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Year-long In-service Science Workshop: Changing Attitudes of Elementary Teachers Toward Science and Science Teaching

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The effect of a year-long in-service workshop on elementary teachers' attitudes toward science and science teaching was investigated. The twenty-six item Science Attitude Scale for In-Service Elementary Teacher II was administered to the 33 teachers (32 females and 1 male) as pre and post measures of attitude toward science and science teaching. All participants attended at least forty-one and a half hours of workshops and fieldtrips. The in-service teachers and university professors collaborated on the selection of workshop topics which correlated with the state science skills objectives. In addition to workshop and field trip participation, each in-service teacher was required to complete either a Unit Box or twenty experiments/activities. The year-long in-service workshop had a significant positive effect in reducing apprehension toward science and in increasing the participants' attitudes toward using science equipment, doing scientific laboratory work, and discussing science topics.

INTRODUCTION

High school science enrollment, especially in the physical sciences, has declined [4, 12, 17]. Few females and minorities major in science [17]. Many elementary teachers are women [17], but often they do not feel qualified to teach science [2]. Goodlad [8] reported that elementary students ranked science as fifth of six subject choices in interest and junior and senior high students ranked it as seventh of eight subject choices. Approximately half of the nine year old students surveyed in the 1976 National Assessment of Educational Progress identified science as their least preferred subject [13]. About one-third of all students dislike science by third grade and only one-fifth enjoy science by the end of the fifth grade [10]. An important related factor is the development of science anxiety or negative attitudes toward science [16, 17], which Mallow claimed cannot be eliminated by increased mandated requirements in science for high school graduation [17].

Koballa and Crawley [14] identified parents, teachers, and peers as social interaction sources for fostering students' attitudes toward science. Emotional intensity [25] or attitude toward science and science teaching influences the teaching of science, (*i.e.*, whether it is taught, how it is taught, and how much it is taught) [7, 9, 14, 18, 21, 22, 24, 26]. Negative attitudes toward science and science teaching can be changed by fostering positive attitudes in students of either gender as a result of success in science process skills and manipulation of science equipment from kindergarten through college [7, 9], in high school and college science courses [27], in preservice science education [7, 15, 21, 22, 27, 28], and in in-service science education [7, 11, 19, 23, 24].

How then is attitude change measured? Attitude scales alone are not sufficient means for measuring attitude changes [5, 20]. Cacioppo et al. [5] and Petty et al. [20] recommended the use of cognitive responses in conjunction with attitude scales. One method of collecting cognitive responses is the written listing technique [5]. The responses can be classified (*e.g.*, polarity, origin, and target).

For in-service elementary teachers, in-service workshops are often the answer. Hone et al. [11] recommended that careful consideration be allotted to the following aspects of the in-service workshop: (a) program, (b) personnel, (c) workshop steering committee, (d) time, and (e) place. The program should involve scientific investigation with science equipment. The personnel should represent all who will be involved, including those who are anxious about science and science teaching. The steering committee should include representatives of the group who act as liaison persons between the consultant and other participants. Koballa et al. [14] labeled this peer influence. A minimum of three workshops of at least four hours each should be required of all participants. The place should be equipped so that scientific investigations can be conducted safely. Female role models are needed for women [1, 3]. Orlich [19] recommended four essential factors of successful in-service programs, (*i.e.*, awareness, application, implementation, and maintenance).

The primary purpose of this study was to investigate the effect of a year-long in-service science workshop on

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the attitudes of K–7 teachers toward science and science teaching. Also investigated were the effects of the teachers' age (under or over 40) and the grade level of the teacher (K–3 or 4–7) on the teachers' attitude toward science and science teaching.

METHOD

Sample

A letter explaining the focus of the year-long science workshop for in-service elementary teachers was mailed to the superintendents of schools in Pope, Yell, and Conway Counties, Arkansas. The superintendents were requested to disseminate the information to their elementary teachers, preferably grade 4–6 teachers. Seventy-five teachers applied. In the selection of the sample, preference was given first to grade 4–6 teachers and then to proportional distribution of the sample among the three counties because of the guidelines of the Education for Economic Security Act Grant. The original sample consisted of 41 teachers (39 females and two males) in grade K–7. Because of scheduling conflicts, workshop requirements, and released time requests, the final sample consisted of 33 teachers (32 females and 1 male) K–7 (11, grade K–3; 21, grade 4–6; and 1, grade 7). Sixteen of the teachers were in rural schools; seven were in a small city of less than 20,000 people. Upon successful completion of the workshop, the participants received reimbursement scholarships, travel expenses, and three graduate semester credit hours. Their school districts also received reimbursement for substitute teachers needed during the teachers' absences due to workshop participation. The only cost to the school districts was a fee of $50.00 per teacher. This fee was established as a way of getting some commitment from the school districts.

Instrument

The Science Attitude Scale for In-service Elementary Teacher II [24] was administered to the sample as pre and post measures of attitude toward science and science teaching in August and April. This twenty-six item Likert-type scale consists of sixteen positive and ten negative statements. Shrigley and Johnson [24] reported a .92 Cronbach's alpha reliability coefficient and a .94 test-retest reliability correlation coefficient.

In addition to the attitude scale, the workshop participants were required to write an evaluation of the workshop focusing on its strengths and weaknesses.

Treatment

The focus of the workshop, designed jointly by university professors and selected public school administrators, consisted of both required and optional sessions. The thirty-three and one-half hours required included one full day and five half days of workshops, plus one all day field trip was required. The full day consisted of six hours; the half day four hours [11]; and the field trip seven and one-half hours for a total of thirty-three and one-half hours. Two optional all day Saturday field trips, one on the formation and uses of minerals and rocks and the other on wildlife and the environment, were offered. All participants attended at least one of the optional field trips of eight hours; therefore, the total engagement time was forty-one and one-half hours.

The topics for the year-long workshop correlated with the Arkansas basic science skills objectives for grade 4 through 6 which consist of process skills and the three branches of science. Five scientists representing the three branches of science and one female science educator, who also served as director of the grant and model teacher [1, 3, 17], conducted the workshops and field trips. The first two workshops focused on scientific reasoning and the structure of science. Prior to the third workshop, teacher representatives from the three counties were invited to participate in a formative evaluation of the progress of the workshop [11, 14]. At this meeting, the teacher representatives and the university professors selected a list of priority objectives from the total list of grade 4 through 6 science skill objectives. Subsequently, a questionnaire which included the selected science skills objectives was sent to each participant, asking them to identify the ten topics of most interest. Those most often identified were chosen for inclusion in the subsequent four workshops and three field trips. The topics were: (a) Rocks and Minerals, (b) Where do you live, how do you fit and why?, (c) What Research Says to the Elementary Teacher?, (d) Field trip on Where do you live . . .?, (e) Geology Field Trip, (f) Weather and the Universe, (g) Holla Bend Wildlife Refuge Field Trip, and (h) Energy and Heat. The workshops were scheduled around the school calendars of the teacher participants, the Project Directors' and professors' schedules, and the participants' other commitments. In addition, the workshop and field trip engagement time, the participants worked on individual projects in their classrooms during which they were encouraged to request assistance from the university instructional team. This approach was one way of tailoring the group workshop format to the individual participants' needs [9].

A lecture/activity-based approach to instruction was implemented. The criteria for presenting an experiment or activity were safety, feasibility, and appropriateness for the elementary students. To allay the participants' anxieties about teaching science, the instructional equipment and materials had to be either available in their schools or readily attainable through the university. To accommodate the eleven K–3 teachers, the instructors were required to suggest ways in which the activities could be modified to meet the needs of younger children.

Evaluation

Both formative and summative evaluations were conducted. The formative evaluation consisted of informal observations of the teacher participants during workshops and field trips and on follow-up laboratory reports. The teacher participants were required to complete either a Unit Box or twenty experiments/activites (ten life science and ten physical science) as the basis for summative evaluation.

Data Analysis

Thompson and Shrigley [26] have suggested the following guidelines for interpreting the results of Likert-type attitude scales: (a) To have evaluative quality, the mean should range between 2.00 and 4.00 with a standard deviation around 1.00. (b) Neutral responses should be below 35%. (c) The distribution should not be skewed. They advised that neutral responses beyond 35% indicate vagueness or ambiguity and that skewed distributions connote a factual level. For the ten statements reflecting negative attitudes toward science and science teaching, (*i.e.*, 1, 5, 8, 11, 13, 18, 20, 22, 25, and 26), the ratings ranged from 1 strongly agree to 5 strongly disagree, the reverse of ratings for positive statements.

The participants' cognitive responses regarding the strengths and weaknesses of the year-long workshop were categorized according to polarity dimensions. the polarity dimensions categories are favorable, neutral, and unfavorable.

RESULTS

The means, standard deviations, the percent of neutral responses, and the results of dependent t-tests for each statement on the attitude scale are given in Table 1. Only three statements on the pretest (21, 25, and 26) and five statements on the post-test (6, 10, 13, 24, and 26) had neutral responses beyond 35%, a sign of vagueness or ambiguity [26]. Statements which had means and standard deviations outside the recommended range, therefore factual rather than evaluative in nature [26], were 8 and 11 on the pretest and post-test and 18 and 22 on the post-test.

TABLE 1
Means, Standard Deviations, Percent of Neutral Responses, and Results of Pre-Post t-Tests for Twenty-Six Science Interests

(N = 33)	Pretest		Neutral Responses		Post-test		Neutral Responses		t-values
Statement	M	SD	n	%	M	SD	n	%	t
1. Demonstrations	3.79	.96	7	21	3.94	.93	3	9	.82
2. Science Topics	3.48	.87	10	30	3.76	.61	5	15	1.79*
3. Workshop	3.55	.87	8	24	3.45	.97	11	33	−.42
4. Laboratory	3.79	.88	4	12	4.00	.71	5	15	.23
5. Background	3.18	1.07	10	30	3.64	1.03	4	12	2.17*
6. Graduate	3.55	.83	10	30	3.42	.87	15	45	−.64
7. Equipment	3.73	.88	6	18	3.88	.60	5	15	1.04
8. Difficult	4.27	.80	1	3	4.36	.65	3	9	.55
9. Barometer	3.45	1.06	11	33	3.76	.94	4	12	1.47
10. Consultant	3.79	.74	10	30	3.52	.76	12	36	−2.18*
11. Equipment Confusing	4.33	.65	3	9	4.36	.65	3	9	.27
12. Equipment	3.64	.78	6	18	3.91	.58	4	12	2.18*
13. Laboratory	3.00	1.15	9	27	3.45	.97	14	42	1.74*
14. Science Courses	3.91	.77	5	15	3.91	.72	4	12	.00
15. Inservice	3.73	1.01	3	9	3.61	.90	7	21	−.51
16. Teaching	3.85	.67	7	21	3.76	.75	8	24	−.57
17. Favorite Subject	2.64	.93	7	21	2.64	.90	9	27	.00
18. Science Boring	3.94	.83	3	9	4.09	.58	4	12	.90
19. Science Teaching	2.42	1.03	6	18	2.45	1.09	8	24	.16
20. Hamster	3.42	1.12	8	24	3.79	1.08	8	24	1.51
21. Departmentalized	2.64	1.19	12	38	2.85	1.23	11	33	.89
22. Apprehensive	3.76	.79	9	27	4.18	.77	1	3	2.60**
23. S & C	3.79	.96	6	19	3.85	.76	3	9	.36
24. Curriculum	3.27	.98	11	34	3.15	1.00	15	45	−.57
25. Improvement	3.45	.87	14	42	3.52	.91	10	30	.29
26. Team Leader	3.24	.83	18	55	3.39	.75	19	58	1.04
Total	91.30	10.57	—	—	94.82	11.36	—	—	1.98**

Note: Numbers 2, 3, 4, 6, 7, 9, 10, 12, 14, 15, 16, 17, 19, 21, 23, and 24 are positive statements; the rest are negative statements.
*$p < .05$, one-tailed.
**$p < .01$, one-tailed.

The dependent t-test was significant at the .01 level for the pretest and post-test total attitude and less apprehension toward science scales (See Table 1). Significant positive increases on background in science, attitudes toward using science equipment, doing scientific laboratory work, and discussing science topics scales and a decrease on the desire to work with the science consultant scale were also found ($P \leq .05$).

The one-way analyses of variance by age (*i.e.*, over forty or under forty) and grade level (*i.e.*, K–3 or 4–7) were not significant.

The cognitive responses of the workshop participants were classified according to polarity dimensions. There were 124 favorable comments, 25 neutral comments, and 31 unfavorable comments. The favorable comments listed most frequently pertained to the workshop leaders, value or worth of workshop, field trips, hands-on materials, and director. The duration of the workshop was given most often as the neutral comment. Under unfavorable comments, disorganization of the year-long workshop at the beginning was mentioned most frequently.

DISCUSSION

According to Thompson and Shrigley's guidelines [26], the means and standard deviations for statements 8, 11, 18, and 22 indicated that these statements were factual rather than evaluative in nature. Since statements on attitude scales should be evaluative in nature, the results of those items should be interpreted as such.

Unlike the results of a four-week NSF science workshop for in-service elementary teachers [7], this year-long in-service science workshop did have a significant positive effect on the attitudes of the 33 in-service elementary teachers. Perhaps in-service science workshops of less intensity and longer duration can bring about greater attitude change [7]. In addition, the year-long workshop had a significant positive effect in reducing apprehension toward science and increasing the participants' attitudes toward using science equipment, doing scientific laboratory work, and discussing science topics [7, 11, 16, 17, 19, 23, 24]. The participants indicated less desire to work with the science consultant. Since the participants listed the workshop leaders and director as positive aspects of the year-long science workshop, the author conjectured that the participants interpreted the science consultant as being a person from the local school district rather than one from the workshop's professional instructional team. If the author's conjecture is correct, then the participants must have viewed their science consultants differently after workshop participation. The activity-based approach to the year-long workshop was expected to produce these favorable results.

Gender differences in attitude toward science have been found in favor of male elementary students [6, 29] and male in-service elementary teachers [24]. In general, Mallow [16, 17] found that females were more anxious about science. Therefore, the results here, with essentially a female sample, cannot be generalized to males. The results of the polarity dimensions indicated that the workshop participants had their most negative attitudes toward the lack of organization at the beginning of the workshop. When the workshop commenced, it was established that quizzes and tests would be administered. This plan, of which the teachers were unaware, created such anxiety that it was dropped. Instead the participants were evaluated on their workshop participation and final project. The workshop participants described the workshop instructors very favorably. As suggested by Hone et al. [11], the director selected the workshop leaders not only on the basis of their scientific expertise but also because of their reputations as effective university professors. A comment closely related to the effectiveness of the workshop leaders is the worth or value of the workshop sessions. The participants commented on the usefulness, the value, the new ideas learned from the workshops, and the practicality of the workshop presentations. These comments were expected since the workshop sessions and field trips were designed for effective coverage of the science skills objectives for grade 4 through 6 in Arkansas; efficient use of materials, equipment, and the processes of science; and relevancy to the elementary teacher's needs, the content areas of life, physical, and earth sciences, and the science processes. The field trips were great successes. The field trips were used to reinforce and apply scientific concepts, laws, and principles which had been presented during a workshop in the laboratory. As recommended by Orlich [19], the year-long workshop had a focus on awareness, application, implementation, and maintenance. Two other areas which received consistently favorable comments from the participants were the hands-on approach and the director's enthusiasm and desire to meet the needs of the elementary teacher. The use of science process skills as recommended by Harty et al. [9], Gabel et al. [7], Lucas et al. [15], Riley [21], Shrigley [22], Shrigley [23], Westerback [27], and Westerback et al. [28] was utilized to implement the hands-on approach to elementary science. The female science educator as the workshop director and a workshop presenter seemed to reduce the elementary teachers' science anxiety [1, 3, 16, 17]. Overall the workshop participants offered favorable comments regarding the year-long workshop.

In regards to the effect of age, the results of the present study and Shrigley et al.'s [24] differ. Shrigley et al. [24] found that in-service elementary teachers who were over forty years of age had more favorable attitudes toward science. Although the author anticipated that the teachers under forty years of age would be more favorable toward science because of their general enthusiastic attitude toward learning more science and beause two of the primary teachers who were under forty years of age even had a Winthrop Rockefeller Grant to develop physical science activities for their students, age was not found to be significant.

The workshop produced positive attitude changes in the 33 in-service elementary teachers. Now, follow-up is needed to determine the lasting effects.

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