DOCUMENT RESUME

ED 374 965 SE 054 800

AUTHOR Anderman, Eric M.; And Others
TITLE Perceptions of Mathematics Classroom Climate: A Multilevel Study.
SPONS AGENCY National Inst. of Child Health and Human Development (NIH), Bethesda, MD.
PUB DATE Aug 93
CONTRACT HD1H553
NOTE 17p.; Paper presented at the Annual Meeting of the American Psychological Association (Toronto, Ontario, Canada, August 1993).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Classroom Environment; *Educational Quality; *Elementary School Students; Grade 5; Intermediate Grades; *Mathematics Instruction; Motivation; Multiple Regression Analysis; *Student Attitudes; Teaching Methods

ABSTRACT

One framework for conceptualizing the study of classroom effects on student motivation asserts that students' perceptions of the classroom environment mediate the relationship between teacher practices and student performance outcomes. This study examined within- and between-classroom effects on 356 fifth-grade students' perceptions of the quality of instruction in their mathematics classes. Results suggest that a positive classroom instructional climate is related to several individual difference variables, including low perceptions of differential treatment by gender and ability. Several classroom level variables were related to positive class instructional climate, including the use of extrinsic motivational incentives, and the infrequent use of individualized forms of instruction. Teachers who used "mastery" oriented instructional strategies tend to have students in their classes who perceive a diminished relationship between teacher expectancies and classroom instructional climate. Contains 10 references. (MKR)

Perceptions of Mathematics Classroom Climate: A Multilevel Study

Eric M. Anderman, Robert W. Roeser, Phyllis C. Blumenfeld, &
Jacquelynne S. Eccles
The University of Michigan

Rena D. Harold
Michigan State University

Allan Wigfield
The University of Maryland

Paper presented at the annual meeting of the American Psychological Association, Toronto, Canada, August 1993. The research reported in this paper is supported by a grant from the National Institute of Child Health and Human Development, #HD17553, to Jacquelynne S. Eccles. Address all correspondence to Eric M. Anderman, 5055 Institute for Social Research, The University of Michigan, P.O. Box 1248, Ann Arbor, MI 48106-1248.

Running head: Perceptions of mathematics

ABSTRACT

The present study uses ordinary least squares and multilevel regression techniques to examine within and between classroom differences in fifth graders' perceptions of mathematics classroom instructional climate. Results suggest that a positive classroom instructional climate is related to several individual difference variables, including low perceptions of differential treatment by gender and ability. Using Hierarchical Linear Modeling, we determined that several classroom level variables are related to positive class instructional climate, including the use of extrinsic motivational incentives, and the infrequent use of individualized forms of instruction. Teachers who use "mastery" oriented instructional strategies tend to have students in their classes who have a diminished relationship between perceptions of teacher expectancies and classroom instructional climate.

BACKGROUND

One framework for conceptualizing the study of classroom effects on student motivation asserts that students' perceptions of the classroom environment mediate the relationship between teacher practices and student performance outcomes. Numerous studies suggest that perceptions of the academic learning environment, including perceptions of classroom instructional climate and the quality of instruction, are related to students' attitudes, interest, and performance in mathematics and other subjects (e.g., Aiken, 1976; Haladyna, Shaughnessy, & Shaughnessy, 1980; Midgley, Feldlaufer, & Eccles, 1989; Moos, 1979). Nevertheless, surprisingly little research has examined domain-specific perceptions of classroom experiences in elementary aged children. In addition, little research has examined the effects of motivational reward systems, such as extrinsic verses intrinsic reward systems (e.g., Deci & Ryan, 1985) and mastery verses performance oriented instructional strategies (e.g., Ames & Archer, 1988) on perceptions of classroom instructional climate. The present study examines within and between classroom effects on fifth graders' perceptions of the quality of instruction in their mathematics classes.

The following research questions are addressed in the present study:

1. What student-specific factors are related to students' perceptions of mathematics instruction?

2. Do students' perceptions of mathematics instruction vary *by classroom*?

3. Once individual differences in perceptions of mathematics instruction have been accounted for, do between-classroom differences (i.e., teacher practices) have an impact on students' perceptions of math instruction?

METHODS

Subjects

The student sample includes 356 fifth grade students, from 26 classrooms in ten school districts in semi-urban areas near a large midwestern city. The children are from lower middle class to middle class socioeconomic backgrounds, and are 95% Caucasian. One half of the students were in K-6 settings; however, 185 students were in a grade 5-6 middle level school. These students did not differ significantly on any of the variables in the present study, and were not treated differently in any of the analyses. The teacher sample includes 26 mathematics teachers.

Procedure

Student data were collected at the end of the 1988 and 1989 academic years; all teacher data were collected at the end of the 1989 school year. Students completed questionnaire booklets assessing their motivational beliefs, self-concepts, choice of free-time activities, and attitudes toward mathematics.[1] Teacher surveys assessed instructional practices, as well as opportunities provided for students (see Eccles, Wigfield, Harold, & Blumenfeld, in press, for detail on items and scales).

[1] The questionnaires contained many items assessing expectancies, values, self-concept of ability, and much additional information, for numerous domains, including mathematics, reading, science, social participation, and sports.

We used factor analysis to guide scale construction. Student-level scales for math were used in this study, and are presented in Appendix I, along with the teacher-level scales.

We then used correlations, ordinary least squares regression, and a multilevel regression technique referred to as Hierarchical Linear Modeling (HLM; Bryk, Raudenbush, Seltzer, & Congdon, 1988) to examine the multivariate relationships.

RESULTS

Correlations among several student-level predictors related to classroom instructional climate are presented in Table 1.

Table 1: Zero Order Correlation Coefficients for Fifth Graders in Mathematics Classrooms

	1	2	3	4	5	6
1. DIFFERENTIAL TREATMENT BY GENDER	1.00					
2. DIFFERENTIAL TREATMENT BY ABILITY	.28**	1.00				
3. PERCEPTIONS OF TEACHER EXPECTANCIES	-.06	.06	1.00			
4. PERCEPTIONS OF MATH INSTRUCTIONAL CLIMATE	-.22**	-.21**	.15**	1.00		
5. MATHEMATICS SELF-CONCEPT OF ABILITY†	-.09	.15*	.13	-.12	1.00	
6. STUDENT GENDER	.23**	.16*	-.02	-.01	.15*	1.00

STUDENT GENDER: 1=Female, 2=Male

† Self-Concept of Ability Measured During Prior School Year (4th Grade)

The correlations suggest that males are more likely than females to perceive that the mathematics teacher treats members of one's own gender better (in terms of fairness and attention) than the other, or treats "smart" students differently than others. Students who perceive that the teacher treats some students differently than others rate the overall classroom instructional climate as lower. Students with higher self-concepts of ability (as measured during the prior school year) are slightly more likely to perceive differential treatment by the teacher during the subsequent school year.

To examine these relationships further we used ordinary least squares (OLS) regressions, predicting perceptions of classroom instructional climate. Results are presented in Table 2:

TABLE 2: ORDINARY LEAST SQUARES REGRESSIONS PREDICTING STUDENTS' PERCEPTIONS OF THE QUALITY OF MATHEMATICS INSTRUCTION

	Results With Self-Concept of Ability Covariate		**Results Without Self-Concept of Ability Covariate**	
PREDICTOR	B	Beta	B	Beta
Differential Treatment by Gender	-.16	-.11	-.23**	-.16**
Differential Treatment by Ability	-.08	-.11	-.12***	-.17***
Perceptions of Teacher Expectancies	.28***	.27***	.17**	.16***
Self-Concept of Ability from Previous Year	-.19*	-.14*	---------	---------
Constant	5.38		5.46	
R-Squared	.12***		.09***	

** p<.05 ** p<.01 *** p<.001*

Results with and without the previous year's measure of self-concept of ability (SCA) as a covariate are presented, since SCA was dropped from later analyses. Results suggest that perceptions of preferential treatment for one's own gender are negatively related to classroom instructional climate. Perceiving that the mathematics teacher has high expectancies is positively related to instructional climate, and self-concept of ability is negatively related to class instructional climate.

A MULTILEVEL MODEL OF CLASSROOM INSTRUCTIONAL CLIMATE

We used HLM (Bryk et al., 1988) to examine between-classroom differences in fifth graders' perceptions of mathematics classroom instructional climate. We felt that HLM was both a reasonable and necessary technique to use with these data because students' perceptions of the quality of instruction are likely to vary by virtue of characteristics and practices of the teacher.

HLM allows for the examination of within and between classroom factors that influence differences in students' perceptions of classroom instructional climate. HLM calculates standard errors more appropriately than OLS regression with multilevel data. In addition, OLS techniques may underestimate effects when used with multilevel data (Patterson, 1991). Consequently, rather than "assigning" classroom level characteristics to individual students, we developed a multilevel model which incorporated student and teacher data, allowing for between classroom variation to be accounted for.

An unconditional analysis of variance is a first-stage HLM analysis, which examines the amount of variance in a construct that lies between groups. HLM revealed that 14% of the variance in perceptions of classroom instructional climate occur between classrooms. The level one, or "student level" equation that we chose to model, is identical to the OLS regression presented in Table 2, although self-concept of ability was dropped, since it no longer was a significant predictor in the HLM analysis. The student-level model is presented below

$$\text{Perceptions of Classroom Climate} = \beta_{0j} + \beta_{1j}\,(\text{Differential Treatment by Gender}) + \beta_{2j}\,(\text{Differential Treatment by Ability}) + \beta_{3j}\,(\text{Perceptions of Teacher Expectancies}) + \varepsilon_{ij}.$$

where β_{0j} = Mean class climate for students in classroom j

β_{1j} = Relationship of climate to differential treatment by gender in classroom j

β_{2j} = Relationship of climate to differential treatment by ability in classroom j

β_{3j} = Relationship of climate to perceptions of teacher expectancies in classroom j

The between class model incorporates teacher-level or classroom-specific data into the model. Specifically, the teacher data are used to try to explain some of the between-classroom variance. We incorporated measures of teachers' use of extrinsic motivational incentives, use of individualized instructional methods in mathematics, and mastery/performance oriented instructional strategies into the level-two models. The first between-classroom equation is presented below:

$$\beta_{0j} = \theta_{00} + \theta_{01}\,(\text{Teacher Uses Extrinsic Incentives}) + \theta_{02}\,(\text{Teacher Uses Individualized Instruction}) + u_{0j},$$

where θ_{00}= the intercept term for classroom climate,

θ_{01} = the effect of extrinsic incentives within a given classroom on students' perceptions of class climate, and

θ_{02} = the effect of individualized instructional practices within a given classroom on students' perceptions of class climate.

The second between-classroom equation is:

$$\beta_{1j} = \theta_{10} + \theta_{11} \text{ (Teacher Mastery-Performance Practice Differential)} + u_{1j},$$

where θ_{10}= the intercept term for preferential treatment by gender, and

θ_{11} = the effect of the difference between teachers' mastery and performance practices on the relationship between the differential treatment by gender slope and class climate.

$$\beta_{1j} = \theta_{30} + \theta_{31} \text{ (Teacher is Mastery Oriented)} + u_{3j},$$

where θ_{30}= the intercept term for perceptions of teacher expectations, and

θ_{31} = the effect of teachers' mastery oriented practices on the relationship between the perceptions of teacher expectancy slope and class climate.

The full HLM Model is presented in Table 3:

Table 3: Full Hierarchical Linear Model

	Gamma Coefficient	P-Value
Base Coefficient	5.31	.000
Teacher Uses Extrinsic Motivational Techniques	0.30	.010
Teacher Uses Individualized Instructional Methods	-0.10	.016
Differential Treatment by Gender *(Teacher treats opposite sex better)*	-0.01	.393
Teacher Mastery-Performance Differential	-0.13	.071
Differential Treatment by Ability*	-0.12	.006
Student Perceptions of Teacher's Expectancies for Child	-0.69	.049
Teacher is Mastery Oriented	0.13	.032

** fixed parameter*
"Teacher" measures are based on teacher reports, and represent classroom or group-level measures.
Other variables are student measures.

Results indicate that differential treatment by ability is negatively related to class climate. The gamma value for teacher expectancies is negatively related to class climate when it is allowed to vary randomly by classroom.

Several teacher (between-classroom) variables emerge as significant in the HLM model. The use of extrinsic motivational techniques increases students' perceptions of class instructional climate (in those classrooms where such techniques are used), and the use of individualized instructional methods decreases ratings of class instructional climate. The negative relationship between perceptions of teacher expectancies and class instructional climate is diminished somewhat in classrooms where teachers are mastery oriented.

Table 4 presents chi square analyses testing for between-classroom differences in the parameters that were not fixed (i.e., these parameters were allowed to vary randomly by classroom):

Chi Square Table For Free Parameters From HLM Analysis

Parameter	Degrees of Freedom	Chi Square
Base Coefficient	23	89.84***
Preferential Treatment by Gender	24	51.86***
Student Perceptions of Teacher's Expectancies for Child	25	33.99

* p<.05 ** p<.01 *** p<.001

The base coefficient (outcome) and preferential treatment by gender slope still vary significantly by classroom. But, all of the between-classroom variance in the perceptions of teacher expectancy slope has been explained by the HLM model.

DISCUSSION

The present study represents a first attempt at combining multilevel regression techniques with classroom level research on students' perceptions of the quality of mathematics instruction during the late elementary school years. Results suggest that once individual differences have been accounted for, classroom-specific instructional practices have an impact on student perceptions.

Our results suggest that:

1. Perceptions of mathematics classroom instructional climate among fifth graders vary significantly by classroom.
2. The use of extrinsic motivational techniques, such as offering rewards or prizes for participation, performance, or achievement, may increase students' perceptions of class instructional climate.
3. The use of individualized instruction, such as seat-work, is related to lower levels of perceived classroom instructional climate.
4. The use of mastery-oriented strategies, such as encouraging students to seek challenges or to work on independent projects that interest them, influences the relationship between perceptions of teacher expectancies and perceptions of classroom instructional climate.

Although research suggests that extrinsic incentives may undermine intrinsic motivation (e.g., Lepper, Greene, & Nisbett, 1973), students' perceptions of classroom instructional climate may be enhanced by such incentives. Future research should examine the more complex relationships among such incentives, perceptions, and outcomes such as performance, persistence, and values, in mathematics as well as other academic and non-academic domains.

Appendix I Student and Teacher Scales

Student Level Scales

Perceptions of Math Instructional Climate *The teacher makes math interesting.* *The teacher tells us why it is important to learn math.* *How good is teacher at explaining math.*	**Alpha=.61**
Preferential Treatment by Gender *Who does teacher treat more fairly (boys/girls)?* *Who is teacher more interested in (boys/girls)?*	**Alpha=.69**
Differential Treatment by Ability *Teacher is more interested in smart kids in math.* *Teacher treats smart kids better than others in math.*	**Alpha=.88**

Teacher Level Scales

Mastery Orientation **Alpha=.81**

Paying attention to own improvement.
Attempting challenging assignments/projects.
Pursuing their own ideas and interests.
Having fund doing projects or assignments.
Choosing or initiating projects on own.

Performance Orientation **Alpha=.77**

Working for top grades in class.
Spending a lot of time studying facts.
Achieving higher test scores.
Knowing who is doing the best.

References

Aiken, T. (1976). Update on attitudes and other affective variables in learning mathematics. *Review of Educational Research*, *46*, 293-311.

Ames. C., & Archer, J. (1988). Achievement goals in the classroom: Students' learning strategies and motivational processes. *Journal of Educational Psychology*, *80*, 260-270.

Bryk, A.S., Raudenbush, S.W., Seltzer, M., & Congdon, R.T. (1988). *An introduction to HLM: Computer program and users' guide. Version 2.0.* Chicago: Department of Education, The University of Chicago.

Deci, E., & Ryan, R. (1985). *Intrinsic motivation and self-determination in human behavior.* New York: Plenum.

Eccles, J.S., Wigfield, A., Harold, R., & Blumenfeld, P. (in press). Age and gender differences in children's achievement self-perceptions during the elementary school years. *Child Development.*

Haladyna, T., Shaughnessy, J., & Shaughnessy, J.M. (1980). A causal analysis of attitude toward mathematics. *Journal for Research in Mathematics Education*, *14*, 19-29.

Lepper, M.R., Greene, D., & Nisbett, R.E. (1973). Undermining children's intrinsic interest with extrinsic reward: A test of the "over-justification" hypothesis. *Journal of Personality & Social Psychology*, *28*, 129-137.

Midgley, C., Feldlaufer, H., & Eccles, J.S. (1989). Change in teacher efficacy and student self- and task-related beliefs during the transition to junior high school. *Journal of Educational Psychology*, *81*, 247-258.

Moos, R.H. (1979). *Evaluating Educational Environments.* San Francisco, CA: Jossey-Bass.

Patterson, L. (1991). An introduction to multilevel modelling. In S.W. Raudenbush & J.D. Willms (Eds.), *Schools, classrooms, and pupils:*

International studies of schooling from a multilevel perspective (pp. 13-24). San Diego, CA: Academic Press.