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EFFECTS OF LEARNING-STYLE AWARENESS AND RESPONSIVE STUDY STRATEGIES ON ACHIEVEMENT, INCIDENCE OF STUDY, AND ATTITUDES OF SUBURBAN EIGHTH-GRADE STUDENTS

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ABSTRACT

This investigation examined the effects of two study strategies on mathematics achievement, studying, and attitudes. One hundred and thirty, eighth-grade students were taught to use either traditional study strategies or learning-style-responsive study strategies when completing mathematics homework and studying for mathematics tests. Analyses of data revealed that the students who applied learning-style-responsive strategies had significantly higher mathematics achievement and attitude scores than the students who applied traditional study strategies. No differences were found in either treatment group regarding the frequency of studying for tests. The learning-style group's significantly higher achievement scores in light of no differences found in its frequency of studying, provided compelling support for the application of learning-style-responsive strategies to studying mathematics.

The effects on achievement of homework and studying vary by grade level, but the positive influence of these two activities on many middle-school students has been well documented (Cooper, 1989). For example, Walberg (1991) reported that eighth graders who averaged the most homework–between eight to nine hours weekly–also had the highest average test scores in a survey of 11 countries.

Positive achievement also was manifested among culturally-diverse student populations who studied and did homework. In 1994, Peng and Wright revealed that the Asian-American students who evidenced higher achievement than other minorities were likely to spend more time doing homework. Similarly, Hernandez-Gantes (1995) found that Hispanic-American students' achievement was strongly influenced by the amount of homework they completed.

Despite these positive findings, two problems diminish reliance on homework as an across-the-board solution for increasing student achievement. The first is that, unlike most in-school activities, homework and studying are self-regulating; as such, they require individual responsibility. Two studies, the first conducted by Senecal, Koestner, and Vallerand (1995) and the second conducted by Schunk (1996), stressed the importance of self-efficacy for self-regulating activities such as homework/studying. However, Weinstein (1987) asserted that we could not expect students to accept responsibility and become self-directed unless we helped them to acquire appropriate competencies and attitudes.

A second problem exists. Despite the general achievement gains that resulted from studying and doing homework, some students who engaged in these two activities did not benefit. Many of these focused on assignments soberly but could not maintain concentration. Others concentrated, but did not retain what they studied. Many experienced anger, anxiety, and diminished curiosity about the subjects they were required to study (Lenehan, Dunn, Ingham, Murray, & Signer, 1994). Why is homework and studying effective for some and not for others? Not all students learn best in the same way (Dunn & Griggs, 1995). The application of learning style strategies was established as an effective approach for accomplishing the retention of new and difficult information for students with a wide range of learning strengths (Dunn & Stevenson, 1997). Therefore, the application of learning-style responsive strategies for studying and doing homework may be effective for students who learn differently from their classmates.

Positive effects have been reported when study strategies were matched to individuals' learning style preferences at the elementary, high school, and college levels. Turner (1993) reported significantly improved spelling achievement for fifth-graders that applied learning-style strategies when completing homework assignments and another study provided similar data for high school students across the board. At the college level, Cook (1989) reported significant increases in achievement for second-term anatomy students merely made aware of their learning styles. Nelson and colleagues (1993) examined the effects of a learning style intervention with more than 1,000 college students. This investigation revealed significantly higher grade-point-averages and improved attitudes for students made aware of their learning style preferences and then provided with suggestions for accommodating those preferences when studying and completing assignments. The findings of Cook (1989) and Nelson et al. (1993) were corroborated by Lenehan et al. (1994) who also reported significant increases in grade-point-averages and improved attitudes for students who had been provided homework/study prescriptions based on their individual learning style preferences.

Conflicting Data Concerning Learning-Style Based Homework Prescriptions for Middle School Students

Despite the successful findings with elementary and college students, evidence at the middle-school level was mixed. Only one of three studies reported significant positive effects when learning style responsive strategies were applied to homework/ studying. Significant effects, as measured by grade-point-averages (especially in mathematics and geography) were reported by Ogden (1989), whereas two other studies at the middle-school level revealed no significant effects when learning-style-responsive strategies were applied to studying. However, these studies had serious methodological limitations.

Although she used a comprehensive model that included many learning style variables, Monsour (1991) examined only a few of its variables–negating the advantage of a model capable of providing multiple data. White (1996) reported that her results were influenced by an unexpected intervening variable–teacher effects. Because of the significant effects reported at both the elementary and college levels, continued investigation at the middle-school level appeared appropriate.

The Dunn and Dunn Learning Style Model

Of the three comprehensive learning-style models available (Dunn & Dunn, 1972; Hill, 1971; Keefe, 1991), only the Dunn and Dunn Model provides instrumentation for identifying and specific approaches for teaching middle-school students. It is one of the most reliable and valid models (Curry, 1987; DeBello, 1990). Because it is comprehensive, it identifies a wide range of learning-style preferences including 21 environmental, emotional, sociological, physical, and psychological elements. Therefore, it was chosen for this investigation.

A meta-analysis of 42 experimental studies conducted with this model between 1980-1990 at 13 different universities revealed that eight variables coded for each study produced 65 individual effect sizes (Dunn & Griggs, 1995). The overall, unweighted group effect size value (*r*) was .384 and the weighted effect size value was .353 with a mean difference (*d*) of .755. Referring to the standard normal curve, this suggests that students whose learning styles are accommodated would be expected to achieve 75% of a standard deviation higher than students who have not had their learning styles accommodated. This indicated that matching students' learning style preferences with educational interventions compatible with those preferences was beneficial to their academic achievement.

Method

Research Design

The research design was structured to assure that what was measured is what it was intended to measure: namely, the absorption of knowledge in mathematics at the middle-school level as a consequence of learning-style responsive strategies applied to homework and studying. Students were assigned to two cohorts–one of average academic ability, the other of below-average ability. Both cohorts were comprised of a learning-style-responsive and a traditional study strategy group. All groups were as comparable in make-up as feasible. The research design is summarized in Table 1. Among the controls built into the design itself were the following:

- student level of intelligence
- amount of mathematics instruction
- teacher experience and preparation (two teachers only, both of whom had masters' degrees and 25+ years of experience)
- student knowledge of nature and meaning of learning style preferences
- prescriptions for studying based on students' individual learning-style preferences
- incidence of study
- frequency of tests
- level of difficulty of tests
- students' awareness of their own learning style preferences

Other possible vitiating factors that could not be built into the design also were identified and every effort was made to control them. Among such additional problem areas, all of whose clouding effects were virtually eliminated, were fire drills, assemblies, nurse visits, and other possible causes of students' class absences. Any of these held the potential to jeopardize the purity of the research design. These careful controls virtually eliminated any possible contaminating viruses they otherwise may have caused. The possible varying difficulty of tests–the results of which were to be compared–were controlled through evaluation by a jury of knowledgeable and experienced teachers. Teacher adherence to lesson plans and to other procedures were monitored religiously. Finally, a comparable composition of all groups was sought in the student assignment process.

Participants

The student population was comprised of 130 middle-school students enrolled in eight mathematics classes in a suburban district in the northeast. These students formed a culturally diverse group (Hispanic-44.6%; Euro-American-33.9%; African-American-20%; Asian-American-1.5%).

Procedures

The study was conducted in three phases. During the first phase, no treatment was administered. Students completed the LSI, which diagnosed individual student learning styles, and the SDS, which assessed attitudes. Two weeks of mathematics instruction were provided and two mathematics tests (Tests 1 and 2) were administered. To assess the incidence of study, a query at the end of the second test (Test 2) asked students to indicate if they had studied for that test.

During the second phase, students were provided with information on study skills. One group in each cohort received information on traditional study skills. This information included suggestions regarding an environment that was quiet, had bright lighting and a formal design (desk or table). Also included were suggestions regarding note taking, questioning, and reviewing.

Students in the second group in each cohort received their learning-style profiles and individual homework prescriptions. The homework prescriptions were generated by a software program that produced suggestions for studying based on each individual's diagnosed learning style. No direct instruction in study-skills strategies was provided.

Following the first treatment, two weeks of mathematics instruction were provided and two mathematics tests (Tests 3 and 4) were administered. As in Phase One, a query at the end of the second test (Test 4) asked students to indicate if they had studied for that test.

During the third phase, students received three lessons in study strategies. One group in each cohort received instruction in traditional study strategies that elaborated on the suggestions given in Phase Two. The second group in each cohort received instruction in learning-style-responsive study strategies that would accommodate individual preferences regarding the study environment, and emotional, sociological, and perceptual preferences. Two weeks of mathematics instruction were provided and two mathematics tests (Tests 5 and 6) were administered. As in the first two phases, a query at the end of the second test (Test 6) asked students to indicate if they had studied for that test.

Results

Mathematics Achievement

Pretest and posttest results for mathematics achievement are given in Table 2 and Table 3. For students of average ability, Test 1 was invalid because one class received only three of the four lessons that were the basis for that test due to an unplanned grade level meeting. An independent samples *t*-test on the data from Test 2 revealed a significant difference in achievement between the groups ($t = 3.235$, $p < .01$). The researchers, then, employed a series of Analyses of Covariance (ANCOVA). Using Test 2 as a covariate, an ANCOVA analyzed the scores on Test 3. This test revealed a significant difference ($F(1,65) = 26.582$, $p < .001$) between the two groups. ANCOVAs performed on the data from Test 4 with Test 2 as covariates uncovered no significant difference between the groups. Similarly, Tests 5 and 6, using the scores of Tests 2, 3, and 4 as covariates, revealed no significant differences between the groups. Thus, for average students there was some limited support for providing students with learning-style-responsive study strategies over traditional study strategies. No additional benefit was realized after direct instruction.

For below-average students, an independent samples *t*-test indicated that on Tests 1 and 2 there were no significant differences between the two groups. Using the scores of these two tests as covariates, ANCOVAs revealed significant differences between the groups on Tests 3 ($F(1, 54) = 4.130$, $p < .05$) and 4 ($F(1, 54) = 4.492$, $p < .05$). Using the first four tests as covariates, Test 5 revealed no significant difference between the groups. However, with the same covariates, Test 6 indicated that there was a significant difference ($F(1, 49) = 4.230$, $p < .05$) between the groups. Thus, the data supported the benefit of providing below-average students with learning-style-responsive study strategies over traditional study strategies.

Attitude Toward Mathematics

Students in both groups were tested on the *Semantic Differential Scale* (SDS) before receiving any mathematics instruction and at the end of the study (see Table 4). For average achievers, the traditional group scored significantly higher than the learning-style group on the first application of the SDS. However, after the students learned about their learning styles and were taught responsive strategies, an ANCOVA (with the first SDS as covariate) revealed that these students attained significantly higher scores than students in the traditional group ($F(1,65) = 7.467$, $p < .01$).

Paired-samples *t*-tests revealed that, for average students in the traditional group, there were no significance differences between pre and posttests. For the learning-style group, there was a significant improvement in mean scores ($t = 3.735$, $p < .01$). Thus, among average students there was not only a significant difference between the learning-style and traditional groups but a significant improvement within the learning-style group.

With below-average achievers, an independent-sample *t*-test revealed no significant difference between the two groups. Using this first test as a covariate, an ANCOVA revealed that the learning-style group received significantly higher scores ($F(1, 46) = 11.236$, $p < .01$) than the traditional group. Similarly for the average students, paired-samples *t*-tests found no change in attitude for the traditional group, and a significant improvement in mean scores ($t = 3.820$, $p < .01$) for the learning-style group.

Incidence of Study/Homework

An independent samples *t*-test revealed that for both average and below-average achievers there were no significant differences between the two groups when they were queried concerning the incidence of study and homework (see Table 5). An analysis of the scores from Tests 3, 4, 5, and 6 (using the same covariates as above) did not reveal any significant differences between the groups after the students were made aware of their learning styles. Thus, with both cohorts of students, there was no change in studying attributable to either treatment.

The frequency of on-time homework completions also were analyzed. The learning-style groups in both cohorts did not experience any significant decrease or increase in homework completions comparing the pre-treatment phase and the final phase of the study.

Table 2
Pre-Treatment Mathematics Achievement Test Scores

	Traditional		Learning Styles		
	M	SD	M	SD	*t*
Cohort One (Average Achievers)					
Test 1			*Invalid Test*		
Test 2	65	14.940	77	13.906	3.235*
Cohort Two (Below-Average Achievers)					
Test 1	71	16.011	75	17.110	.969
Test 2	65	23.669	69	15.978	.731

* $p < .01$

Table 3
Post-Treatment Mathematics Achievement Test Scores

	Traditional		Learning Styles		
	M	SE	M	SE	*F*
Cohort One (Average Achievers)					
Test 3	69	2.070	84	1.826	26.582**
Test 4	64	3.961	74	3.600	3.188
Test 5	76	3.348	77	2.987	.037
Test 6	72	3.756	72	3.352	.000
Cohort Two (Below-Average Achievers)					
Test 3	70	2.797	78	2.896	4.130*
Test 4	70	3.083	79	3.192	4.492*
Test 5	78	2.627	83	2.725	1.483
Test 6	67	3.113	76	3.301	4.230*

* $p < .05$. ** $p < .001$
Note: Means are estimated marginal means with standard errors.

Table 4
Posttest Scores: Attitude Toward Homework/Studying Mathematics

	Traditional		Learning Styles		
	M	SE	M	SE	*F*
Cohort					
Average Achievers	37.5	1.593	43.2	1.373	7.467*
Below-Average Achievers	38.3	1.533	45.7	1.565	11.236*

$p < .01$.
Note: Means are estimated marginal means with standard errors. Minimum score = 12; maximum score = 60.

Table 5
Homework Completions, Traditional Groups, Cohorts One and Two

	Phase One		Phase Three		
	M	SD	M	SD	*t*
Cohort One	5.4	.80	4.8	.99	3.214**
Cohort Two	5.6	.64	4.9	1.80	2.430*

* $p < .05$; ** $p < .01$.
Note: Mean scores indicate on-time completions out of 6 required assignments.

However, the traditional group in each cohorts experienced a significant *decrease* in on-time homework completions (Cohort One, $t = 3.214$, $p < .01$; Cohort Two, $t = 2.430$, $p < .05$).

Conclusions

Middle-school students who studied mathematics with prescriptions based on their learning-style preferences achieved statistically higher achievement test scores than their counterparts in an equivalent group who studied with prescriptions based on conventional study methods. Furthermore, the learning-style group did not study longer; they merely studied more efficiently. The data from this investigation corroborated those of previous studies in which students followed procedures for studying that complemented their individual strengths (Cook, 1989; Lenehan et al., 1994; Nelson et al., 1993; Ogden, 1989; Turner, 1993). The difference herein was that adolescents demonstrated that they, too, could assume responsibility for their learning by focusing on their unique learning-style strengths rather than on traditional study practices.

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