DOCUMENT RESUME

ED 319 603 SE 051 413

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TITLE What Do Prospective Science Teachers Understand about the Nature of Science?
PUB DATE 90
NOTE 13p.; Paper presented at the Annual Meeting of the National Association for Research in Science Teaching (63rd, Atlanta, GA, April 8-11, 1990).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150) -- Tests/Evaluation Instruments (160)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Beliefs; *Creationism; *Evolution; Higher Education; *Methods Courses; Preservice Teacher Education; Science Instruction; *Science Teachers; *Scientific Methodology; Teacher Characteristics; *Teacher Education Curriculum; Teacher Education Programs
IDENTIFIERS *Nature of Science

ABSTRACT

The questions for this research were: (1) what did preservice teachers know about the nature of science; (2) what were their religious beliefs that had implications for how they viewed science; and (3) what effect did instruction on the nature of science have in changing their knowledge level? A 25-item questionnaire was given to secondary science methods students (N=63) before and after a course. Instruction about the nature of science constituted the first two to three class periods. Students read articles, received lectures, and held discussions pertaining to theories, laws, hypotheses, and scientific processes. Two factors were determined using a factor analysis: religious belief, and nature of science and evolution. Factor 1 had .31 correlation with knowledge of theory and evolution. Many students were very unsure of their knowledge of the nature of science and many had misinformation. The questionnaire is attached. (YP)

What Do Prospective Science Teachers Understand About the Nature of Science?

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Paper presented to the Annual Meeting of the National Association for Research in Science Teaching, April 8-11, 1990, Atlanta, Georgia

What Do Prospective Science Teachers Understand About the Nature of Science?

The teaching of evolution and of content that suggests the earth and the universe are extremely old, have been met with controversy in various parts of the country. Earlier in this century the teaching of evolution was banned in a number of states. The Scopes trial in Dayton, Tennessee became the cause celebre. Scopes did lose the case and the law remained on the books until the 1960's. The recent attacks on evolution have been to declare it merely a "theory" and that if evolution is taught, something called creation science should be given equal time in public school classrooms. Laws to this effect were enacted in Arkansas and Louisiana. The Arkansas Supreme Court and the U. S. Supreme Court in the instance of Louisiana declared such laws to be unconstitutional. In addition these courts declared creationism not to be a scientific theory.

In light of this controversy the knowledge of the nature of science by preservice science teachers is important. In a summary of research about beliefs of teachers Grossman, Wilson and Shulman (1989) write "What emerges from our work, as well as that of other researchers ...is the notion that prospective teachers' beliefs about subject matter are as powerful and influential as their beliefs about teaching and learning" (p. 32). In the same review of research these authors comment on syntactic knowledge for teaching. Syntactic knowledge is the knowledge of the means by which new knowledge is brought into a discipline. "When teachers whom we have studied knew more about the syntactic structures of their disciplines, they included this aspect of the subject matter in their curriculum" (Grossman, Wilson, and Shulman, p. 30). Additionally, Eve and Dunn (1990) investigated

the level of pseudoscientific beliefs among high school biology teachers finding it "high enough to warrant significant concern."

The question of this research was: what do preservice teachers know about the nature of science; what are the religious beliefs that have implications for how they view science; and what effect does instruction on the nature of science have in changing their knowledge level?

Method

The subjects of this study were secondary science methods students at the University of Arkansas certifying in one or more of the areas of science teaching. Students were given a twenty-five question form on the first day of classes for the course and again on the next to last day of classes for the semester. Questions were chosen from those used by Roelfs (1987) in her dissertation study and by Feder (1986). Each student was given the option of not participating during both sessions. Subjects could respond to each of the questions by selecting a response of agree, disagree, or don't know. Between the first and second time students answered the questionnaire, students participated in their science methods classes. Instruction about the nature of science constituted the first two to three class periods. Students read articles, were lectured, and held discussions pertaining to theories, laws, hypotheses, and scientific processes. The reading material included articles by Feynman (in Good, 1972), Horner and Rubba (1978 and 1979), Lerner and Bennetta (1988), and a lecture about the work of Kuhn (1970). Also, students discussed what these works said about the nature of science and how this affected the way they would teach a science class. Evolution, creationism, carbon dating, the geologic time scale, Big Bang Theory and other topics were discussed in the light of the lectures and articles.

Results and Analysis

The total number of students in this sample was sixty-three in five methods classes from the fall of 1986 to the fall of 1988. A factor analysis of the first test administration was used to determine if any sets of questions were measuring a similar factor or concept. Statements 8, 10, 12, 13, and 15 clustered to form a factor which can be termed religious belief. Statements 17, 18, and 19 form a second factor which is knowledge of science pertaining to evolution. See Table 1 for a listing of the statements that form each factor.

The score on items 20-24, knowledge of theory and evolution at the end of the course, was regressed on factor 1 (religious beliefs as stated at the beginning of the course) and the number of hours of college level biology classes. Items 20-24 were scored 2 points for a correct answer, 1 point for a don't know answer, and 0 for an incorrect answer. Only factor 1 and knowledge of theory and evolution correlated with each other at a significant level with the correlation being 0.31. Table 2 summarizes the regression results.

Table 3 summarizes the results of preservice students understanding of the the nature of science and knowledge of evolution. In the table the results of the first administration at the beginning of the course are displayed next to the results at the end of the course. The results show a great amount of variability due to students generally changing their responses from an incorrect response to a don't know or a correct response. Consequently, many students are very unsure of their knowledge of the nature of science and many have misinformation.

Conclusions

What do preservice student teachers know about the nature of science? According to this survey these students have limited knowledge of the nature of science and evolution. This knowledge is not related to the number of hours of biology classes. What effect does ones religious beliefs have on the knowledge of the nature of science and evolution? The results show that there is a relationship that indicates that the more Biblically literal a person claims to be the less likely they will understand how scientific knowledge is developed and how this applies to the knowledge about evolution. What effect does instruction in a methods class have on knowledge of the the nature of science and evolution? Such instruction does create more uncertainty in the minds of the students about their level of knowledge. Responses change from incorrect responses to the don't know category.

The importance of addressing changes in syntactic knowledge is underlined by Grossman, Wilson, and Shulman (1988), "We believe that they (preservice teachers) consequently run the risk of misrepresenting the subject matters they teach" (p. 30). Not only this, but also the belief structures preservice teachers have affect their understanding of the nature of science and evolution. The more Biblically literal a person is the more likely they are to see science as the revelation by humans of a divinely inspired truth. Consequently, science should be taught as a body of factual information. The interaction of religious beliefs with the knowledge of science should then have a noticeable impact on how these preservice teachers will teach the nature of science and the science that is taught..

Acknowledgement: The author wishes to thank Sturman Mackey for his invaluable assistance in reducing mounds of data to an interpretable form and Dr. Betty Koball with her help with the statistical analysis.

References

Eve, R. and Dunn, D. (1990). Psychic powers, astrology & creationism in the classroom? The American Biology Teacher, 52. 10-21.

Feder, K. (1986). The challenges of pseudoscience. Journal of College Science Teaching, 15. 180-186.

Good, R. (1972). Science--children: Readings in elementary science education. Dubuque, Iowa: William C. Brown Company Publishers.

Grossman, P., Wilson, S., and Shulman, L. (1989). Teachers of substance: Subject matter knowledge for teaching. In M. Reynolds (Ed.), Knowledge Base for the Beginning Teacher (pp. 23-36). New York: Pergamon Press.

Horner, J. and Rubba, P. (1978). The myth of the absolute truth. The Science Teacher, 45(1). 29-30.

Horner, J. and Rubba, P. (1979). The laws are mature theories fable. The Science Teacher, 46(2). 31.

Kuhn, T. (1970). The structure of scientific revolution. Chicago: University of Chicago Press.

Lerner, L. and Bennetta, W. (1988). The treatment of theory in textbooks. The Science Teacher, 55(4). 37-41.

Roelfs, F. (1987). Academic factors affecting the status of the teaching of evolution in Arkansas and Missouri (Doctoral dissertation, University of Missouri, 1987). Dissertation Abstracts International, 48, 2593A.

Table 1

Statements Composing Factors

Factor 1 (Religious Beliefs)

8. There is a God.

10. Human beings came about through evolution.

12. Every word in the Bible is true.

13. God created the universe.

15. The flood of Noah as described in the Bible really happened.

Factor 2 (Nature of Science and Evolution)

17. The universe is about 5 billion years old.

18. God created the universe in 6 actual, 24 hour days.

19. Human beings biologically just like us have been around for about 40,000 years.

Table 2

Multiple Regression Results

Correlations

	Factor 1	Hours	Knowledge
Factor 1		-0.023	0.31
Hours			0.033

ANOVA

	MS	df	F	prob. F
Regression	14.93901	2	3.24	.046
Error	4.609226	58		
Total	4.953552	60		

R-squared 0.1005

Dependent Variable: Knowledge of Evolution and Theory

	b	t	prob. t
Intercept	6.399	12.26	0.0000
Factor 1	.705	2.53	0.0141
Hours	.006	0.33	0.7541

Table 3

Summary of Results for Nature of Science Statements

Statement	Mean (1)	Std. Dev. (1)	Mean (2)	Std. Dev. (2)
1	1.73	.65	1.83	.55
2	1.87	.49	1.86	.50
3	1.94	.35	1.94	.35
4	0.57	.87	0.75	.88
5	0.41	.73	0.37	.74
6	1.02	.85	0.94	.82
7	0.52	.80	0.48	.80
20	1.41	.84	1.41	.84
21	1.67	.67	1.67	.70
22	1.27	.92	1.49	.84
23	0.55	.86	0.44	.82
24	1.60	.66	1.59	.64
25	0.17	.52	0.06	.30

Responses coded as: 0 for incorrect; 1 for don't know; and 2 for correct

Questionnaire

Student Identification Number
Teaching Major
Teaching Minor
Number of hours of Biology
Date

Directions: Please answer the following questions by answering Agree, Disagree, or Don't know

1. The goals and values of a society directly influence the existence and development of science. (Agree)*

2. Science is concerned with the formation of general principles, theories and laws. (Agree)*

3. If a scientist reports his/her results precisely and truthfully, other scientist should accept the findings without skepticism. (Disagree)*

4. The scientific method, i.e., stating a problem, formulating a hypothesis, designing and carrying out an experiment, and drawing conclusions, is central to the scientific enterprise. It is the exact process that scientists use in their daily work because it ensures objectivity. (Disagree)*

5. The universe is ordered and it is the job of science to discover the order and specify the relationship between events. (Disagree)*

6. Science starts with publicly observable data that should be described atheoretically. (Disagree)*

7. When scientists choose between theories, both of which explain the same natural phenomena, the choice between theories is rational, objective, and based on specifiable data. (Disagree)*

8. There is a God.

9. Science and religion often contradict each other.

10. Human beings came about through evolution.

11. Nothing can go faster than the speed of light.

12. Every word in the bible is true.

13. God created the universe.

14. Reincarnation is an established fact.

15. The flood of Noah as described in the Bible really happened.

16. Most scientists are atheists.

17. The universe is about 5 billion years old.

18. God created the universe in 6 actual, 24 hour days.

19. Human beings biologically just like us have around for about 40,000 years.

20. Evolutionary theory denies the role of God in the in the creation of life. (Disagree)*

21. Evolution is a valid theory, supported by factual historical and laboratory data. (Agree)*

22. Evolutionary theory states that man evolved from monkey. (Disagree)*

23. Evolutionary theory states that an organism gradually evolves into a better organism. (Disagree)*

24. Evolutionary theory states that man was the ultimate goal of evolution. (Disagree)*

25. The primary purpose of evolution is adaptation. (Disagree)*

*Response scored as a correct response