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ABSTRACT

Writing is frequently neglected in American schools. Writing-to-learn approaches can develop writing skills and help learners form connections between scientific and mathematical concepts. Teachers often avoid writing in their classes because of a lack of class time and the demands of grading student writing. The Write Now Approach uses the beginning of a class period, typically a non-instructional time when the teacher completes tasks before the commencement of teaching, as a writing-to-learn experience. Students share their responses with their peers, so the teacher does not need to read, edit, or grade the writing. This paper reviews the advantages of the writing-to-learn approaches, describes the theoretical basis of the Write Now Approach, explains how the method is implemented, and presents evaluation data from an exploratory study (N=35') implementing the approach with eighth grade students and teachers. Analyses of the data from this exploratory study indicate limited significant differences in students' attitudes toward science or mathematics, proficiency in science and mathematics according to district and school tests, and improvement in writing according to district tests. The findings, however, provide valuable information if interpreted in light of delimitations within the setting. (Author/JRH)

Write from the Start:

Writing-to-Learn Science and Mathematics

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Abstract

Writing is frequently neglected in American schools. Writing-to-learn approaches can develop writing skills and help learners form connections between scientific and mathematical concepts. Teachers often avoid writing in their classes because of a lack of class time and the demands of grading stacks of student writing. The Write Now Approach uses the beginning of a class period—typically a non-instructional time when the teacher completes tasks before the commencement of teaching—as a writing-to-learn experience. Students share their responses with their peers, so the teacher does not need to read, edit, or grade the writing. This paper reviews the advantages of writing-to-learn approaches, describes the theoretical basis of the Write Now Approach, explains how the method is implemented, and presents evaluation data from an exploratory study (N=353) implementing the approach with eighth grade students and teachers.

Studies over the past decade indicate that, in the schools, "not only is little time spent on writing, but the emphasis in what instruction exists is not on content and cohesion but on grammar and punctuation" (Mavrogenes & Bezruczko, 1994, p. 228). Moore (1993) found that eighth graders spend only ten to twenty minutes weekly receiving writing instruction. Some research suggests that students do poorly on questions that require written responses (for example, Manitoba Education and Training, 1993, Bransky & Qualter, 1993). It appears that there is need not only to increase the amount of writing students do but also to improve the kinds of writing students experience.

The use of writing as a tool for science and mathematics concept learning is often promoted (e.g. Abell, 1992; Butler, 1991; Kober, 1993; Koeller, 1982; National Council of Teachers of Mathematics (NCTM), 1989; NCTM, 1991; Sturtevant, 1994; Wood, 1992). Kober (1993) justifies the use of writing in science: "When students are asked to write about their observations, results, reasoning processes or attitudes, they are forced to pay closer attention to details, organize data more logically, and structure their arguments in a more coherent way. In the process, they clarify their own understanding of science and hone their communication skills" (p. 45). The NCTM (1989) considers students' writing and thinking creatively about problems as integral to mathematics instruction. Writing about mathematics helps students clarify their thinking and deepens their understanding.

Despite the many advocates of writing-to-learn approaches in science and mathematics, many have noted there is scant research to show the effectiveness of this tool for learning science and mathematics concepts (Holliday, Yore, & Alvermann, 1994; Moore, 1993; Peasley, Rosaen, & Roth, 1992; Rivard, 1994). Evidence supporting writing-across-the curriculum is frequently only anecdotal (Moore, 1993). "The links between writing to learn and conceptual change, and writing to learn and critical thinking have not received sufficient attention. Carefully designed studies, both qualitative and quantitative, are still required to provide data from a variety of perspectives" (Rivard, 1994, p. 969). This study will provide evidence regarding the effects of daily writing assignments on writing ability, achievement in science and mathematics, and attitudes.

The Write Now Approach

Although benefits of writing-to-learn are known to numerous teachers, many middle school science teachers have not infused writing into the curriculum because of shortages of class time and the onerous task of routinely marking hundreds of student essays. Indeed, many teachers view writing in content areas to be "'frills' in an already packed curriculum" (Sturtevant, 1992, p. 174). "The potential value of writing-to-learn is offset by the additional burden placed on the instructor in terms of evaluating students' efforts" (Liss & Hanson, 1993, p. 342). The Write Now Approach uses class time efficiently and promotes daily writing without requiring the teacher to read and grade huge stacks of student essays.

In many middle school classrooms, students enter class and are idle until the teacher begins a lesson. Before beginning instruction certain tasks must be completed: taking attendance, talking to students who may have missed class or assignments, and setting up equipment and manipulatives. While the teacher is completing these duties, it is hoped that the students will be getting ready for the lesson—perhaps opening their notebooks and taking out pens More often, however, students are conversing, walking around the room, and perhaps engaging in unruly behavior. When ready to begin instruction, the teacher spends more time bringing the class to order.

From a classroom management perspective, the Write Now Approach is an effective technique. Without much difficulty, a teacher can have students enter the classroom, sit down, take out notebooks and pens, read the Write Now question, think of responses, and begin writing answers. Students will have reflected on prior learning and be ready to begin a new lesson. However, the most important benefit of the Write Now Approach is in helping students construct their own knowledge.

Questions for Learning

Powerful Write Now questions allow for a diversity of student responses. Quasar questions incite students' imaginations and excite their thinking to higher levels. The questions focus on concepts already explored in class. The open-ended nature of the questions allows students freedom in writing their responses. Individuality and creativity are expressed in their answers. When students explain, compare, contrast, and evaluate they are thinking at higher cognitive levels. Students enjoy the process; it helps them comprehend science concepts and discover why science is useful.

Examples of effective Write Now questions used in the implementation of the approach by eighth grade teachers are:

- Describe (in detail) your favorite solution.
- You're stranded on Gilligan's Island! If you could have an unlimited supply of any ELEMENT on the periodic table, which one would you want and why?
- If you were a farmer and could grow any one crop, what would it be and why?
- Explain why 28 cents is 28 percent of a dollar.
- What would you say to a friend to convince him that a line has an infinite number of points?

Effective questions focus on topics from the previous day's class, elicit varied responses, and require transferring knowledge to another situation or explaining a concept instead of merely reproducing something that has been said previously. The Write Now Approach can encourage deeper understanding as well as provide the teacher with an informal assessment of students' knowledge.

For many teachers, the most challenging aspect of the Write Now Program is developing questions that appeal to higher levels of thought and relate to concepts learned in the class. Open-ended questions encourage student writing; however, the questions should be designed so they can be answered in about five minutes. Developing effective questions may be difficult at first; nevertheless with experience we feel that teachers will be able to quickly develop creative and effective Write Now questions.

Sharing Responses

Science and mathematics teachers are busy preparing creative lessons; assembling materials and equipment; and grading portfolios, homework, quizzes, and tests. For most teachers, reading every student's Write Now answer is simply not practical. To be sure, people tend to write better knowing they will have an audience for their writing. However, the teacher need not be the sole audience; peers are often a better audience than the teacher. After sufficient time to write an answer has transpired, the teacher should call on a few students to share their answers with the class. At times, it is a good idea to start with non-volunteers (i.e., students who have not raised their hands), so all students know they may potentially be called upon. We recommend calling on both non-volunteers and volunteers to maximize sharing of responses. It is very important that the students not simply answer the question, but that they read what they wrote. Knowing they will read what they write increases student motivation to think of a good answer and to write articulately.

When the students share their responses, the other students gain as they hear a variety of viewpoints about the question. Students typically have more in common with their peers than with their teacher, so many times the students are better at explaining concepts to one another. Hearing a variety of peer responses assists students with their own conceptual development. It also helps students to know their classmates better.

The Write Now Philosophy

The Write Now Approach is supported by educational theory. People learn when they construct their own understandings of the world. Effective educators provide experiences to foster conceptual development.

Writing promotes conceptual development. Before students write, they must first organize and develop their thoughts. Composing consists of joining concepts into relationships (Van Nostrand, 1979). By writing, an individual becomes aware of connections between concepts. Thus writing is an important tool in the constructivist classroom.

Effective Write Now questions appeal to high cognitive levels and promote divergent responses. Thinking at high levels, such as synthesizing, contrasting, and evaluating, induces students to combine concepts in new ways. As they do so, students are constructing their own understanding. The open-ended aspect of Write Now questions not only allows for a variety of correct responses, but also helps students project themselves into their answers.

Having students share their responses motivates students to write. It also lets students hear different perspectives about a question. An individual's world view is unique. Hearing different views and explanations of concepts helps students develop deeper understandings. Discussions that take place as a result of sharing ideas helps students to reflect on their own ideas and build connections between concepts.

A constructivist mantra could be "less is more." The "more" is a richer understanding that stems from visiting concepts through a variety of approaches. When more time is spent on key topics and concepts, less material is covered, but the conceptual development is deeper. The Write Now Approach helps students focus and reflect on concepts. Perhaps the hands-on activity they did yesterday was a good learning experience. By having students focus on it today, they remember it and are induced to build deeper understandings.

For a teacher to effectively help students construct their own understanding of science concepts, it is important for the teacher to assess what students have learned. The Write Now Approach provides a daily assessment of student progress. "Writing can be a rich source of information for teachers who wish to take their students' present understandings into account as they plan and carry out instruction" (Ammon & Ammon, 1990, p. 1). Hearing (or reading) student Write Now responses helps the teacher understand how far the students have progressed in their conceptual development. The process is useful not only in finding misconceptions, but also in addressing these misconceptions through class discussions.

Implementation Evaluation

Exploratory research was conducted to study the implementation of the Write Now Approach with eighth grade mathematics and science teachers and students. The questions guiding this research were: (a) Is the Write Now Approach effective in improving writing skills, science and mathematics attitudes, and content achievement in science and mathematics, and (b) How do participants feel about using the Write Now Approach?

Research Design

This research was conducted in an urban middle school in Phoenix. Two eighth grade science teachers and two eighth grade mathematics teachers participated in the study. The population at the school is comprised of students with diverse multicultural backgrounds; twelve language groups are spoken as the primary home languages. Sixty percent of the students receive free or reduced-cost lunches.

Following a model proposed by Slavin (1992), within-teacher random assignment of classes was undertaken.

> In schools with departmentalization, where teachers have more than one class in the same subject, it is often possible to have teachers serve as their own controls by randomly assigning two or more of their classes to experimental and control conditions. A very good study can be done in such circumstances with as few as two teachers, where each teaches at least two experimental and control classes. (p. 29)

The study used a quasi-experimental control group design. Each of the two science teachers was assigned to teach four periods of eighth grade general science. For each of the teachers, two of the pre-existing classes were randomly selected as the treatment groups. The remaining four classes were controls. The resulting sample included 139 students in the treatment group and 119 in the control group for a total of 258. Of those, 141 were males and 117 were females.

One of the mathematics teachers was assigned to teach three periods of eighth grade general mathematics. Two of those periods were randomly selected as treatment groups and the other was designated a control. The other mathematics teacher was also assigned to teach three periods of eighth grade general mathematics. One of those periods was randomly selected as treatment with the remaining two control. Thus the treatment and control each included three classes. In addition, one of the mathematics teachers was also assigned to teach two pre-algeb.. classes. One on those was randomly assigned as treatment and the other control. The resulting sample of all mathematics students included 140 students in the treatment group and 132 students in the control group for a total of 272. Of those, 131 were males and 139 were females.

It is noted that 179 students, due to their course assignments, were in both the science sample and the mathematics sample resulting in a total of 353 subjects in the project.

The working hypotheses guiding this research were: (a) students using the Write Now Approach will show greater academic achievement and attitude improvement than students in the control group, and (b) these participants will have positive views of the Write Now Approach. Experimental groups were compared and analyzed for gender and teacher interactions.

Participation in the Write Now Approach was the independent variable. The dependent variables were science achievement and attitude, mathematics achievement and attitude, and writing ability. Student performance on subject-specific instruments, routinely administered by the school, provided comparisons of treatment and control groups. District wide tests were used to provide measures of achievement in mathematics and language arts. These tests used multiple choice formats. School wide science tests were combined to provide a measures of science achievement. This test was composed of multiple choice questions and questions that required student writing. Additionally, Germann's (1988) *Attitude Toward Science in School Assessment* Instrument was used as a unidimensional measure of science attitude. This instrument was adapted and also used to assess students' attitudes toward mathematics.

Additional information to address pedagogical and instructional efficacy was collected from students in the treatment group. A questionnaire was used as a source of information about students' feelings and attitudes toward the Write Now Approach. A T-Units testing analysis (Hunt, 1977) of selected students' Write Now answers was conducted throughout the study to determine how writing ability changed. Interviews with students and teachers were conducted to explore the personal perspectives and experiences of people involved in the Write Now program, as recommended by Patton (1990). These interviews were recorded, transcribed, and subjected to content analysis procedures to identify generalizations.

Data Analysis

A pretest, posttest design was used in the analysis of science and mathematics achievement, science and mathematics attitude, and writing achievement. Mathematics and Science classes were analyzed separately. Pretests were used as covariates to statistically adjust for initial group differences.

For science, Analyses of Covariance (ANCOVA) were employed to determine the effects of group (treatment vs. control), teacher, and gender on each post-treatment measure (science attitude, total science test, close-ended science items, open-ended science items, and district language arts score).

Similarly, for mathematics, ANCOVA were used to determine the effects of group (treatment vs. control), teacher, and gender on each post-treatment measure (mathem tics attitude, district mathematics score, and district language arts score).

Descriptive statistics were used to report the data from the participant questionnaire and to report results of the T-Unit analyses of writing samples. A content analysis of student and teacher interview transcripts provided additional sources of information.

Science Class Results

There were no significant effects for gro up, teacher, or gender on the post-science attitude using the pre-attitude as a covariate.

ANCOVA indicated a significant effect for group on total science post-test scores with total science pre-test used as a covariate, $F(1, 192) = 7.67$, $p<.006$. The treatment group scored lower than the control group with adjusted means of 44.30 and 50.00, respectively (see Table 1).

Scores were analyzed separately for the close-ended items and the items that required student writing using pre-test scores on the corresponding items as covariates. For the close-ended items, ANCOVA indicated a significant difference between groups, F(1, 191) = 14.16, p<.001. Students in the treatment group scored lower than the control group with adjusted means of 30.57 and 36.99, respectively. For this same set of items there was also a significant interaction effect of teacher by group, F(1, 191) = 5.50, p<.02 (see Table 2).

For the open-ended items requiring writing a response, ANCOVA indicated a significant effect for teacher, F(1, 191) = 22.74, p<.001. The adjusted mean for Teacher1 was 15.72 compared to 10.81 for Teacher2 (see Table 3).

There were no significant effects for group, teacher, or gender on district language arts scores.

<u>Teacher1</u>

Because of the significant interaction effect of teacher and group on the close-ended test items and a significant effect for teacher on the open-ended items, an analysis of scores for those measures was conducted with subjects separated by teacher.

For Teacher1, ANCOVA indicated a significant effect for group on the close-ended science test items, F(1, 122)=23.64, p<.001. The treatment group scored lower that the control group with mean total scores of 29.31 and 39.48, respectively (see Table 4). A separate ANCOVA indicated a significant effect for group on the open-ended writing items of the science post-test, F (1, 122)=5.49, p<.021. The treatment group scored higher than the control group on this set of items with mean total scores of 17.73 and 14.80, respectively (see Table 5).

<u>Teacher2</u>

For the students of Teacher2 there were no significant effects for group, gender or the interaction of group and gender on either the close- ended or open-ended items.

<u>Write Now Attitudes for Science Classes</u>

Students in the treatment groups completed a questionnaire containing 36 Likert items about their experience with and feeling toward Write Now on a 1 to 5 scale, five indicating strong agreement and one indicating strong disagreement. Factor analysis indicated loadings on the five following factors with means in parentheses: enjoyed participating (2.73) , improved writing due to participation (2.41), improved attitude toward science due to participation (2.77), learned more science by listening to others answers (3.30), and worked hard at writing good responses (3.23).

Mathematics Class Results

ANCOVA indicated a significant effect for gender on mathematics attitude, $F(1,170)=4.63$, $p<.033$. Adjusted means indicated that males had a significantly better attitude toward mathematics than females with means of 3.13 and 2.91, respectively (see Table 6).

ANCOVA also indicated a significant effect for teacher on district mathematics scores, $F(1,164)=5.43$, $p<.021$. Adjusted means indicated that the students of Teacher2 scored significantly higher than students of Teacher4 with means of 72.98 and 67.14, respectively (see Table 7). It is noted that the pre-algebra students of Teacher3 were included in the sample and no doubt affected the group mean.

There were no significant differences in district language arts scores for the mathematics students.

Because of the variation in teaching assignments between the two mathematics teachers participating in the projects, results from their students were investigated separately. ANCOVA were used to determine the effects of group and gender on attitude, district mathematics, and district language arts scores. For

Teacher3, the general mathematics students were considered separate from the pre-algebra students.

Teacher3, General Mathematics

ANCOVAs indicated no significant effects for group or gender on either attitude or district mathematics. However, a significant effect for group did exist on district language arts scores, $F(1, 58) = 5.39$, $p<.024$, with the treatment group scoring higher than the control group with adjusted means of 91.68 and 84.52, respectively (see Table 8).

Teacher3, Pre-algebra

ANCOVAs indicated no significant effects for group or gender on either attitude or district language. However, a significant effect for gender existed for district mathematics scores, $F(1, 48) = 4.272$, $p<.044$, with males scoring higher than females with means of 88.87 and 83.11, respectively (see Table 9).

Teacher4

No significant effects were identified for group or gender on the targeted variables.

Write Now Attitudes Mathematics

Students in the treatment groups completed a questionnaire containing 36 Likert items about their experience with and feeling toward Write Now on a 1 to 5 scale, five indicating strong agreement and one indicating strong disagreement. Factor analysis indicated loadings on the five following factors with means in parentheses: enjoyed participating (2.69), improved writing due to participation (2.60), improved attitude toward mathematics due to participation (2.80), learned more mathematics by listening to others answers (3.11), and worked hard at writing good responses (3.26).

Interview Data: Students

Interviews with the students and teachers during their first semester of using the Write Now Approach, validated by classroom observations, revealed the following. It was apparent that students lacked experience in content area writing. Some were quick to comment that "It takes longer [to answer the question] because I have to write it." Others expressed difficulty writing responses to the questions. "It was hard for me to write down exactly what I was thinking." Nevertheless, students seemed to develop an understanding of the power of writing. One student commented, "I think Write Now is helping because everyone tells what they think, it makes you think about your work more, and I found that I can remember things I learned longer."

Students especially enjoyed sharing responses with other classmates. Some expressed that they "liked to hear the way that other people think of things." But they were not threatened by the diversity of answers; instead they reported feeling that the different opinions were "just different ways to think about things." Students also seemed aware of the importance of sharing responses as a learning experience. In a student's words, "[Reading the answers] can help me rephrase my answer. You can think of something that is really hard to say and you can rephrase it so that someone else can understand it." It is noted that the questions used for Write Now were intended to solicit a variety of answers which probably influenced the diversity of responses made by students.

Interview Data: Teachers

The teachers were enthusiastic about Write Now and appreciated its power. First, teachers realized that it was useful as an assessment tool. One teacher stated, "If [the students] don't understand...it is really obvious when I read their Write Now [responses]." Teachers felt that their students were motivated to write responses to the questions. This was partially attributed to the fact that "[all of the] students know that I'm going to ask them possibly [to read their answers] because I always choose a couple of students who don't have their hands up."

The teachers also agreed that Write Now fulfilled its management function by allowing them time to take attendance and so forth while the students were addressing a relevant question. In the words of one teacher, "It gives me time....When I am busy doing attendance...they are already getting their minds set into math, and it gives them something to do when they walk into the class."

The major difficulty reported by teachers was developing the questions. Before the onset of the project, the teachers and professors met and discussed writing question appropriate for the project. The discussion included ideas about Bloom's taxonomy, open- versus closed-ended questions, and authentic versus inauthentic questions. At that time the teachers felt confident in writing questions that would target current topics in their classes. However, the teachers experienced difficulty creating questions they felt were appropriate and, as a result, several times during the semester the university professors were asked to provide additional ideas for suitable questions. The teachers reported that "it was hard to think of the questions....Some assistance on that...did help."

Discussion of Results

Analyses of the data from this exploratory study indicate limited significant differences in students' attitudes toward science or mathematics, proficiency in science and mathematics according to district and school tests, and improvement in writing according to district tests. The findings, however, provide valuable information if interpreted in light of delimitations within the setting.

That male students showed a more positive attitude toward mathematics than females was consistent with other studies. That there was no significant gender difference for attitudes toward science may have resulted from the types of Write Now questions one of the science teachers (Teacher1) asked, questions that required students to fly with their imaginations and express their opinions. Interviews of female students appear to support this interpretation, as girls commented more than boys about their being able to voice their own thoughts through the Write Now Approach.

A similar phenomenon may be the source of the significant difference in the science test results. Only in science did the test include both close-ended questions and open-ended written responses. For Teacher1, there was a significant difference in both areas of these results; his control groups scored significantly better on the close-ended items and his experimental groups significantly better on the written responses. It should be noted that he had been using a similar opening for all of his classes prior to the study, but with questions that required more convergent thought. For the study, there was no change to routines, only a difference in the types of questions he posed to the experimental groups. The control group continued to receive daily practice in answering close-ended questions, while the experimental group wrote daily in response to open-ended items. It seems possible that students performed best in the formats in which they received extended practice. The mathematics tests provided no opportunity for written responses and therefore no avenue for students to respond in the mode used in their daily Write Now reviews.

Since the mathematics classes were at two distinct levels, the algebra and the general mathematics classes were analyzed separately. There was a significant and positive difference in the language arts scores for the general mathematics students only. It would appear that the extra practice in writing had a positive effect on the language performance of these students, as the general mathematics control groups experienced virtually no writing in mathematics classes.

In retrospect, the investigators see several factors which should be considered for any future implementation and/or study. Since interviews of teachers indicated that the greatest challenge was the creation of questions to stimulate higher order thinking, ample time should be spent on training teachers to generate Write Now questions so they are adequately prepared.

Better testing instruments might surface more reflective results. The teachers' enthusiastic comments that the approach was raising the level of learning for their students was not borne out in the test results. Unfortunately, the district tests used for the analyses for mathematics and language arts were close-ended tests, focusing on computations and mechanics respectively. The impact of this format mismatch to their daily review procedures cannot be measured, but should be a consideration for future investigations.

All innovation takes time. With only ten weeks' intervention time, this study is indeed only exploratory in nature; but it has produced results that encourage continuation of efforts in this direction.

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Table 1
The Effects of Gender, Teacher, and Group on the Science Posttest with the Science Pretest as a Covariate

ANALYSIS OF COVARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GENDER	64.487	1	64.487	0.370	0.544
TEACHER	554.284	1	554.284	3.183	0.076
GROUP	1334.916	1	1334.916	7.665	0.006
GENDER *TEACHER	23.689	1	23.689	0.136	0.713
GENDER*GROUP	0.024	1	0.024	0.000	0.991
TEACHER *GROUP	141.930	1	141.930	0.815	0.368
GENDER *TEACHER *GROUP	21.659	1	21.659	0.124	0.725
TOTAL SCI PRETEST	11940.912	1	11940.912	68.564	0.000
ERROR	32393.280	186	174.157		

ADJUSTED LEAST SQUARES MEANS.

			ADJ. LS MEAN	SE	N
GROUP	=	TREATMENT	44.296	1.388	106
GROUP	=	CONTROL	49.999	1.509	89

Table 2

The Effects of Gender, Teacher, and Group on the Close-ended Portion of the Science Posttest with the Close-ended Portion of the Science Pretest as a Covariate

ANALYSIS OF COVARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GENDER	19.491	1	19.491	0.162	0.688
TEACHER	0.087	1	0.087	0.001	0.979
GROUP	1701.039	1	1701.039	14.161	0.000
GENDER *TEACHER	9.403	1	9.403	0.078	0.780
GENDER*GROUP	0.192	1	0.192	0.002	0.968
TEACHER *GROUP	660.409	1	660.409	5.498	0.020
GENDER *TEACHER *GROUP	128.203	1	128.203	1.067	0.303
CLOSE-ENDED PRETEST	1711.037	1	1711.037	14.244	0.000
ERROR	22222.125	185	120.120		

ADJUSTED LEAST SQUARES MEANS.

			ADJ. LS MEAN	SE	N
GROUP	=	TREATMENT	30.572	1.153	105
GROUP	=	CONTROL	36.988	1.250	89
TEACHER GROUP	= =	1.000 TREATMENT	28.615	1.339	71
TEACHER GROUP	= =	1.000 CONTROL	38.992	1.466	56
TEACHER GROUP	= =	1.000 TREATMENT	32.528	[illegible]	34
TEACHER GROUP		2.000 CONTROL	34.985	[illegible]	33

Table 3

The Effects of Gender, Teacher, and Group on the Writing Portion of the Science Posttest with the Writing Portion of the Science Pretest as a Covariate

ANALYSIS OF COVARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GENDER	20.800	1	20.800	0.474	0.492
TEACHER	998.402	1	998.402	22.736	0.000
GROUP	63.074	1	63.074	1.436	0.232
GENDER *TEACHER	0.055	1	0.055	0.001	0.972
GENDER*GROUP	4.599	1	4.599	0.105	0.747
TEACHER *GROUP	163.130	1	163.130	3.715	0.055
GENDER *TEACHER *GROUP	37.508	1	37.508	0.854	0.357
WRITING SCI PRETEST	4490.684	1	4490.684	102.264	0.000
ERROR	8167.778	186	43.913		

ADJUSTED LEAST SQUARES MEANS.

			ADJ. LS MEAN	SE	N
TEACHER	=	1.000	15.715	0.595	128
TEACHER	=	2.000	10.810	0.835	67

TABLE 4

The Effects of Gender, Teacher, and Group, for Teacher1 only, on the Close-ended Portion of the Science Posttest with the Close-ended Portion of the Science Pretest as a Covariate.

ANALYSIS OF COVARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GENDER	46.904	1	46.904	0.351	0.555
GROUP	3159.812	1	3159.812	23.642	0.000
GENDER*GROUP	91.351	1	91.351	0.683	0.410
CLOSE-ENDED PRETEST	504.336	1	504.336	3.773	0.054
ERROR	16305.733	122	133.654		

ADJUSTED LEAST SQUARES MEANS.

			ADJ. LS MEAN	SE	N
GROUP	=	TREATMENT	29.314	1.393	71
GROUP	=	CONTROL	39.481	1.550	56

Table 5

The Effects of Gender, Teacher, and Group, for Teacher1 only, on the Writing Portion of the Science Posttest with the Writing Portion of the Science Pretest as a Covariate.

ANALYSIS OF COVARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GENDER	14.785	1	14.785	0.321	0.572
GROUP	252.845	1	252.8	5.490	0.021
GENDER*GROUP	51.477	1	51.477	1.118	0.292
PRETEST WRITING ONLY	3745.716	1	3745.716	81.3 4	0.000
ERROR	5664.592	123	46.054		

ADJUSTED LEAST SQUARES MEANS.

			ADJ. LS MEAN	SE	N
GROUP	=	TREATMENT	17.733	0.822	72
GROUP	=	CONTROL	14.797	0.923	56

Table 6
The Effects of Gender, Teacher, and Group on the Mathematics Attitude Posttest with the Mathematics Attitude Pretest as a Covariate

ANALYSIS OF COVARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GENDER	1.526	1	1.526	4.634	0.033
TEACHER	0.013	1	0.013	0.039	0.844
GROUP	0.097	1	0.097	0.294	0.588
GENDER *TEACHER	0.397	1	0.397	1.20	0.274
GENDER*GROUP	0.216	1	0.216	0.656	0.419
TEACHER *GROUP	0.001	1	0.001	0.004	0.952
GENDER *TEACHER *GROUP	0.155	1	0.155	0.472	0.493
MATH ATT PRETEST	8.810	1	8.810	26.750	0.000
ERROR	55.988	170	0.329		

ADJUSTED LEAST SQUARES MEANS.

			ADJ. LS MEAN	SE	N
GENDER	=	MALE	3.125	0.071	89
GENDER	=	FEMALE	2.909	0.072	90

Table 7

The Effects of Gender, Teacher, and Group on the District Mathematics Posttest with the District Mathematics Pretest as a Covariate

ANALYSIS OF COVARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GENDER	38.217	1	38.217	0.247	0.620
TEACHER	839.831	1	839.831	5.431	0.021
GROUP	266.974	1	266.974	1.727	0.191
GENDER *TEACHER	121.471	1	121.471	0.786	0.377
GENDER*GROUP	40.369	1	40.369	0.261	0.610
TEACHER *GROUP	221.989	1	221.989	1.436	0.233
GENDER *TEACHER *GROUP	63.350	1	63.350	0.410	0.523
MATH PRETEST	13604.494	1	13604.494	87.982	0.000
ERROR	25358.936	164	154.628		

ADJUSTED LEAST SQUARES MEANS.

			ADJ. LS MEAN	SE	N
TEACHER	=	3.000	72.980	1.127	126
TEACHER	=	4.000	67.139	2.234	47

Table 8

The Effects of Gender, Teacher, and Group, for Teacher3-General Mathematics Only, on the District Language Posttest with the District Language Pretest as a Covariate

ANALYSIS OF COVARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GENDER	99.775	1	99.775	0.765	0.385
GROUP	702.488	1	702.488	5.385	0.024
GENDER*GROUP	53.966	1	53.966	0.414	0.523
LANGUAGE POSTTEST	3563.979	1	3563.979	27.320	0.000
ERROR	7566.370	58	130.455		

ADJUSTED LEAST SQUARES MEANS.

			ADJ. LS MEAN	SE	N
GROUP	=	TREATMENT	91.681	2.315	26
GROUP	=	CONTROL	84.520	1.924	37

Table 9

The Effects of Gender, Teacher, and Group, for Teacher3-Prealgebra Only, on the District Mathematics Posttest with the District Mathematics Pretest as a Covariate

ANALYSIS OF COVARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
GENDER	342.312	1	342.312	4.272	0.044
GROUP	187.442	1	187.442	2.339	0.133
GENDER*GROUP	97.902	1	97.902	1.222	0.274
MDMNEW	1995.228	1	1995.228	24.903	0.000
ERROR	3845.835	48	80.122		

ADJUSTED LEAST SQUARES MEANS.

			ADJ. LS MEAN	SE	N
GENDER	=	MALE	88.867	2.329	16
GENDER	=	FEMALE	83.108	1.518	37