest and their ratings of their confidence, $\underline{r}$ (71) = .23, $\underline{p}$ = .05. To determine the predictive value of previous science experiences on these two variables, two multiple regression equations were computed, using interest in science at the beginning of the course and science teaching confidence at the beginning of the course as the dependent variables. The predictor variables were (1) elementary school experience, (2) high school experience, (3) courses taken in college, and (4) informal science experiences.

The best predictor of interest in science was a positive experience with science in elementary school, although high school experience and informal science experience also contributed significantly. Number of college courses did not enter the equation because the strong relationship between courses and interest were accounted for by the other variables.

The best predictor of confidence was experience in elementary school followed by the number of science courses taken in college. High school and informal experiences did not contribute significantly to confidence. Table 1 presents the summary of both analyses, with the correlations among the variables presented in Table 2.

Change in Interest and Confidence Ratings

In order to ascertain whether student interest and confidence increased during the quarter, paired sample *t*-tests were computed. In the first analysis, students' self-ratings of their interest at the beginning of the quarter were compared with their self-ratings at the end of the quarter. In the second analysis, their beginning of

Table 1
Summary of Simultaneous Regression Analyses for Variables Predicting Initial Interest in *Science and Initial Confidence in Teaching Science* (N = 67)

Variable	B	SE B	Beta
Initial interest in science			
Elementary school experience	.48	.17	.30**
Informal science experience	.31	.12	.27*
High school experience	.24	.10	.27*
Number of college science courses	.17	.11	.17
Initial confidence in teaching science			
Elementary school experience	.69	.23	.36**
Number of college science courses	.40	.16	.31*
Informal science experience	–.21	.17	–.15
High school experience	–.01	.13	-.02

Note: R^2 = .31 for initial interest and R^2 = .18 for initial confidence.

*p < .05
**P < .01

Table 2
Intercorrelations Between Background Variables and Initial Interest in Science and Confidence in Teaching Science

	1	2	3	4	5	6
Confidence in teaching science	—					
Interest in science	.23*	—				
Elementary school science experience	.24*	.35***	—			
High school science experience	.04	.27**	.10	—		
College science courses	.24*	.26*	-.10	.04	—	
Informal science experience as a child	-.04	.37***	.19	-.06	.21	—

Note: N between interest and number of college science courses was 109. Other "N"s ranged from 68-71.

*p < .05
**p < .01
***p < .005

the quarter and end of the quarter self-ratings of their confidence were compared. Students increased their interest in science, t (107) = 6.40, p < .001, and their confidence in teaching science, t (66) = 7.54, p < .001. Table 3 presents the means for interest and confidence. The results indicated that the experience of the quarter had a highly significant effect on the students.

Relationship Among Variables at the End of the Quarter

After completion of the science methods class, the correlation between interest and confidence was highly significant, r (67) = .38, p < .001. The other significant correlation at the end of the quarter, that between university science courses and interest, r (106) = .27, p < .005, remained similar to the correlation at the beginning of the quarter. At the end of the quarter, there was no longer a significant correlation between confidence and the number of courses taken or between other background experiences and interest and confidence. A matrix of correlations at the end of the course is found in Table 4.

Discussion

The finding that elementary school science experience is a strong predictor of both interest in science and confidence in teaching science supports the pessimistic view that future teachers who were taught "little and poorly" as children become teachers who teach "little and poorly" (Hawkins, 1990. p. 97). A good elementary school experience appears to be very important not only in fostering later interest in science but also in providing models for good teaching which enhance prospective teachers' confidence that they also can teach well. For some children, informal experiences such as collecting bugs or rocks; playing with Legos, chemistry sets, and microscopes; and taking nature walks and visiting science museums may counter a negative school experience. For children without those advantages, science taught "little and poorly" in elementary school may have an adverse effect on their later science interest, curiosity, and confidence in their ability to understand and teach science.

To counteract the low interest and confidence of many prospective teachers, science methods courses need to find ways to inspire their students, especially those

Table 3
Change in Attitude from Beginning to End of Science Methods Course

	n	Beginning of Course	End of Course
Interest in science	108		
M		3.69	4.27
SD		.84	.73
Confidence in teaching science	68		
M		3.39	4.08
SD		1.00	.68

Note: Five-point Likert scale: The higher the number is, the more interest or confidence.

Table 4
Intercorrelations Between Background Variables and Interest in Science and Confidence in Teaching Science at the End of the Course.

	1	2	3	4	5	6
Confidence in Teaching Science	—					
Interest in Science	.38**	—				
Elementary School Science Experience	.15	-.05	—			
High School Science Experience	.16	-.01	.10	—		
College science courses	.22	.27*	-.10	.04	—	
Informal Science Experience as a child	-.01	.02	.19	-.06	.20	—

Note: N between interest and number of college courses was 106. Other "N"s ranged from 65-71.

* $p = .005$
**$p = .001$

with poor science backgrounds, and give them knowledge and skills to build their confidence in teaching science. The present research shows that interest and confidence are related, and that both can be increased through a hands-on field-based methods class. Confidence in teaching science increased even for those students who had taken no science courses in college. The pattern of correlations at the end of the course suggests that interest and confidence remain closely related but that interest is no longer dependent on early childhood and school experiences and that confidence is no longer dependent on number of science courses taken in college. The continued correlation between interest in science and number of college science courses probably reflects the enduring interest in science that induced some students to take science courses in college.

In the science methods course discussed here, prospective teachers learned ways to increase their content knowledge. They also learned that there were many things they could discover along with the children. Hopefully, an increase in *competence* accompanies the increase in *confidence*. Those teachers with poor science backgrounds, who have become more confident in providing interesting and challenging science learning experiences for children, still need to find ways to improve their content knowledge. Further research should examine whether teachers continue to educate themselves, and, if so, what strategies they use to further their scientific understandings.

Follow-up research is needed on the long-term effects of science methods courses which capture the interest of teachers. Is the increased interest in science sustained? Do the positive effects last over the first, second, and third year of teaching as evidenced by more inquiry teaching, less reliance on the text as a cookbook, and the assumption of science-related leadership positions in school and after-school programs? Does teacher interest and confidence promote student interest and achievement? If these links are found, the key to science education reform may be the development of teacher interest.

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