DOCUMENT RESUME

ED 416 091 SE 061 140

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TITLE	Effects of a Resident Mentor Teacher on Student Achievement in Mathematics.
PUB DATE	1997-11-13
NOTE	21p.
PUB TYPE	Reports - Research (143)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Grade 7; Grade 8; Junior High Schools; *Mathematics Achievement; Mathematics Education; Mathematics Teachers; *Mentors; Professional Development; *Student Attitudes; Teaching Methods; Teaching Models; *Teaching Skills

ABSTRACT

Early research has shown that using practicing mathematics teachers as mentors results in increased teacher self-respect, improved teaching skills, and renewed enthusiasm for teaching. The purpose of this study was to determine the effects of a resident mentor teacher on student achievement in mathematics. Measures of achievement were obtained from ITBS Performance Assessment scores from eighth grade rural and suburban school students in 1994, 1995, and 1996. One seventh grade mathematics teacher from a rural school and one seventh grade mathematics teacher from a suburban school volunteered to receive instruction from the researcher in performance teaching and analysis and in the creation and use of rubrics. One teaching unit was prepared by the researcher and presented to the teachers. Using this unit as a model, the teachers created three more units and trained teachers in their local schools. Simple analysis of variance using 1995 mean scores as a covariate revealed mean score differences in both treatment schools were statistically significantly higher in graphing and computation. Mean score differences in the rural schools were not statistically significantly different in problem solving. All schools showed a statistically significant decrease in mean scores in measurement. Possible reasons for this decrease are discussed. It is concluded that utilizing a mentor model where a master teacher trains resident mentor teachers results in higher student mean scores when compared with mean scores of non-mentored students. This paper also contains additional evidence that the model helps increase student interest levels in mathematics and increases teacher enthusiasm for teaching. (Author/NB)

Effects of a Resident Mentor Teacher On Student Achievement in Mathematics

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Early research showed that using practicing mathematics teachers as mentors resulted in increased teacher self-respect, improved teaching skills, and renewed enthusiasm for teaching. The purpose of this study was to determine the effects of a resident mentor teacher on student achievement in mathematics. Measures of achievement were obtained from ITBS Performance Assessment scores from eighth grade rural and suburban school students in 1994 (102 control, 155 treatment (rural); 455 control, 279 treatment (suburban)), 1995 (100 control, 132 treatment (rural), 451 control, 273 treatment (suburban)), and 1996 (403 control, 312 treatment (suburban)).

One seventh grade mathematics teacher from a rural school and one seventh grade mathematics teacher from a suburban school volunteered to receive instruction from the researcher in performance teaching and analysis and in the creation and use of rubrics. One teaching unit was prepared by the researcher and presented to the teachers. Using this unit as a model, the teachers created three more units and trained teachers in their local schools.. Simple analysis of variance using 1995 mean scores as a covariate revealed mean score differences in both treatment schools were statistically significantly higher in graphing and computation. Mean score differences in the rural schools were not statistically significantly different in problem solving. All schools showed a statistically significant decrease in mean scores in measurement. Possible reasons for this decrease are discussed.

It can be concluded that utilizing a mentor model where a master teacher trains resident mentor teachers resulted in higher student mean scores when compared with mean scores of non-mentored students. The paper includes additional evidence that the model helps increase student interest levels in mathematics and increases teacher enthusiasm for teaching.

Effects of a Resident Mentor Teacher on Student Achievement in Mathematics

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Mathematics education is in the midst of change. Heeding the claims of business and industry, which state that today's students are unprepared for the needs and demands of the current technological workplace, the National Council of Teachers of Mathematics (NCTM) examined the scope and sequence of mathematics instruction from the kindergarten level through twelfth grade. Their recommendations, published in 1989 as Curriculum and Evaluation Standards for School Mathematics, became a blueprint for nationwide efforts in mathematics education reform.

The state of Mississippi adopted each of NCTM's recommendations for mathematics reform. Beginning in the fall of 1995, teachers in Mississippi began to teach from the new mathematics curriculum. With the change in instruction came a change in the assessment of students. The Stanford Achievement Test was replaced by the Iowa Test of Basic Skills (ITBS) and the Mississippi Riverside Performance Assessment (M-RPA) instruments. These instruments required students to explain the thought processes used in deriving their solutions, contained open-ended questions, and placed heavy emphasis on data analysis and reporting of results. Recognizing that teachers required training in the new curriculum, the Mississippi State Department of Education provided

This study was made possible by a grant from Mid-South Educational Research Foundation.

several staff development sessions to all school districts throughout the state. Participation in these sessions was limited to one teacher per school district. It was the responsibility of each school district to provide time for this teacher to present the information in regional staff development sessions.

Rankin County and Clinton schools used the 1994 - 1995 school year as a pilot year for the new curriculum. Each district encouraged local school administrators to plan and implement programs of training for their teachers. Grade level staff development meetings were implemented throughout the 1995 - 1996 school year. No plans existed for providing teachers with continuous on-site support as they worked to implement the new curriculum.

Research showed that using practicing mathematics teachers as mentors for math teachers resulted in improved teaching skills, increased teacher self-respect, and renewed enthusiasm for teaching (Miller, 1989). Analysis of staff development efforts showed that the most successful activities/practices were those that delivered instruction in a timely fashion; matched training to the needs of teachers; offered staff development sessions at convenient times and locations; emphasized hands-on practical activities, techniques, and materials; piloted new staff development efforts on a small scale; and provided time for participants to share information and experience (Guerro, 1989).

The researcher in this study trained one teacher specialist per school in the techniques and assessment strategies required by the new curriculum. This resident mathematics specialist taught coworkers these techniques and provided them with prepared units of instruction. The specialist was available as needed to provide support, encouragement and advice to the cooperating teachers. The researcher met with the specialists at regular intervals throughout the school year. The purpose of this study was to determine if the use of a series of prepared instructional units combined with the daily presence of a mathematics teacher specialist trained in the implementation of the new curriculum improved student achievement in the Mississippi Riverside Performance Assessment.

Method

Four middle schools participated in the program. Two schools were large (1000+) suburban schools and two schools were medium sized (300+) rural schools. Three of the schools were located in Rankin County and one school was located in Clinton, MS. One suburban and one rural school served as treatment schools, and the other suburban and rural school served as the control schools. The target population was all students enrolled in seventh grade math in each school.

One seventh grade mathematics teacher from each of the treatment schools volunteered to participate in the study and agreed to act as the resident mathematics specialist for the school year. The rural school teacher had 10 years teaching experience and the suburban school teacher had 24 years teaching experience, and each received training from the researcher with input from an outside evaluator. This training consisted of three Saturday meetings and four after school support sessions scheduled throughout the school year. At the first meeting, teachers were trained in performance instruction and alternative assessment strategies and were given the first unit of instruction for the project. This unit of instruction served as a replacement unit for a topic within the seventh grade mathematics curriculum and fit naturally into the scope and sequence of instruction. Included in this unit, and in each unit prepared for this project, were discovery lessons, student projects and activities, assessment techniques, and journal prompts. The teacher specialists practiced with this unit and used the information gained to prepare a second unit of instruction. One unit of instruction was administered during each nine-week grading period. Topics for the units were graphing, computation and estimation, measurement, and problem solving and reasoning. Each resident mathematics specialist used regularly scheduled staff development sessions in the local school to train fellow teachers in performance instruction and assessment and to provide continuing support and training in these techniques. The resident mathematics specialist was also available on a daily basis whenever teachers had questions or concerns about performance or instruction.

The second meeting occurred after the winter holiday. Teacher specialists discussed their experiences with the first two units and discussed student responses to the assessments and to the journal prompts. Content for the remaining two replacement units was selected, and the teacher specialists prepared the units.

The culminating meeting occurred at the end of the 1996 school year. Teachers discussed the program and reviewed student responses. Suggestions for improvement in the program were incorporated into each unit of instruction. These units were incorporated into the scope and sequence of lessons for the 1996-1997 school year.

The ITBS and M-RPA assessments were administered in the fall of each school year. Measurement of the effectiveness of intervention in the seventh grade year was obtained by collecting data from the eighth grade mathematics performance scores of the Mississippi Riverside Performance Assessment (M-RPA) instrument. Scores from the 1994-1995 school year, the first year this test was administered, were collected. Scores from the 1995-1996 school year test administration represented gains in scores due to state and county staff development sessions. Scores from the 1996-1997 school year test administration were analyzed to determine the significance of a resident mathematics specialist in the school.

Results

Simple analysis of the percent change over time indicated that all schools demonstrated marked improvement in scores from school year '94-'95 to school year '95-'96. The percent increase in scores on various subtests ranged from 19% to 37% (Table 1). Consequently, it was concluded that the school district staff development programs during the 1994 - 1995 school year were effective in training the teachers to align their teaching techniques with the new assessment

Table 1 Percent Change in Mean Scores from 1994 through 1996

Content Area	School	Score 94	95	96	Percent 94-95	Change 95-96	94-96
Rural							
Computation / Estimation	Control	1.333	1.950	2.495	31.63	21.85	87.15
	Treatment	1.316	2.083	2.517	36.83	17.24	91.26
Measurement	Control	1.520	2.230	1.598	31.86	-39.54	5.16
	Treatment	1.542	2.364	1.648	34.76	-43.40	6.90
Graphing	Control	n / a	2.120	2.832		25.14	
	Treatment	n / a	2.303	2.876		19.92	
Problem Solving	Control	n / a	1.700	3.383		49.75	
	Treatment	n / a	1.894	3.407		44.41	
Suburban							
Computation / Estimation	Control	1.760	2.176	2.370	19.11	8.19	34.65
	Treatment	1.584	2.301	2.454	31.16	6.23	54.92
Measurement	Control	1.950	2.655	2.095	26.58	-26.72	7.48
	Treatment	1.762	2.628	1.956	32.95	-34.37	11.00
Graphing	Control	n / a	2.744	3.000		8.52	
	Treatment	n / a	2.894	3.267		11.42	
Problem Solving	Control	n / a	1.888	3.530		46.51	
	Treatment	n / a	2.042	3.568		42.77	

model. As a result, test scores from 1996 were analyzed using 1995 scores as a covariate. Using the information provided by the test publishers, contents of the M-RPA tests were divided into four subtests. These subtests were graphing, measurement, problem solving and reasoning, and computation and estimation. An independent *t*-test was used to determine prior differences in ability on the subtests for the rural schools (Table 2) and the suburban schools (Table 3). A simple factorial ANOVA analysis was run on SPSS, using scores from the 1995 assessment as a covariate.

Rural Schools

Results of the 1995 administration showed no statistically significant differences in mean scores between control and treatment schools in the areas of measurement ($\underline{M}_{control}$ = 2.23; $\underline{M}_{treatment}$ = 2.36; p = .280), computation and estimation ($\underline{M}_{control}$ = 1.95; $\underline{M}_{treatment}$ = 2.08; p = .093), or graphing ($\underline{M}_{control}$ = 2.12, $\underline{M}_{treatment}$ = 2.30; p = .108), The treatment school demonstrated a statistically significantly higher mean score in the area of problem solving ($\underline{M}_{control}$ = 1.70, $\underline{M}_{treatment}$ = 1.89; p = .049).

Results of the 1996 administration showed no statistically significant differences in mean scores between control and treatment schools in the areas of measurement ($\underline{M}_{control}$ = 1.60; $\underline{M}_{treatment}$ = 1.65; p = .590), computation and estimation ($\underline{M}_{control}$ = 2.50; $\underline{M}_{treatment}$ = 2.52; p = .108), graphing ($\underline{M}_{control}$ = 2.83, $\underline{M}_{treatment}$ = 2.88; p = .711), or problem solving ($\underline{M}_{control}$ = 3.38, $\underline{M}_{treatment}$ = 3.41; p = .760).

Table 2 Comparison of Performance Assessment Mean Scores - Rural Schools

Topic	School	Year	Mean	N	SD	signif.
Computation / Estimation	Control	94	1.333	102	0.635	0.821
	Treatment		1.316	155	0.567	
	Control	95	1.950	100	0.925	0.093
	Treatment		2.083	132	.0990	
	Control	96	2.495	107	1.119	0.108
	Treatment		2.517	145	1.167	
Measurement	Control	94	1.520	102	0.576	0.770
	Treatment		1.542	155	0.627	
	Control	95	2.230	100	0.983	0.280
	Treatment		2.364	132	0.876	
	Control	96	1.598	107	0.738	0.590
	Treatment		1.648	145	0.722	
Graphing	Control	95	2.120	100	0.891	0.108
	Treatment		2.303	132	0.828	
	Control	96	2.832	107	0.947	0.711
	Treatment		2.876	145	.0920	
Problem Solving	Control	95	1.700	100	0.689	0.049
	Treatment		1.894	132	0.803	
	Control	96	3.383	107	0.624	0.760
	Treatment		3.407	145	0.595	

Table 3 Comparison of Performance Assessment Mean Scores - Suburban Schools

Topic	School	Year	Mean	N	SD	signif.
Computation / Estimation	Control	94	1.760	455	0.985	0.016
	Treatment		1.584	379	0.909	
	Control	95	2.176	403	1.032	0.096
	Treatment		2.301	312	0.948	
	Control	96	2.370	451	1.196	0.348
	Treatment		2.454	273	1.114	
Measurement	Control	94	1.950	455	0.950	0.023
	Treatment		1.762	379	0.840	
	Control	95	2.655	403	0.929	0.707
	Treatment		2.628	312	0.970	
	Control	96	2.095	451	1.019	0.063
	Treatment		1.956	273	0.902	
Graphing	Control	95	2.744	403	0.830	0.009
	Treatment		2.894	312	0.650	
	Control	96	3.000	451	0.966	0.000
	Treatment		3.267	273	0.780	
Problem Solving	Control	95	1.888	403	0.881	0.020
	Treatment		2.042	312	0.861	
	Control	96	3.530	451	0.647	0.030
	Treatment		3.568	273	0.566	

Simple factorial ANOVA analysis of the 1996 assessment showed the treatment school posted statistically significantly higher gains in scores than did the control schools in the areas of computation and estimation ($p = .023$) and graphing ($p = .048$). No statistically significant gains in scores were noticed in the areas of problem solving ($p = .114$), or measurement ($p = .099$)(Table 4).

Both schools showed an increase in mean scores in the areas of computation and estimation (Control = 21.85%; Treatment = 17.24%), graphing (Control = 25.14%; Treatment = 19.92%), and problem solving (Control = 49.75%; Treatment = 44.41%). Both schools showed a decrease in mean scores in the area of measurement (Control = -39.54%; Treatment = -43.40%).

Suburban Schools

Results of the 1995 administration showed no statistically significant differences in mean scores between control and treatment schools in the areas of measurement ($\underline{M}_{control} = 2.66$; $\underline{M}_{treatment} = 2.63$; $p = .707$), or computation and estimation ($\underline{M}_{control} = 2.18$; $\underline{M}_{treatment} = 2.30$; $p = .096$). The treatment school demonstrated a statistically significantly higher mean score in the area of graphing ($\underline{M}_{control} = 2.74$, $\underline{M}_{treatment} = 2.89$; $p = .009$) and problem solving and reasoning ($\underline{M}_{control} = 1.89$, $\underline{M}_{treatment} = 2.04$; $p = .020$).

Results of the 1996 administration showed no statistically significant differences in mean scores between control and treatment schools in the areas of measurement ($\underline{M}_{control} = 2.10$; $\underline{M}_{treatment} = 1.96$; $p = .063$), or computation and estimation ($\underline{M}_{control} = 2.37$; $\underline{M}_{treatment} = 2.45$; $p = .348$). The treatment school

Table 4 Analysis of Covariance of Mathematic Skills by Rural Schools with 1995 Scores

Condition		SS	df	MS	F	signif.
Computation / Estimation						
Covariate	95	2.073	1	2.073	8.647	0.004
Main Effect	96	2.218	3	0.739	3.084	0.028
Explained		2.487	4	0.622	2.594	0.037
Residual		54.410	227	0.240		
Total		56.897	231	0.246		
Measurement						
Covariate	95	0.627	1	0.627	2.576	0.110
Main Effect	96	1.138	3	0.569	2.339	0.099
Explained		1.431	4	0.477	1.961	0.121
Residual		54.466	227	0.243		
Total		56.897	231	0.246		
Graphing						
Covariate	95	2.287	1	2.287	9.554	0.002
Main Effect	96	1.921	3	0.640	2.675	0.048
Explained		2.558	4	0.639	2.671	0.033
Residual		54.339	227	0.239		
Total		56.897	231	0.246		
Problem Solving						
Covariate	95	1.912	1	1.912	7.940	0.005
Main Effect	96	1.317	3	0.439	1.823	0.144
Explained		2.228	4	0.557	2.313	0.058
Residual		54.669	227	0.241		
Total		56.897	231	0.246		

demonstrated a statistically significantly higher mean score in the areas of problem solving ($\underline{M}_{control}$ = 1.70, $\underline{M}_{treatment}$ = 1.89; p = .049) and graphing ($\underline{M}_{control}$ = 3.00, $\underline{M}_{treatment}$ = 3.27; p = .000).

Simple factorial ANOVA analysis of the 1996 assessment showed the treatment school posted statistically significantly higher gains in scores than did the control schools in the areas of graphing (p = .000), problem solving (p = .010), and computation and estimation (p = .000). The control school posted statistically significantly higher gains in scores than did the treatment schools in the area of measurement (p = .000)(Table 5). Both schools showed an increase in mean scores in the areas of computation and estimation (Control = 8.19%; Treatment = 6.23%), graphing (Control = 8.52%; Treatment = 11.42%), and problem solving (Control = 46.51%; Treatment = 42.77%). Both schools showed a decrease in mean scores in the area of measurement (Control = -26.72%; Treatment = -34.37).

Measurement

Measurement scores decreased at all schools from 1995 to 1996. However, a comparison of scores from the 1994 and 1996 test administrations shows an increase (Table 1). In 1994, mean score analysis showed that the suburban control school ($\underline{M}$ = 1.95) had statistically significantly higher scores than did the treatment school ($\underline{M}$ = 1.76). There was no statistically significant difference in mean scores between the rural control ($\underline{M}$ = 1.52) or treatment ($\underline{M}$ = 1.54)(p = .023) schools.

Table 5 Analysis of Covariance of Mathematic Skills by Suburban Schools with 1995 Scores

Condition			SS	df	MS	F	signif.
Computation / Estimation							
	Covariate	95	23.740	1	23.740	116.834	0.000
	Main Effect	96	26.323	3	8.774	43.181	0.000
	Explained		26.405	4	6.601	32.486	0.000
	Residual		136.345	671	0.203		
	Total		162.750	675	0.241		
Measurement							
	Covariate	95	16.814	1	16.148	78.432	0.000
	Main Effect	96	16.571	3	5.524	25.765	0.000
	Explained		18.902	4	4.726	22.043	0.000
	Residual		143.848	671	0.214		
	Total		162.750	675	0.241		
Graphing							
	Covariate	95	19.242	1	19.242	94.793	0.000
	Main Effect	96	26.541	3	8.847	43.583	0.000
	Explained		26.546	4	6.636	32.694	0.000
	Residual		136.204	671	0.203		
	Total		162.750	675	0.241		
Problem Solving							
	Covariate	95	1.740	1	1.740	7.299	0.007
	Main Effect	96	2.744	3	0.915	3.837	0.010
	Explained		2.800	4	0.700	2.937	0.020
	Residual		159.950	671	0.238		
	Total		162.750	675	0.241		

Simple factorial ANOVA analysis using 1994 test scores as a covariate showed that, on the 1996 assessment, students in both treatment schools posted statistically significantly higher gains in scores than did students in the control schools ($p_{suburban}$ =.016; p_{rural} = .000)(Table 6).

Teacher Attitude

Both cooperating teachers reported an increase in their enthusiasm for teaching, an improvement in their teaching skills, and an increase in their feelings of confidence. Participating teachers reported increases in their perceptions of their ability to teach, increases in their enthusiasm, and increases in their desire to incorporate additional performance based instruction and assessment activities into their lessons. All teachers viewed the use of portfolios and journals as a beneficial practice in mathematics instruction and planned to continue using these assessment techniques (personal communication, 1997).

Teachers were surprised to discover that inclusion of projects and activities did not negatively impact instructional time. The primary concern of the participating teachers at the start of the study was that no spare time existed in the school year to allow for the inclusion of week-long performance and/or manipulative activities. By designing the activities as replacement units for existing content areas, additional teaching time was not necessary for implementation of this study. One replacement unit, the study of percents, reduced teaching time significantly. Traditional instruction required 15 class periods to teach and assess the concept of percent. At the end of the three day

Table 6 Analysis of Covariance of Measurement Skills by Suburban and Rural Schools with 1994 Scores

Condition		SS	df	MS	F	signif.
Rural Schools						
Covariate	94	4.745	1	4.745	21.097	0.000
Main Effect	96	5.190	3	1.730	7.692	0.000
Explained		5.452	4	1.363	6.060	0.000
Residual		54.427	242	0.225		
Total		59.879	246	0.243		
Suburban Schools						
Covariate	94	1.309	1	1.309	5.640	0.018
Main Effect	96	1.379	3	0.460	1.980	0.016
Explained		3.182	4	0.796	3.428	0.009
Residual		166.877	719	0.232		
Total		170.059	723	0.235		

replacement unit, traditional testing of the skill revealed that 100% of the students in the suburban school and 98% of the students in the rural school demonstrated mastery at or above the 70% level. All teachers also reported an increase in student participation and interest in the mathematics lessons presented during this study. These observations were supported by comments written by students in their journals.

Analysis of Journal Entries

Student journal entries were examined for evidence of recurring themes or attitudes. Five distinct themes were noticed: student confidence, student understanding of mathematics, student trust, ability to communicate, and attitudes towards performance instruction and assessment. The resident teacher specialists could not distinguish among responses between students at the two treatment schools. Journals were not assigned at the control schools (Table 7).

Conclusions

Preliminary evidence indicated that utilizing a mentor model where a master teacher trains resident mentor teachers may result in higher student mean scores when compared with mean scores of students taught by non-mentored teachers. Students at the rural treatment school showed a statistically significantly increase in scores when compared to students in the control school in the areas of graphing and computation. No statistically significant differences were noted in the areas of measurement or problem solving. Students at the suburban treatment school showed a statistically significantly increase in scores when compared to students in the control school in the areas of problem solving, graphing, measurement, and computation.

Test scores in the area of measurement demonstrated a sharp decrease from 1995 to 1996. Scores from the 1996 test administration were statistically significantly higher than scores from the 1994 test administration, with the rural and suburban treatment schools posting statistically significant increases in scores when compared to the control schools. A possible explanation for these results could be that test forms were not equivalent, with the 1995 edition of the test being more difficult than the 1994 and 1996 editions.

This study raises several questions for further research. All eight grade students in all four cooperating schools were tested using the ITBS and M-RPA instruments. Seventh grade students taking basic mathematics participated in the study. Seventh grade students enrolled in pre-algebra did not participate in this study. It was not possible to separate the scores for these two groups.

Enrollment in eighth grade pre-algebra has increased in the two treatment schools but remained relatively stable in the two control schools. Further research is needed to determine if this observation is a result of the mentoring program, of the schools' efforts to enroll more eligible students in pre-algebra, or of some variables yet to be determined.

The mentoring model utilized in this study appears to be an effective method of offering teacher training to large numbers of teachers. The current method of teacher training is to train one or two teachers and have them offer a staff development session to the other teachers in the district. A more effective method could be to have those one or two teacher specialists train a resident mentor teacher from each school and have the mentor teachers train school staff. The teacher specialists would act as mentors to the local school specialists, who in turn would mentor the members of their staff.

Table 7: Sample Student Responses to Journal Prompt: Using group work in math makes me feel ___ because ___.

Theme	Student Response
Student Confidence	Working in a group makes me feel more confident about myself. The reason why it makes me feel that way is if somethings (sic) wrong somebody will most likely pick up on it. I also feel better about my class mates (sic) by working in groups; because I get to know them better. Most importantly I get to know which ones I can trust. Working in groups also helps you learn better because if you don't understand something, your group can help you.
Student Understanding of Mathematics	It makes me feel good because I'm an auditory learner, it helps me for someone to explain things to me. When we work in groups, the people in my group can explain things to me. Also, if there is someone in the class who doesn't understand, if I am in a group with them, I can help them. To me working in groups really helps me understand and I can pull my grade up by understanding.
Student Trust	Using groups in math makes me feel happy. Because that shows Ms. ___ trust us (sic). I like that because if you trust we can do a whole lot more.
Student Ability to Communicate	Response: Well, group work makes me feel good. You come in contact with opposing view points and comments. It also makes me feel good when I'm right. Also group work in math gives you the chance to make easy good grades. It's also fun to do, you get to talk and have fun. (Written by a student whose first journal responses consisted of one sentence or less.)
Student Attitudes	Using group work in math makes me feel better in understanding things I don't understand. I really don't like working in a big group cause if there is (sic) six people in a group and 3 people don't know what there (sic) doing it is just harder to work with, but in a 2 people group it is very easy because you work together. Working in groups is fun sometimes, because if it is very easy and you just speed threw (sic) it and the other person really does not no (sic) how to do it you have to double explain it. On a big project now it is good to work in groups. On small problems or projects there is just no need in that. So I think there is just situations where you need to work in groups and situations when you don't.

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Title: Effects of a Resident Mentor Teacher On Student Achievement in Mathematics

Author(s): Cynthia W. Wilkins

Corporate Source: Rankin County Schools and Mid-South Educational Research Foundation

Publication Date: 11/13/97

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