DOCUMENT RESUME

ED 076 425 SE 016 099

AUTHOR Van de Walle, John A.

TITLE Attitudes and Perceptions of Elementary Mathematics Possessed by Third and Sixth Grade Teachers as Related to Student Attitude and Achievement in Mathematics.

PUB DATE Apr 73

NOTE 12p.; Paper presented at the annual meeting of the National Council of Teachers of Mathematics, Houston, Texas, April 1973

EDRS PRICE MF-$0.65 HC-$3.29

DESCRIPTORS *Achievement; *Attitudes; *Elementary School Mathematics; Elementary School Teachers; Mathematics Education; *Research; Teacher Attitudes; *Teacher Characteristics

IDENTIFIERS Research Reports

ABSTRACT

The purpose was to define and determine the influence which different perceptions of mathematics held by elementary teachers may have on student computational ability, comprehension of mathematical concepts, and attitudes, at grade levels three and six. The perception factor was contrasted in the design with teacher attitude toward mathematics. Data were obtained from 62 third- and 51 sixth-grade classes (approximately 3,100 students). Six student instruments were adapted from attitude scales taken from the National Longitudinal Study of Mathematical Abilities (NLSMA), computation items from Seeing Through Arithmetic Tests, and comprehension tests from the Wisconsin Contemporary Test of Elementary Mathematics. Sixteen items measuring teacher perception of elementary school mathematics were selected from scales used in the Collier, NLSMA, and Rettig studies; teacher attitude was measured by the Revised Mathematics Attitude Scale. Results showed that no significant causal relations can be inferred between teacher attitude and perception and student achievement. It was found that teachers with informal perceptions of mathematics taught students who scored significantly higher on attitude, computation, and comprehension at the third-grade level. No significant differences were observed at the sixth-grade level. (DT)

FILMED FROM BEST AVAILABLE COPY

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY

ED 076425

ATTITUDES AND PERCEPTIONS OF ELEMENTARY MATHEMATICS POSSESSED BY THIRD AND SIXTH GRADE TEACHERS AS RELATED TO STUDENT ATTITUDE AND ACHIEVEMENT IN MATHEMATICS

John A. Van de Walle

This study was made in an attempt to define and seek out the influence which different perceptions of mathematics held by elementary teachers may have on student computational ability, comprehension of mathematical concepts and attitudes, at grade levels three and six. The perception factor was contrasted in the design with teacher attitude toward mathematics. The object of the teacher's attitude is as important a consideration as the attitude itself. Certainly one would expect a teacher's perception of the content being taught to alter his methodology.

A perception of mathematics was considered to be an intuitive judgement or understanding of mathematics existing along a formal - informal continuum. A formal perception of mathematics was understood as a judgement of mathematics as a subject which is a rigid set of memorized rules, facts and procedures. An informal perception of mathematics was understood as a judgement of mathematics as a subject which is probing, creative and involving definite aspects of originality and trial and error.

To test the null hypotheses that students taught by teachers with different perceptions of and attitudes toward mathematics do not perform significantly different on measures of attitude, computation ability and comprehension, a two by two factorial, quasi-experimental design was developed at each grade level. Efforts were also made to determine the direction of causal relationships among the student and teacher variables.

SE 016 099

BACKGROUND

Only four studies were found by the researcher which were concerned with the variable of beliefs or perceptions of mathematics.

One subscale of an instrument developed by Rettig (1971) for use with secondary teachers was concerned with the nature of mathematics. The Rettig scale was used with inservice teachers, but no attempt was made to answer the types of questions to which this study is addressed.

The International Study of Achievement in Mathematics (1967) used an eight item scale with thirteen year old children. The scale was based on an underlying continuum ranging from a view of mathematics as fixed and formal to a view that mathematics is still in a process of development, allowing for different ways of viewing and solving problems. It was found that older students viewed mathematics as less changing than younger students. Also, where the "New Mathematics" was taught there was a tendency to view mathematics as more open and changing.

Collier (1969) developed two parallel 20 item scales to be used with prospective elementary teachers. One scale attempts to measure a formal - informal dimension of attitudes toward mathematics. The other twenty items are similarly concerned with the teaching of mathematics. Collier reported a change from a neutral to an informal attitude as the students moved through their content and methods courses.

The National Longitudinal Study of Mathematical Abilities (1968) used a ten item scale to measure teacher perceptions of mathematics on a creative vs. rote continuum.

None of the four studies mentioned above addressed themselves to the problem of discovering relationships between the variables of teacher perception of mathematics and student achievement or other student variables.

Furthermore, the variable of perception was in no way contrasted with teacher attitude.

It was hypothesized that the effect of a teacher with an informal view of mathematics is more likely to be reflected in student behavior at the higher cognitive levels. Students who not only learn to probe, but develop their own ideas, should perform better on tasks whic re- quire the ability to relate two or more concepts, or to integrate facts. Furthermore, it is possible that the influence will be more noticeable in the lower grades since, as the students are exposed to more teachers, the probability of exposure to one with a more rigid viewpoint increases.

The assumption was made that both the attitude and perception factors influence in some way, the behavior of the teacher in the classroom. A small pilot study indicated that attitude and perception were not highly correlated and hence were used as blocking variables, producing a two by two design.

METHOD

Instrumentation

Thirty Likert-type items were selected from the scales used in the Collier, NLSMA and Rettig studies. Items were chosen to agree maximally with the definition of perception on the informal - informal continuum. Items were omitted which contained emotionally weighted, in-vogue terminology. The thirty items were administered to 57 elementary school teachers enrolled in graduate classes at The Ohio State University. The Aiken attitude scale was also administered at this time. A factor analysis was performed and 16 items were chosen to constitute the scale of Perceptions of Elementary School Mathematics (PESM). The reliability estimate of the PESM based on the pilot study data was .77.

The Revised Mathematics Attitude Scale (RMAS) developed by Aiken (1963), a 20 item Likert-type scale, was used to measure teacher attitude. The reliability estimate of the RMAS for the pilot study data was .97. The observed correlation between the RMAS and PESM was .17.

Six student instruments were adapted from existing scales and tests to measure attitude toward mathematics, computational ability and comprehension ability. Parallel instruments were devised for use with third and sixth grade children. The student attitude scales (SAS-3, grade three, SAS-6, grade six) were taken from the NLSMA scales PX010 and PX011 (1968). Some changes in wording were made with the aid of reading experts to adapt the scale to a third grade readability level.

The computation tests (AT-1,3, grade three, AT-1,6, grade six) and comprehension tests (AT-2,3, grade three, AT-2,6, grade six) each consisted of 25 multiple choice items taken from the Seeing Through Arithmetic Tests (Hartung, Van Engen, et al., 1969) and the Wisconsin Contemporary Test of Elementary Mathematics (DeVault, et al., 1968) respectively. The latter test is devised to measure mathematical concepts in agreement with a wide range of current text series. It was thought that this test contained items which were suited to measure cognitive skills higher than those required for straightforward computation.

<u>Sample and Data Collection</u>

The teachers and classes were selected from three school systems in central Ohio. In all, 66 third and 56 sixth grades comprised the original sample. Complete data was obtained from 62 third and 51 sixth grade classes (approximately 3100 students). The socio-economic backgrounds of these schools included no extremes at either the lower or upper levels.

During the second full week of classes in September, materials were distributed to the teachers for administration during the third week. In a given class, each child responded to only one instrument, the materials having been distributed randomly to the class. Thus a mean score from approximately one third of each class was used as an estimate of the class score for that instrument.

During the first week of March, data was collected in a similar manner using the same student and teacher instruments. Teachers were also asked to indicate their years of teaching experience.

<u>Design</u>

The entire study was viewed as two separate but parallel investigations at the third and sixth grade levels. Pre-test scores on the PESM and RMAS were used as blocking variables with cells divided on median values. Classes with teacher PESM and/or RMAS scores on the medians were deleted from the analysis.

FIGURE 1

TWO BY TWO FACTORIAL DESIGN

Attitude		Perception: P1	Perception: P2
	A2	Gr.3 n = 11 Gr.6 n = 6	Gr. 3 n = 16 Gr. 6 n = 16
	A1	Gr.3 n = 17 Gr.6 n = 11	Gr. 3 n = 6 Gr. 6 n = 8

A1 Negative P1 Formal
A2 Positive P2 Informal

Values of n do not include classes on median values

Table 1 gives the within cell mean and standard deviations of the pre and post criterion measures. The unit of analysis was the estimated class mean. Deviations reported are across classes.

TABLE 1

CELL MEANS AND STANDARD DEVIATIONS OF PRE AND POST STUDENT VARIABLES

Factor	n*		Pre-test AT-1,3	Pre-test AT-2,3	Pre-test SAS-3	Post-test AT-1,3	Post-test AT-2,3	Post-test SAS-3
A1,P1	17	M	9.08	7.87	25.27	15.30	10.50	26.03
		SD	2.30	1.23	1.38	3.05	2.05	[illegible]
A1,P2	6	M	9.10	7.18	25.27	17.65	10.10	26.77
		SD	2.50	1.32	1.47	1.47	2.05	2.39
A2,P1	11	M	10.18	7.66	25.15	16.52	10.18	25.91
		SD	2.81	1.04	1.32	4.26	2.52	1.71
A2,P2	16	M	9.57	7.35	25.46	16.36	11.09	26.83
		SD	2.42	1.39	1.49	3.09	2.63	1.78
Factor	n*		Pre-test AT-1,6	Pre-test AT-2,6	Pre-test SAS-6	Post-test AT-1,6	Post-test AT-2,6	Post-test SAS-6
A1,P1	11	M	7.67	9.11	29.46	12.43	10.43	30.34
		SD	1.25	1.07	1.73	2.38	1.67	2.03
A1,P2	8	M	8.46	9.18	29.91	11.40	10.48	28.80
		SD	0.95	1.95	1.24	1.84	1.98	2.01
A2,P1	6	M	7.22	8.36	28.56	10.76	9.86	30.34
		SD	0.54	2.13	1.98	1.84	2.46	2.40
A2,P2	16	M	8.64	9.62	29.42	12.00	11.16	29.78
		SD	1.46	1.85	1.56	1.95	2.38	1.94

*12 of the original third grade classes and 10 of the original sixth grade classes are not included due to PESM and/or RMAS scores on median values.

The correlations between the PESM and RMAS pre-test scores were .27 for the third grade and .51 for the sixth grade. These correlations are significant at the .05 level and account for the unbalanced cell sizes. These results are in marked contrast to the .17 correlation observed for the pilot study. There is no obvious explanation for this contrast but the disproportionate cell sizes must be considered a major limitation of the study. However, it was decided that random deletion of data to produce equal cell sizes constituted a more severe threat to the study in the form of excessive lost data.

Multivariate analysis of covariance was used to test the hypotheses concerning the relationship between the teacher and student variables. The three student post-test scores were the criterion measures with the pre-test scores serving as covariates.

The cross-lagged panel technique described by Campbell and Stanley (1966) and suggested by Aiken (1970) was used to test for direction of causality between teacher and student variables.

Results

Reliability estimates using the sample data were computed for each instrument on the pre- and post-tests. Only 50 students were used to compute the estimates for the pre-test. These results are summarized in Table 2. An analysis of variance technique was used for the Likert-type instruments and the KR-20 formula for the achievement tests.

In most instances the reliability estimates for the student measures are low and should be treated with caution. However, since mean scores for each class were used as criterion values, the estimates reported, which are based on individual scores, are adequate. An exception is the sixth grade computation pre-test score.

TABLE 2

RELIABILITY OF INSTRUMENTATION

Instrument	r_k (pre)	n	r_k (post)	n
RMAS	.84	116	.95	107
PESM	.66	116	.79	107
SAS-3	.50	50	.65	588
SAS-6	.68	50	.76	467
AT-1,3	.76	50	.84	565
AT-2,3	.50	50	.67	561
AT-1,6	.39	50	.72	460
AT-2,6	.52	50	.69	461

A two way analysis of variance was performed on each pre-test. No significant differences were observed at the third grade level. A significant F was observed ($P < .01$) due to factor P at the sixth grade level. (Results are not listed here.) While no differences were observed at the third grade, high correlations between pre and post measures were seen as a sufficient reason to use covariance at both grade levels. Tests of equality of regression indicated that homogeneous regression could be assumed at both grades.

The MANOVA results can be found in Tables 3 and 4. The nature of this study indicated that the detection of possible differences in student behavior due to the variable of perception was more important than rigidly verifying such effects. That is, a type II error was considered to be a more serious threat than a type I error. Hence, hypotheses were tested

TABLE 3

MULTIVARIATE ANALYSIS OF COVARIANCE - GRADE THREE

Source	F	df(Hyp)	df(Err)	P less than
A	0.080	3	41	.970
P	2.316	3	41	.090
AP	2.368	3	41	.085

ERIC

TABLE 4

MULTIVARIATE ANALYSIS OF COVARIANCE - GRADE FOUR

Source	F	df(Hyp)	df(Err)	P less than
A	0.368	3	32	.777
P	0.907	3	32	.449
AP	0.621	3	32	.607

at the .10 level.

For grade three there was a significant difference (P .085) for the interaction of the attitude and perception factors. There was a significant difference ($P < .090$) for the perception factor. There was no significant difference observed for the attitude factor at grade three.

At the sixth grade level, no significant differences were observed.

The MANOVA program employed computes discriminant function coefficients which, when used to form a linear combination of the criterion measures, produce maximum deviations for each test made. These coefficients give some help in interpretation of the multivariate analysis. For grade three in the test of the interaction effect, the attitude scale received almost no weight while the coefficients respectively for the computation and comprehension scores were approximately plus and minus one. In the third grade test of P the computation and attitude scores were given the greatest weight. The coefficients used in the sixth grade analyses were quite different.

The cross-lagged panel technique compares two correlations: r_{12} - a teacher pre-measure with a student post-measure and r_{21} - a teacher post-measure with a student pre-measure. If r_{12} is significantly greater than r_{21}, the teacher factor can be inferred as causal and vice-versa.

TABLE 5

STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS

Variable	Test of A	Test of P	Test of AP
AT-1,3	-0.178	0.536	1.156
AT-2,3	0.974	0.181	-1.057
SAS-3	0.539	0.792	-0.081
AT-1,6	0.553	0.053	0.943
AT-2,6	-0.720	0.165	-0.089
SAS-6	-0.345	0.944	0.247

In the present study, the two teacher measures and three student measures produced a total of 12 such observable pre-post correlations at each grade level. For each grade, six null hypotheses were tested at the .05 level. The probabilities of the z statistic ranged from .021 to .944. However, the .021 figure was inflated to .115 by the formula $P = 1 - (1 - P_{obs})^6$ since six observations were made at each grade. Hence, no significant causal relations could be inferred.

Finally, no significant correlations were observed between scores on the PESM or RMAS and years of teaching experience.

DISCUSSION

Both the student and teacher attitude scales and the PESM rely for their validity on the conscientiousness and introspection of the subjects. Teachers, capable of recognizing the more "desireable" responses, may have difficulty in being honest, even with themselves.

Among the classes sampled, the correlation between PESM and RMAS scores was higher than expected. Few teachers with very high positive attitudes and formal perceptions, or vice-versa, were found.

These two facts constitute major limitations to the study. However, the size of the study and the robust nature of the techniques used permit the results to be considered seriously.

ERIC

At the third grade level, multivariate differences were observed due to the perception factor and the interaction of perception and attitude. For the interaction effect (grade three) the result was produced essentially by the difference of the AT-1,3 and AT-2,3 scores with the SAS-3 partialed out. There exists some support for the hypotheses that teachers with informal perceptions coupled with positive attitudes tend to be associated with student comprehension of mathematical concepts. On the other hand, a negative teacher attitude with an informal perception tends to be associated with student computational ability. Causal relationships cannot be inferred. In the test of P, the standardized discriminant function is between .1 and .8 for all three variables. Teachers with informal perceptions of mathematics taught students who scored significantly higher on all three variables (attitude, computation, comprehension). The composite score was influenced most by the attitude score and least by the comprehension score. It is safe to conclude that the dimension of teacher perceptions is worth further investigation, at least at the lower grades.

The absence of differences at the sixth grade level was predictable due to the longer history of teacher and text influences diminishing the effects of a single teacher over a six month period.

A possible hypothesis explaining the absence of differences in the cross-lagged panel tests is that causal relationships between student and teacher variables are two way. This proposal is suggested by Aiken (1970) and is not denied by the present results.

The researcher strongly suggests the use of observation and interview techniques in smaller studies primarily for the purpose of refinement of the perception variable and a corresponding measuring instrument. The results of this study suggest that attitude alone, long a favorite variable in studies of elementary teachers, is inadequate. Furthermore, more work involving both variables (attitude and perception) may well give some needed insight into appropriate avenues of mathematical preparation for the elementary teacher.

REFERENCES

Aiken, Lewis R., Jr. "Attitudes Toward Mathematics," Review of Educational Research, 4 (October, 1970), 551-596.

Aiken, Lewis R., Jr. "Nonintellective Variables and Mathematics Achievement: Directions for Research," The Journal of School Psychology, 8 (1970), 28-36.

Aiken, Lewis R., Jr. "Personality Correlates of Attitude Toward Mathematics," The Journal of Educational Research, 56 (May-June, 1963), 476-480.

Campbell, Donald T. and Stanley, Julian C. Experimental and Quasi-Experimental Designs for Research. Chicago: Rand McNally and Co., 1966.

Collier, Charles Patrick. "The Formal-Informal Dimensions of Attitude Toward Mathematics and Mathematics Instruction of Prospective Elementary Teachers." Unpublished Ph.D. Dissertation. University of Wisconsin, 1969.

Husén, Torsten. (ed.) The International Study of Achievement in Mathematics, Vols. I and II. New York, New York: John Wiley and Sons, 1967.

Rettig, William L., Sr. "Views of Mathematics Held by a Selected Group of Secondary Mathematics Teachers in Pennsylvania." Unpublished Ph.D. dissertation. The Ohio State University, 1971.

Wilson, James W., Cahen, Leonard S. and Begle, Edward G. (eds.) NLSMA Reports, No. 7: The Development of Tests, by Romberg, Thomas A. and Wilson, James W., Stanford: The Board of Trustees of the Leland Stanford Junior University (SMSG), 1968.