DOCUMENT RESUME

ED 291 586 SE 048 918

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TITLE The Relationships among Elementary School Teachers' Attitudes and Beliefs about Science and Their Teaching Style.
PUB DATE Apr 88
NOTE 10p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (61st, Lake of the Ozarks, MO, April 10-13, 1988).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Ability Identification; Cognitive Ability; *Cognitive Processes; College Science; Elementary Education; *Elementary School Science; *Formal Operations; Higher Education; *Preservice Teacher Education; *Process Education; Science Education; Science Instruction; *Scientific Attitudes; Student Teachers; Teacher Education Curriculum; Teaching Methods
IDENTIFIERS *Science Education Research; Thinking Skills

ABSTRACT

Popular sentiment toward the teaching of thinking skills and, in particular, higher order skills, is on the rise. Many people are wondering about the best way for teachers to foster the growth of reasoning skills in their classrooms. This study attempts to improve the teaching of reasoning by investigating teaching behaviors or characteristics that might be related to the teachers' reasoning ability. Since there are many science teacher variables that could be related to reasoning ability, a sequential approach was adopted to investigate the problem. Researchers first investigated the degree of clarity of concrete and formal reasoning teachers exhibited in their classroom teaching, their attitudes toward science, and their beliefs about science teaching. Next, researchers replicated their initial findings and investigated other possibilities. The subjects chosen for the study were preservice elementary school teachers. The subjects were in their last quarter of methods instruction before student teaching and were divided into two groups (30 students in the first group, 31 in the second). The critical assessment for this study was formal reasoning ability. The results showed few consistent differences between teachers classified as formal reasoners and those classified as concrete. There was no relationship between reasoning ability and belief in structured science teaching or laboratory oriented science, degree of clarity in the student teaching setting, or learning style. Some speculations about the nature of preservice teachers were advanced. (CW)

THE RELATIONSHIPS AMONG ELEMENTARY SCHOOL TEACHERS' ATTITUDES AND BELIEFS ABOUT SCIENCE AND THEIR TEACHING STYLE

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THE RELATIONSHIPS AMONG ELEMENTARY SCHOOL TEACHERS' ATTITUDES AND BELIEFS ABOUT SCIENCE AND THEIR TEACHING STYLE

In a 1984 poll (Gallup, 1985) teachers ranked improvement in thinking as the most important of twenty-five educational goals. Popular sentiment toward the teaching of thinking or higher order skills is sweeping the country (Chance, 1986). But what is the best way for teachers to foster the growth of reasoning skills in their classrooms?

Lawrenz and Lawson (1986) found that elementary school students gained the most in reasoning ability when they were taught by teachers who were classified as concrete as opposed to formal reasoners. This intriguing and somewhat counter-intuitive result provided the focus for the present study. Why would students of concrete reasoning teachers experience greater gains? Lawrenz and Lawson suggest that the effect might have been due to the similarity of the reasoning patterns between these teachers and their students. This certainly seems plausible, but claiming similarity of reasoning patterns does not explain why the students improved more. What behaviors might these concrete resoning teachers have exhibited in their classrooms that were reflective of their reasoning ability? If these behaviors can be identified, they could be used to improve the teaching of reasoning by teachers from any level of reasoning ability.

This study begins the attempt to improve the teaching of reasoning by investigating teaching behaviors or characteristics that might be related to the teachers' reasoning ability. There are many science teacher variables that could be related to reasoning ability, and it would be impossible to test all of them simultaneously. Therefore a sequential approach was adopted to investigate the problem.

The first step in the approach was to investigate the degree of clarity concrete and formal reasoning teachers exhibited in their classroom teaching, their attitudes toward science, and their beliefs about science teaching. Degree of clarity was selected because it has been shown to be strongly and directly linked to desirable student outcomes (Hines, Cruickshank and Kennedy, 1985). Also teacher attitudes and beliefs have been repeatedly used in studies of science teaching as indicators of successful teaching (Druva and Anderson, 1983).

The second step was to replicate initial findings and to investigate further possibilites exploring the relationships among teacher reasoning level, teacher attitude toward science, teacher attitude toward teaching science and teacher learning style. Two new variables were added while retaining some of the previous ones. Determining teacher attitude toward teaching science has been advocated by

Thompson and Shrigley (1986) and learning style research, which began long ago with the attribute-treatment-interaction studies, has been refined today into a variety of learning style categories (Gregorc, 1982; Butler, 1984).

Sample

The samples used for the two components of the study were two groups of preservice elementary school teachers. The first group contained 30 students and the second 31 in their last quarter of methods instruction before student teaching. The methods course was designed to promote the teaching of science in an inquiry, laboratory fashion and included a substantial amount of classroom teaching experience. The class was taught by the same instructor both years during the fall quarter.

The students had minimum overall GPA's of 2.5 although most were much higher, and had completed at least three science courses (one in physical science, one in earth science and one in life science). They also had completed a previous methods course and introductory education classes with practicum experiences. They did not hold previous degrees in any other academic area and basically had planned to be elementary school teachers from beginning college. Both classes were predominately female.

Instruments

The critical assessment for this study was formal reasoning ability. The test used contained nine items. Five were from the Lawson Classroom Test of Formal Reasoning (Lawson, 1978): conservation of weight, displaced volume, proportional reasoning-1, controlling variables-1 and probability-3. The remaining four items were the Trees Problem (Lawson and Hegebush, 1985) and a correlational and a probabilistic reasoning item from Lawson, Karplus and Adi (1978). The reliability and validity of these items were established in the research cited. Items were scored as correct only if a correct reason were given.

Several different attitude instruments were used. Teacher attitude toward science was measured by the Wareing Attitude Toward Science Protocol (WASP) (Wareing, 1982). The WASP is a 50 item 5 choice Likert-type scaled instrument with a Cronbach alpha reliability of .9. Teacher beliefs about science teaching were assessed by the Beliefs about Science and Science Education (BSSE) (Good, 1971) using the factor structure specified by Lawrenz (1984). The factors and their Cronbach alpha reliabilities are Laboratory Oriented Science (LOS) r = .6, Specific Science Concepts (SSC) r =

.5, and Structured Science Teaching (SST) r = .7. The BSSE is a 23 item 5 option Likert-type instrument. The third attitude instrument was the Science Attitude Scale (Thompson and Shrigey, 1986). This is a 22 item 5 option Likert-type instrument designed to assess attitude toward teaching science. The Cronbach alpha reliability was .8.

The preservice teachers' clarity in presenting their lessons was measured by the Teacher Clarity Instrument (TCI) (Hines et al., 1985). The TCI has two sections, one to facilitate frequency counts of behavior and one to rate the observer's perception of the behavior for an entire teaching episode. Only the second section of the TCI was used in this study. The ratings were done using a 5 option Likert-type scale on thirteen types of teacher behaviors related to clarity.

The final instrument was the Gregorc Style Delineator (1982). This instrument assesses a person's style in four different areas, concrete sequential (CS), concrete random (CR), abstract sequential (AS) and abstract random (AR). The score for each area is obtained by summing the ratings of an individual's perception of the relationships between a stimulus word, e.g., insightful, and himself. A brief description of each category is as follows: CS, ordered and practical; CR, independent and creative; AS, logical and academic; AR, sensitive and emotional.

Method

Elementary presence teachers in two separate years were examined to check for replication of findings and to allow for the administration of a variety of instruments. The students in both groups took the reasoning test and were pre and posttested with the WASP. In addition, the students in the first group completed the BSSE pre and post and were rated using the TCI both during their practicum experience and during their student teaching. The students in the second group completed the SAS pre and post and the Gregorc Style Delineator in addition to the WASP and the reasoning test.

Both sets of students were classified into two groups. Those students scoring below 6 on the 9 point reasoning test were classified as concrete reasoners and those scoring above 6 were classified as formal reasoners. This classification scheme essentially divided both groups into thirds. Approximately one third of the students scored in the middle both years and one third scored at each end. The middle third of the students were not used in the concrete/formal comparisons either year.

Results

Several different t test comparisons were conducted for the various instruments, for the two years and most importantly between the concrete and formal reasoners. The results of these tests along with the mean scores and standard deviation are presented in Table 1. Only a few of the comparisons between the concrete and formal reasoners were significant.

In the first year the concrete and formal reasoners had significantly different pre and post test scores for the specific Science Concepts scale of the BSSE. A lower score indicates more agreement with the scale and therefore these data show that the students classified as concrete reasoners believed significantly more strongly in teaching specific science concepts than the students classified as formal reasoners. Another interesting result was that although both groups of students became to believe less in teaching specific science concepts, the students classified as concrete changed more during the course than the students classified as formal reasoners. A t test comparison of these two pre/post difference scores, however, was not significant, i.e., the change experienced by students in each group was statistically similar.

In year two the attitude toward teaching science instument, the SAS, showed significant differences between the students classified as concrete and formal reasoners. The students classified as formal reasoners were significantly more positively oriented toward teaching science. As in year one, although students in both groups became more positively oriented toward teaching science during the course the formal reasoners were still more positive. Again the t test comparison of these two pre/post difference scores was not significant, i.e., the change experienced by students in each group was similar.

The WASP showed somewhat contradictory results in the two years. In the first year there were no significant differences on the pre and posttest scores between the students classified as concrete and those classified as formal. In the second year, however, there was a significant difference between the students classified as concrete and those classified as formal on the pretest scores. The students classified as formal reasoners the second year had significantly higher initial attitudes toward science. The posttest attitude scores for the two groups were not significantly different nor was there a significant difference in the change experienced by students in the two groups even though the students classified as concrete reasoners improved their attitudes more than the students classified as formal. In contrast to this finding, there was a significant difference in the change experienced by the students classified as concrete and that experienced by the students classified as formal in year one. The students classified as concrete reasoners improved their attitudes toward science while the students classfied as formal reasoners actually went down in their attitudes toward science.

Correlations among the instruments were conducted for both years to examine the data from a different perspective. Scores from all the students were used in these analyses. In year one significant correlations were found between the score on the reasoning test and the pretest score on the specific science concepts scale of the BSSE ($r = .5$ $p < .01$) i.e., the lower the belief in teaching specific science concepts (a high score) the higher the reasoning ability. Also the pre and posttest SSC scale scores correlated negatively with the posttest WASP score (SSCPRE and WASPPOST $r = -.4$ $p < .02$; SSCPOST and WASPPOST $r = -.6$ $p < .00$). In other words, the higher the posttest attitude toward science the stronger the belief in teaching specific science concepts. The Laboratory Oriented Science scale score was also correlated with the WASP posttest (LOSPRE and WASPPOST $r = .4$ $p < .02$; LOSPOST and WASPPOST $r = .4$ $p < .03$) i.e., the higher the posttest attitude toward science the lower the attitude toward laboratory oriented science. These contradictory results may have been an artifact of including the middle group of students or due to the lower posttest WASP scores for the formal reasoners.

In year two the correlations were more regular. The pre and posttest WASP scores were significantly correlated with the attitude toward teaching science scores (WASPPRE and SASPRE $r = .6$ $p < .00$; SASPPRET and EASPOS $r = .8$ $p < .00$; WASPPOST and SASPRE $r = .4$ $p < .05$; WASPPOST and SASPOST $r = .7$ $p < .00$). In other words, students with positive attitudes toward science had positive attitudes toward teaching science. The WASP and SAS pre and posttests were also marginally related (p's of .06 to .10) to formal reasoning ability, i.e., the higher the reasoning ability the higher the attitude toward science and teaching science.

Implications

It is somewhat difficult to draw conclusions from these data. More studies in the series will have to be undertaken to identify variables that discriminate between teachers classifed as formal reasoners and those classified as concrete. The instruments used here show few consistent differences between the concrete and formal reasoners. There appears to be no relationship between reasoning ability and belief in structured science teaching or laboratory oriented science, degree of clarity in the practicum setting or in the student teaching setting, or learning style.

Some speculations about the nature of preservice students classfied as concrete and formal reasoners, however, can be made. It appears that the distribution of reasoning ability among these students is a fairly consistent trait. In both years the students in the classes could be divided into thirds on the basis of a score of 6 on the reasoning test. It also seems true that the students classified as formal reasoners have initially more positive attitudes toward science and different beliefs or attitudes toward teaching science than the students classified as concrete reasoners. These differences appear to center around a positive attitude toward teaching science and a belief in a more generalized approach to teaching science concepts. Since the finding for the specific science concepts was not supported by the correlational analyses, this should be retested. It also appears that the students classifed as concrete reasoners may be more suceptible to positive change during participation in a methods class.

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Table/Mean Scores and Standard Deviations for all Instruments by Year and Level of Resoner

	Concrete Reasoners								Formal Reasoners							
	Year 1 N=13				Year 2 N=11				Year 1 N=11				Year 2 N=12			
	Pre		Post		Pre		Post		Pre		Post		Pre		Post	
	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd
WASP	210[1]	12.4	216[1]	19.7	192[2]	15.8	205	18.3	213[1]	10.0	208[1]	11.1	210[2]	19.9	218	22.4
LOS	16	2.6	16	2.8					17	2.7	16	2.1				
SST	13	2.1	15	2.2					15	2.9	16	2.4				
SSC	23[3]	2.9	23[4]	3.0					27[3]	2.6	25[4]	2.1				
TCR(P)			19	4.6							20	3.4				
TCR(ST)			58	6.3							62	4.9				
SAS					64[5]	11.3	71[5]	10.6					72[5]	7.0	79[6]	11.1
CS							27	6.4							27	6.9
AS							21	4.1							24	6.6
AR							29	4.0							27	6.4
CR							22	6.2							22	6.2

1 Difference between pre and post change of concrete and formal reasoners significant at $p < .04$

2 Difference between concrete and formal reasoners significant at $p < .02$

3 Difference between concrete and formal reasoners significant at $p < .00$

4 Difference between concrete and formal reasoners significant at $p < .03$

5 Difference between concrete and formal reasoners significant at $p < .08$

6 Difference between concrete and formal reasoners significant at $p < .09$