DOCUMENT RESUME

ED 325 333 SE 051 669

AUTHOR Rowland, Paul McD.

TITLE Using Science Activities To Internalize Locus of Control and Influence Attitudes towards Science.

PUB DATE 90

NOTE 19p.; 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)

EDRS PRICE MF01/PC01 Plus Postage.

DESCRIPTORS *Attitudes; Individual Power; Inquiry; Intermediate Grades; Junior High Schools; *Locus of Control; *Personal Autonomy; Pretests Posttests, Science Activities; Science Education; *Scientific Literacy; Secondary Education; *Secondary School Science; Self Concept; Tests

ABSTRACT

This study investigated the relationships between science activities that emphasize cause-and-effect and a learner's locus of control. Pretests included the Nowicki-Strickland Abbreviated Scale 7-12 to measure locus of control, and a modification of the Test of Science Related Attitudes to measure attitudes toward science. The findings suggest that the combination of discipline problems and inexperience of teachers might be important variables influencing the internalizing of locus of control. Doing science activities that emphasize cause-and-effect relationships improved attitudes on the attitude subscales Social Implication of Science, Normality of Scientists, and Inquiry; however, such activities did not contribute to the enjoyment of science classes. (KR)

USING SCIENCE ACTIVITIES TO INTERNALIZE LOCUS OF CONTROL AND INFLUENCE ATTITUDES TOWARDS SCIENCE

Paul McD. Rowland
Assistant Professor
Center for Excellence in Education
Northern Arizona University
Flagstaff, AZ 86011

Paper presented April 9, 1990
National Association for Research in Science Education
Atlanta, GA

USING SCIENCE ACTIVITIES TO INTERNALIZE LOCUS OF CONTROL AND INFLUENCE ATTITUDES TOWARDS SCIENCE

Research Objective

The purpose of the research was to answer the following questions: (1) Do science activities emphasizing cause-and-effect relationships cause the learner's locus of control to become more internal? (2) Is the change in locus of control accompanied by a change in science related attitudes? (3) At what grade level is intervention in locus of control most effective?

Significance

The Using Science Activities to Internalize Locus of Control (USAIL) project was designed to investigate the effect of increasing the use of cause-and-effect activities in the science curriculum on the locus of control of the learner. This research was based on claims that such activities should increase the internality of students (Rowe, 1978). Kahle (1982) has suggested that such activities would cause a shift in locus of control that would be especially important for externally oriented minority students.

An important component of science literacy is a positive attitude toward using scientific inquiry and toward science as an activity. Rowland and Stuessy (1989) have shown that a positive attitude towards science is correlated with an internal locus of control. Consequently, one would expect an increase in internality to be accompanied by an improvement in attitude towards science.

Methodology

The study employed a quasi-experimental nonequivalent control group design (Campbell & Stanley, 1963). Roughly equivalent intact classrooms were assigned to either treatment or control groups. Pretests and post-tests were used to determine the influence of the treatment.

Subjects: The subjects for this study were seventh and eighth grade science students, ninth grade physical science students, and tenth grade biology students in eastern North Carolina. One seventh grade classroom, two eighth grade classrooms, three ninth grade classrooms and one tenth grade classroom were designated as treatment groups and matched with control classrooms at the same school and grade level.

Pretests: During January, pretests were administered to all participants. These pretests included the Nowicki-Strickland Abbreviated Scale 7-12 (Nowicki & Strickland, 1973) to measure locus of control, and a modification of the Test of Science Relates Attitudes (Fraser, 1981) to measure attitude toward science. The modification of the Test of Science Related Attitudes (TOSRA), based on factor analyses of prior use of the instrument, used only four of the original seven subscales: Society and Science, Normality of Scientists, Attitude Towards Inquiry, and Enjoyment of Science Classes. Each subscale consisted of eight questions, and each question was scored on a scale of one to five with higher scores indicating a more positive attitude. A sum of the scores of the questions on each subscale yielded the subscale score.

Treatment: Following administration of the pretests, the treatment classrooms took part in weekly science activities designed to illustrate cause-and effect relationships. All activities were designed by science education graduate assistants in cooperation with the classroom teacher and were integrated with the ongoing curriculum. At the end of each activity, students were asked to respond in writing to questions that explicitly used the terms "cause" and "effect." In many activities, students were asked to construct graphs showing the relationships.

In the control classrooms, the teachers presented the existing curriculum in the normal manner.

Post-tests: During May, the same instruments administered as pretests were administered to students in both control and treatment classrooms.

Results

Instruments. The Nowicki-Strickland instrument reliability (Cronbach's alpha) was .69 on the pretest and .72 on the post-test. For the TOSRA Social Implications of Science subscale (SUBS) the pretest reliability was .49 and the post-test reliability was .59. Reliability for the Normality of Scientists subscale (SUBN) was .47 for the pretest and .55 for the post-test. The Attitude To Inquiry subscale (SUBI) had reliabilities of .73 (pretest) and .78 (post-test). The highest reliabilities were for the Enjoyment of Science Lessons (SUBE): .90 and .91 on the pretest and post-test respectively.

Locus of control. Adjusted means were calculated using the pretest as covariate (see Table 1). Analysis of covariance indicated no main effects on locus of control due to grade or treatment. However, an interaction between treatment and grade was found to be significant (see Table 2). Univariate analyses of covariance "by grade" were conducted, and since this process involved multiple comparisons the significance level of alpha was adjusted to .013 to avoid the compounding of Type I errors due to the multiple comparisons. The univariate tests revealed that there were no significant differences due to treatment at the seventh, ninth and tenth grade levels (See Table 3). At the eighth grade level there was a significant (p .01) treatment effect resulting in an increase in internality in the experimental group. At the ninth grade level a non-significant but interesting difference ($p = .05$) indicated a greater increase in internality within the control group as compared to the experimental group.

Attitudes towards science. An examination of the mean scores of the four attitude subscales revealed a general but slight improvement in attitude in all areas except Enjoyment of Science Lessons (see Table 4). The analysis of covariance showed significant treatment effects in improving the attitudes towards Social Implications of Science, Normality of Scientists, and Inquiry, while a grade effect was found for the Enjoyment of Science Lessons subscale (See Table 5). Follow-up tests (LSD) of the Enjoyment of Science Lessons subscale adjusted means indicated that eighth and ninth grade attitudes were more positive than seventh grade attitudes at the .05 level.

Discussion and Conclusions

Locus of Control. Doing science activities that emphasized cause-and-effect relationships increased the internal locus of control of students in the eighth grade. It appears that, at least at this grade level, a concerted effort to shift locus of control to a more internal orientation can be accomplished through the use of cause-and-effect science activities. However, the verification of the prediction made by Rowe only at one grade level raises questions as to why the effect is not found at other grade levels.

The graduate assistant administering the tests indicated that seventh grade students demonstrated some problems in reading the Nowicki-Strickland instrument. Thus, the data for these students may simply be unreliable. Further research with students at this level should examine the appropriateness of this instrument for poor readers or the instrument should be read aloud to students.

It is possible that locus of control becomes relatively solidified with students at the ninth and tenth grade level. Science experiences may be such a small factor in these students' lives that, given the smaller likelihood of shifting locus of control, the science activities may be ineffective. It may simply be that high school science class intervention is too little, too late.

The nearly-significant, but nonetheless troubling, results at the ninth grade level are worth discussing. The experimental group's locus of control remained unchanged, while the control group became more internal. This contrary result may have occurred for any of several possible reasons.

First, the ninth grade experimental classes were characterized both by their teacher and by the graduate assistant working with them as "full of discipline problems." The graduate assistant frequently returned from her sessions frustrated with how little that group had done or understood. Class time was reduced due to discipline problems. It is likely that in this type of situation the discipline procedures, based on the authority of a "powerful other," interfere with the internalization process. Students receiving discipline comments from teachers may come to see powerful others as being in control of their lives. This concern with powerful others may result in either a failure by students to discover the cause-and-effect relationships in their science activities or a failure to carry the concept of causation over to the areas measured by the locus of control instrument.

Second, the graduate assistant working with the ninth and tenth grade students was an inexperienced teacher while the graduate student in the junior high had nine years of science teaching experience. It may be that new teachers are not effective at providing the environment necessary for students to discover and internalize cause and effect relationships. Indeed, the combination of discipline problems and inexperience might be synergistic in preventing an increase in the internalizing of locus of control.

These findings suggest that the claims by Rowe (1978) and Kahle (1982) may be correct but that the implementation of the appropriate program is more complicated than simply offering students cause-and- effect activities. The age of the students and the skill of the teacher may be important variables influencing the outcome of such interventions.

Attitudes. Doing science activities that emphasize cause-and-effect relationships improves attitudes towards Social Implication of Science, Normality of Scientists, and Inquiry. It is interesting that such activities do not contribute to the enjoyment of science classes. It is likely that the enjoyment of science classes is a subset of enjoyment of school, a factor that appears to decline as a function of schooling (Mullis and Jenkins, 1988). The findings of this study are in contrast to those of Stefanich and Kelsey (1989) who studied a population of college elementary education majors. The contrast emphasizes the importance of not over-generalizing findings into unsampled populations.

Of the attitude subscales, the Inquiry scale is most interesting. Attitudes toward inquiry are an essential component of the scientific attitude (Diederich, 1967). In the North Carolina Course of Study one of the key learning outcomes is "attitudes (positive) toward the use of scientific inquiry . . . . . . " (p. 269, North Carolina Department of Public Instruction, 1985). Thus, it was heartening to find that doing science activities consistently increased the students desire to use the inquiry process for learning. This finding is especially interesting in that the students in the experimental groups improved their attitude towards inquiry despite the lack of improvement in their attitude toward enjoying the class.

The inquiry subscale is also of interest because it measures an intention to perform a particular behavior and thus is fits neatly with Ajzen and Fishbein's (1980) use of the term attitude The use of the Ajzen and Fishbein (1980) Theory of Reasoned Action by Koballa (1988, 1989) and Krynowsky (1988) to investigate science attitude change has been useful in clarifying what Munby (1983) referred to as the "conceptual ambiguities" of science attitudes research.

It appears from this study that an important variable for altering an individual's attitude toward inquiry is experience doing science activities. This shift towards a more positive attitude occurred independent of a shift in locus of control (i.e. the treatment effect was found for all grades, not just the eighth grade) other factors need to be looked at as causal.

The Ajzen and Fishbein model proposes that attitudes may shift as an individual's values concerning the attitude shift or as the attitudes of others (and the importance of those attitudes) shifts. By having students carry out inquiry together to discover cause-and-effect relationships, the learners impression of the importance of inquiry to others may increase thus increasing the learner's intent to perform the activity. This raises the question of whether group inquiry is essential to obtaining the improved attitude. This research has not addressed that issue but evidence from cooperative learning research and the model both suggest that it is possible that group inquiry is superior to individual inquiry in improving attitude towards inquiry. Research using the Theory of Reasoned Action and the subsequent revision by Ajzen and Madden (1986) may provide a theoretical basis for further investigations of attitudes toward inquiry and to developing an understanding of the mechanisms that contribute to the attitude component of scientific literacy.

References

Ajzen, I. & Fishbein, M. (1980). Understanding Attitudes and Predicting Social Behavior. Englewood Cliffs, NJ: Prentice Hall.

Ajzen, I. & Madden, T. (1986). Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. Journal of Experimental Social Psychology, 22, 453-474.

Campbell, D. T., & Stanley, J. C. (1963). In N. L. Gage (Ed.) Handbook of Research on Teaching. Chicago: Rand McNally. pp. 171-246.

Diederich, P. (1967). Components of the Scientific Attitude. The Science Teacher, 40 (2), 23-24.

Fraser, B. (1981). Test of Science Related Attitudes. Melbourne, Australia: Australian Research Council.

Kahle, J. B. (1982). In Rowe, M. B. (ed.) What Research Says to the Science Teacher - Vol. 1. Washington, DC: NSTA.

Koballa, T. R. (1988). Attitude and related concepts in science education. Science Education, 72(2), 115-126.

Koballa, T. R. (1989). Using salient beliefs in designing a persuasive message about teaching energy conservation practices to children. Science Education, 73(5), 547-567.

Krynowsky, B. A. (1988). Problems in assessing student attitude in science education: A partial solution. Science Education, 72(5), 547-560.

Mullis, I. and Jenkins, L. (1988). The Science Report Card. Princeton, NJ: Educational Testing Service.

Munby, H. (1983). An Investigation Into the Measurement of Attitudes in Science Education. Columbus, OH: SMEAC Information Reference Center.

North Carolina Department of Public Instruction. (1985). Standard Course of Study. Raleigh, NC: Author.

Nowicki, S. & Strickland, B. (1973). A locus of control scale for children. Journal of Consulting and Clinical Psychology, 40, 148-154.

Phares, E. (1976). Locus of Control in Personality. Morristown, NJ: General Learning Press.

Rowe, M. B. (1978). Teaching Science as Continuous Inquiry. New York: McGraw Hill.

Rowland, P. & Stuessy, C. L. (1989). Locus of Control and Attitude Toward Science. Paper presented at the annual meeting of the North Carolina Association for Research in Education, Research Triangle Park, NC. March 2, 1989

Stefanich, G. P. & Kelsey, K. W. (1989). Improving science attitudes of preservice elementary teachers. Science Education, 73 (2), 187-194.

Table 1. Nowicki-Strickland External Locus of Contro! Post-test Means Adjusted for Pretest Covariate.

	Group		
Grade	Cntl	Expt	Total
7	9.1	10.6	9.9
8	10.3	8.6	9.5
9	8.3	9.4	8.8
10	9.3	9.4	9.4
All	9.3	9.5	

Table 2. ANCOVA of Nowicki-Strickland External Locus of Control Post-test Scores.

Source	Degrees of Freedom	F	p
Treatment	1	0.41	.43
Grade	3	1.52	.21
Treatment x Grade	3	4.51	.004

Table 3. Values of F and Their Level of Significance for the Treatment Effect on External Locus of Control, by Grade.

Grade	F	p
7	2.18	.148
8	6.62	.012
9	4.00	.049
10	0.00	.953

Table 4. Test of Science Related Attitudes Post-test Means Adjusted Using Pretest Covariate.

Society and Science

	Group		
Grade	Cntl	Expt	Total
7	23.5	25.8	24.6
8	25.7	26.2	26.0
9	25.2	24.9	25.1
10	23.9	25.6	24.4
All	24.6	25.6	

Normality of Scientists

	Group		
Grade	Cntl	Expt	Total
7	27.4	29.0	28.2
8	28.4	28.6	28.5
9	27.1	27.4	27.2
10	26.7	28.5	27.6
All	27.4	28.4	

Inquiry

	Group		
Grade	Cntl	Expt	Total
7	27.5	30.8	29.2
8	30.5	32.5	31.5
9	30.7	30.3	30.5
10	29.7	30.4	30.1
All	29.6	31.0	

Enjoyment of Classes

	Group		
Grade	Cntl	Expt	Total
7	23.4	23.6	23.5
8	27.1	26.0	26.5
9	26.8	25.5	26.0
10	25.6	25.1	25.4
All	25.7	25.0	

Table 5. ANCOVA of Test of Science Related Attitudes Subscales.

Source	Degrees of Freedom	F	p
	Society and Science		
Treatment	1	6.45	.012
Grade	3	2.17	.092
Treatment x Grade	3	2.08	.104
	Normality of Scientists		
Treatment	1	4.54	.034
Grade	3	2.07	.105
Treatment x Grade	3	0.93	.427
	Attitude Towards Inquiry		
Treatment	1	4.36	.038
Grade	3	2.15	.094
Treatment x Grade	3	1.54	.205
	Enjoyment of Science Classes		
Treatment	1	0.89	.345
Grade	3	2.92	.035
Treatment x Grade	3	0.23	.877

Postscript:

In the February 1990 issue of JRST. Shrigley reviews and organizes attitude research into several categories based on different interpretations of the relationship between attitude and behavior. This research supports the view that attitude and behavior are reciprocal. If this is further supported, then it will be important to look closely at the linking mechanisms in this cycle. The model of Ajzen may still be a strong contender for explaining the attitude/behavior relationship, but there need to be some links constructed that show the feedback nature of experience on attitudes and intentions. It may be profitable to explore a model where intervention using science inquiry stimulates changes in attitude and subjective norms thus improving the intention to perform the behavior independently. Like most models, this raises questions instead of answering them but it may serve as a useful guide to further research.

Shrigley, R. (1990). Attitude and Behavior are Correlates. Journal of Research in Science Teaching 27(2), 115-126.

Appendix 16

END

U.S. Dept. of Education

Office of Education
Research and
Improvement (OERI)

ERIC

Date Filmed

March 29, 1991