Learning and Instruction in Mathematics: A Study of Achievement in Saigon, Vietnam.

Thienhuong Hoang, Ph.D.
California State Polytechnic University, Pomona

Abstract

The purpose of this study was to investigate the relationship between learning and instruction in mathematics achievement of 12-year-old students in Saigon, Vietnam. The researcher examined several instructional practices and employed variance estimation procedures for complex sampling designs. There were several significant findings from this study and these results identify significant relationships between classroom teaching practices and mathematics achievement. These results also extend previous findings by simultaneously assessing the effects of multiple instructional strategies and by examining students in a cross-cultural setting where high levels of mathematics achievement have been noted.

Introduction

There has been considerable interest in the study of instructional practices for mathematics teaching in Asia. Recent assessments have indicated that students in several Asian countries, such as Japan, Hong Kong, Korea, and Singapore, have tended to score above international averages (Kelly, Mullis, & Martin, 2000). In order to explore possible explanations for these achievement differences, an international study has been conducted to examine cultural factors, such as mathematics curriculum and content, student characteristics and learning styles, and instructional strategies (International Commission on Mathematical Instruction, 2000). Leung (2001) has considered East Asian approaches to mathematics and suggested that Asian students have been encouraged to use memorization as part of the learning process, have been expected to understand that success is dependent upon hard work and studying, and that Eastern cultural values tend to result in whole-class teaching and learning. For example, students in Chinese Taipei (Taiwan) have been found to spend more time on academic activities (such as after-school instruction and studying) than did American students (Fuligni & Stevenson, 1995). Similarly, Asian students were more likely than American students to have parents with high expectations and to express beliefs that academic success is achieved through hard work (Chen & Stevenson, 1995). Other research indicates that students in Japan have extensive practice incorporated into their daily schedule (Shimizu, 1998) and that they are required to complete more daily homework (Stigler, Lee, Lucker, & Stevenson, 1982). Results from an observational study of activities in elementary-school mathematics classrooms in the United States and Japan indicated that teachers in Japanese classrooms spent significantly more class time asking academic questions of the entire group while United States teachers asked significantly more questions of individual students (Stigler, Lee, & Stevenson, 1987). Mathematics classes in Japan may spend an entire period examining multiple facets of a single problem and teaching aids that can be manipulated by students are often used to illustrate how to use multiple problem-solving strategies (Sawada, 1999). Similarly, teachers in Japanese classrooms were found to provide students with more extended explanations in their mathematics lessons (Perry, 2000) and were more likely to give positive responses to students' answers in class, even if those answers were incorrect (Whitman & Lai, 1990). These findings suggest that there are cultural differences in expectations for student achievement in mathematics and in classroom practices and instructional strategies.

Theoretical Framework

One strategy that has been used for mathematics teaching is the incorporation of cooperative learning activities into mathematics lessons. Research findings suggest that cooperative learning strategies are typically associated with improved student achievement and more favorable attitudes toward mathematics. Cooperative learning activities provide variety for elementary-school mathematics (Lemme, 1998). Similarly, results from a study of secondary school students indicated that the use of cooperative learning groups resulted in higher mathematics achievement test scores and also suggested that students enjoyed working together (Whicker, Bol, & Nunnery, 1997). Wickert (2000) found that cooperative learning during elementary-school mathematics provided students with improved self-confidence and opportunities to share problems. Further, the use of cooperative learning in a middle-school mathematics classroom resulted in increased mathematical communications which subsequently enabled students to use more active learning strategies that improved understanding (Leikin & Zaslavsky, 1999). Recent findings indicate that students in Japan who reported that they more frequently used cooperative learning strategies during their mathematics lessons also tended to express more enjoyment for learning mathematics (House, 2001). House (2001) found that students who used cooperative learning more frequently during their typical mathematics lessons tended to earn higher mathematics test scores; however, more frequent use of cooperative learning when new mathematics topics were being introduced was associated with lower achievement test scores.

Several studies have examined features of cooperative learning that are conducive to student outcomes. Artzt (1996) indicated that monitoring group discussions during cooperative learning is critical for students to develop mathematical reasoning and for monitoring their own problem-solving strategies. Further, an analysis of fifth-grade students using cooperative learning groups indicated that students were motivated by the use of practical mathematics problems and that is was important to use multiple assessment techniques to fully measure students' learning gains (Bulgar & Tarlow, 1999). In addition, the composition of cooperative learning groups is important for enhancing student achievement. Ma (1996) found that students who were at lower achievement levels tended to gain the most from group learning in mathematics. These findings provide evidence that cooperative learning strategies can be effective for improving student achievement in mathematics.

The effective use of homework has been found to facilitate student achievement. Research has indicated that, in general, students who spend more time on homework tend to show higher levels of academic achievement (Cooper & Valentine, 2001). Analyses of the mathematics performance of tenth-grade students as part of the National Education Longitudinal Study of 2003 (NELS: 83) indicated that the amount of time students spent on homework was significantly related to mathematical knowledge, but not with mathematical reasoning (Kupermintz, Ennis, Hamilton, Talbert, & Snow, 2005). House (1999) reported that the number of hours per week that older adolescent students spent on studying/homework was significantly correlated with degree completion. Homework activities may serve to enhance student performance by providing opportunities for increased practice, more frequent parent-child interactions, increased learning involvement, and more opportunities for peer interactions (Epstein & Van Voorhis, 2001). More frequent homework assignments were more effective for improving mathematics achievement than were longer assignments (Trautwein, Koller, & Schmitz, 2002). Other findings indicate that students who showed more positive attitudes about homework tended to complete their homework more often and earn higher grades (Cooper, Lindsay, & Nye, 1998). Cultural differences have been

noted regarding the use of homework. Findings from the NELS: 88 study indicated that Asian-American students spent more time on homework activities (Peng & Wright, 1994) while students from Asian immigrant and Asian-American families spent more time doing homework than did students from majority families (Mau, 1997). Finally, it has been found that Chinese students who were at lower levels of mathematics achievement showed learning gains from cooperative homework activities (Ma, 1996). Consequently, it is important to consider the effects of homework activities when assessing the relationship between instructional strategies and students' academic achievement.

Several international assessments of student performance have been done and the Third International Mathematics and Science Study (TIMSS) is the largest and most comprehensive international assessment of educational contexts and student achievement yet conducted (Martin, 1996). As part of the TIMSS assessment, a model was proposed to examine the unique effects of contextual factors such as classroom environment and instructional practices, family expectations and resources, and student self-beliefs on science and mathematics achievement (Schmidt & Cogan, 1996). Several initial findings from the TIMSS assessment have identified factors associated with student achievement in cross-cultural contexts. For instance, findings from numerous countries indicated that several factors were consistently associated with student achievement, including the amount of time spent on mathematics homework, educational aspirations of the student, and being in an orderly classroom (Martin, Mullis, Gregory, Hoyle, & Shen, 2000). Other research identified a significant negative relationship between the frequency of calculator use and mathematics achievement test scores of adolescent students in Japan and a non-significant relationship for adolescent students in the United States (Tarr, Mittag, Uckawa, & Lennex, 2000).

House (2001) identified several classroom strategies that were associated with the mathematics achievement of adolescent students in Japan; students who indicated that their teachers more frequently explained the rules and definitions when learning new topics and that they more frequently tried to solve an example related to the new topic tended to show higher mathematics test scores. In addition, students who reported that their teachers more frequently gave them homework, showed them how to do mathematics problems, and more frequently used things from everyday life for solving mathematics problems tended to have higher mathematics test scores (House, 2001). In addition to the TIMSS international assessment, a second study (the TIMSS Videotape Classroom Study) was conducted to examine classroom factors in an international context and their relationship to student performance (Stigler, Gonzales, Kawanalta, Knoll, & Serrano, 1999). Results from that study indicated that students in Japan spent more time inventing and proving mathematical concepts while students in the United States spent more time on routine practices (Stigler, Gallimore, & Hiebert, 2000). Finally, a case study of a geometry lesson in Japan from the TIMSS Videotape Classroom Study identified specific instructional activities designed to enhance student attention and interest that were incorporated into computer-based teaching for mathematics (House, 2002). The purpose of this study was to investigate the relationship between learning and instruction in mathematics achievement of 12-year-old students in Saigon, Vietnam. The researcher examined several instructional practices and employed variance estimation procedures for complex sampling designs. There were several significant findings from this study and these results identify significant relationships between classroom teaching practices and mathematics achievement. These results also extend previous findings by simultaneously assessing the effects of multiple instructional strategies and by examining students in a cross-cultural setting where high levels of mathematics achievement have been noted.

Methods

The researcher involved a two-stage stratified cluster design. In this design, schools were sampled during the first stage of sampling and then classrooms within schools were sampled during the second stage. A student questionnaire written in Vietnamese was used to collect data regarding classroom instructional activities, student and family characteristics, learning resources, out-of-school activities, and mathematics achievement. Students included in these analyses were in Saigon, Vietnam. There were 564 students (282 females and 282 males) who completed all of the measures regarding instructional activities used when introducing new mathematics topics, 564 students (281 females and 282 males) who completed all of the items regarding homework activities, and 565 students (281 females and 284 males) who provided complete responses about teaching activities used in typical mathematics lessons.

The researcher examined the effects of three types of instructional activities (teaching strategies for new mathematics topics, homework activities, and typical classroom activities) on mathematics achievement. With regard to teaching strategies used when introducing new mathematics topics, students indicated how frequently the following activities were used in their mathematics classes: “When we begin a new topic in mathematics, we begin by...” (a) Having the teacher explain the rules and definitions, (b) Discussing a practical or story problem related to everyday life, (c) Working together in pairs or small groups on a problem or project, (d) Having the teacher ask us what we know related to the new topic, (e) Looking at the textbook while the teacher talks about it, and (f) Trying to solve an example related to the new topic.

Considering homework activities, students indicated how frequently the following techniques were used in their mathematics classes: (a) The teacher gives us homework, (b) We can begin our homework in class, (c) The teacher checks homework, (d) We check each other’s homework, and (e) We discuss our completed homework. With respect to typical classroom instructional activities, students reported: “How often does this happen in your mathematics lessons?” (a) The teacher shows us how to do mathematics problems, (b) We copy notes from the board, (c) We work on mathematics projects, (d) We work from worksheets or textbooks on our own, (e) We use computers, (f) We use things from everyday life in solving mathematics problems, (g) We work together in pairs or small groups, and (h) The teacher uses a computer to demonstrate ideas in mathematics. On each of these items, original codings were transformed such that the following levels of agreement were indicated: (a) never, (b) once in a while, (c) pretty often, or (d) almost always. Finally, the researcher examined each student’s score on the Mathematics assessment. Several mathematics content areas were included on this achievement test, including fractions and number sense, measurement, geometry, algebra, and data representation, analysis, and probability. Multiple regression procedures were used to simultaneously assess the relative contribution of each instructional activity toward the explanation of mathematics achievement test scores. Separate analyses were conducted for each of the three types of instructional activities included in this study. For each of the three types of activities, analyses were conducted for the entire sample and separately for male and female students.

Data

Separate analyses were conducted for each of the three types of instructional activities included in this study. For each of the three types of activities, analyses were conducted for the entire sample and separately for male and female students. The overall multiple regression equation that assessed the joint significance of the complete set of teaching strategies for introducing new mathematics topics was significant, $F(6,70) = 70.64$, $p < .001$, and explained 12.2% of the variance in test scores. When analyzed by student gender, the same six variables entered the multiple regression equation

for female students and the relationships observed were similar to those noted for the entire sample. In addition, the multiple regression equation that assessed the joint significance of the complete set of reaching strategies for introducing new mathematics topics was significant for female students, $F(6, 70) = 44.78$, $p < .001$, and explained 10.7% of the variance in test scores. With regard to male students, four variables significantly entered the multiple regression equation. Three teaching strategies showed significant positive associations with mathematics achievement. Male students who indicated that their teachers more frequently explained the rules and definitions for new topics also tended to earn higher test scores. Similarly, male students who reported that they more frequently tried to solve an example related to the new topic and looked at the textbook while their teachers talked about it also tended to show higher test scores. However, male students who more frequently worked together in pairs or small groups on a problem or project were more likely to earn lower mathematics test scores. Finally, the overall multiple regression equation that included the complete set of teaching strategies for introducing new mathematics topics was significant for male students, $F(6,70) = 49.56$, $p < .001$, and explained 14.6% of the variance in mathematics test scores.

Students who reported that their teachers more frequently gave them homework also tended to earn higher mathematics test scores. Students who indicated that they more frequently discussed their completed homework during their mathematics lessons also tended to show higher test scores. The overall multiple regression equation that assessed the joint significance of the complete set of homework activities was significant, $F(5,71) = 40.1$, $p < .001$, and explained 7.3% of the variance in mathematics test scores. When analyzed by student gender, the same three variables entered the multiple regression equations for male and female students and the relationships observed were similar to those seen for the entire sample. The overall multiple regression equation that included the complete set of homework activities was significant for female students, $F(5,71) = 29.19$, $p < .001$, and explained 7.3% of the variance in mathematics test scores. Similarly, the overall multiple regression equation that considered all homework activities was significant for male students, $F(5,71) = 24.02$, $p < .001$, and explained 7.5% of the variance in mathematics achievement test scores.

In addition, students who reported that their teachers more frequently used a computer to demonstrate ideas in mathematics tended to show lower mathematics test scores. Similarly, students who more frequently used computers in their mathematics lessons tended to show lower test scores. The overall multiple regression equation that assessed the joint significance of the complete set of instructional activities was significant, $F(8,68) = 77.87$, $p < .001$, and explained 17.8% of the variance in mathematics test scores. When analyzed by student gender, the same six variables entered the multiple regression equation and the relationships obtained were similar to those noted for the entire sample. In addition, the overall multiple regression equation including the complete set of instructional activities was significant, $F(8,68) = 31.48$, $p < .001$, and explained 15.0% of the variance in mathematics achievement test scores. With regard to male students, seven variables significantly entered the multiple regressions. The same six variables that entered the multiple regressions for the entire sample also were significant for male students and the relationships observed were similar to those seen for the entire sample. In addition, male students who reported that they more frequently copied notes from the board during their mathematics lessons also tended to show lower test scores. Finally, the overall multiple regression equation that assessed the joint significance of the complete set of instructional strategies was significant, $F(8,68) = 63.75$, $p < .001$, and explained 21.1% of the variance in mathematics achievement test scores for male students.

Results

Descriptive statistics for each teaching strategy and mathematics achievement test scores for the entire sample are presented in Table 1. It is important to note that those values are not descriptive statistics for the sample of students from Vietnam. Rather, for each variable estimates of the population mean and the standard errors of those estimates are presented. Similar descriptive statistics were computed by student gender and are shown in Table 2.

Table 1. Descriptive Statistics (All Students)

Instructional Strategy	Mean Estimate	Standard Error of Estimate
A. *Teaching Strategies for New Mathematics Topics*		
Having the Teacher Explain the Rules and Definitions	3.48	0.018
Discussing a Practical or Story Problem Related to Everyday Life	2.57	0.019
Working Together in Pairs or Small Groups on a Problem or Project	1.65	0.026
Having the Teacher Ask Us What We Know Related to the New Topic	2.57	0.018
Looking at the Textbook While the Teacher Talks About It	2.78	0.028
Trying to Solve an Example Related to the New Topic	2.76	0.020
B. *Homework Activities*		
We Can Begin Our Homework in Class	2.24	0.021
We Discuss Our Completed Homework	2.62	0.023
We Check Each Other's Homework	2.42	0.028
The Teacher Gives Us Homework	2.89	0.046
The Teacher Checks Homework	2.79	0.037
C. *Typical Classroom Instructional Activities*		
The Teacher Shows Us How to Do Mathematics Problems	3.48	0.015
We Work on Mathematics Projects	2.66	0.020
We Work From Worksheets or Textbooks on Our Own	2.72	0.021
We Use Things From Everyday Life in Solving Mathematics Problems	2.37	0.018
We Use Computers	1.52	0.016
We Work Together in Pairs or Small Groups	1.61	0.034
The Teacher Uses a Computer to Demonstrate Ideas in Mathematics	1.10	0.007
We Copy Notes From the Board	2.69	0.037
Mathematics Achievement Test Score	587.09	4.135

Table 2. Descriptive Statistics (By Student Gender)

	Female		Male	
Instructional Strategy	Mean Estimate	Standard Error of Estimate	Mean Estimate	Standard Error of Estimate
A. *Teaching Strategies for New Mathematics Topics*				
Having the Teacher Explain the Rules and Definitions	3.54	0.021	3.42	0.020
Discussing a Practical or Story Problem Related to Everyday Life	2.57	0.024	2.57	0.022
Working Together in Pairs or Small Groups on a Problem or Project Having the Teacher Ask Us	1.54	0.031	1.76	0.028
What We Know Related to the New Topic	2.55	0.022	2.58	0.021
Looking at the Textbook While the Teacher Talks About It	2.80	0.034	2.75	0.032
Trying to Solve an Example Related to the New Topic	2.76	0.024	2.76	0.023
B. *Homework Activities*				
We Can Begin Our Homework in Class	2.21	0.027	2.28	0.022
We Discuss Our Completed Homework	2.67	0.028	2.57	0.027
We Check Each Other's Homework	2.45	0.035	2.37	0.028
The Teacher Gives Us Homework	2.88	0.051	2.89	0.047
The Teacher Checks Homework	2.76	0.041	2.82	0.039
C. *Typical Classroom Instructional Activities*				
The Teacher Shows Us How to Do Mathematics Problems	3.56	0.016	3.40	0.019 0.022
We Work on Mathematics Projects	2.69	0.023	2.62	0.023
We Work From Worksheets or Textbooks on Our Own	2.75	0.024	2.69	0.019
We Use Things From Everyday Life in Solving Mathematics Problems	2.40	0.023	2.34	0.024
We Use Computers	1.44	0.017	1.59	0.024
We Work Together in Pairs or Small Groups	1.57	0.040	1.66	0.032
The Teacher Uses a Computer to Demonstrate Ideas in Mathematics	1.07	0.009	1.14	0.010
We Copy Notes From the Board	2.69	0.048	2.69	0.033
Mathematics Achievement Test Score	586.27	3.757	587.92	5.409

Correlations between teaching strategies for new mathematics topics and mathematics test scores are summarized in Table 3. Four significant positive correlations were obtained. Students who reported that their teachers more frequently explained the rules and definitions were more likely to earn higher test scores. Further, students who more frequently tried to solve an example related to the new topic in their mathematics lessons also tended to show higher test scores. Two additional teaching practices (discussing a practical or story problem related to everyday life and having

students look at the textbook while the teacher talked about it) were positively correlated with mathematics test scores when used more frequently in mathematics lessons. In addition, one significant negative correlation was observed. Students who indicated that they more frequently used cooperative learning activities (worked together in pairs or small groups on a problem or project) when learning new mathematics topics tended to show lower mathematics achievement test scores. When analyzed by student gender, the same five variables were significantly correlated with mathematics test scores for both male and female students and the relationships observed were similar to those seen for the entire sample.

Table 3. Correlations between Teaching Strategies for New Mathematics Topics And Mathematics Achievement Test Scores

When We Being a New Topic in Mathematics, We Began By:	All Students	Females	Males
Having the Teacher Explain the Rules and Definitions	.269**	.217**	.315**
Discussing a Practical or Story Problem Related to Everyday Life	.080**	.098**	.064**
Working Together in Pairs or Small Groups on a Problem or Project	-.158**	-.156**	-.163**
Having the Teacher Ask Us What We Know Related to the New Topic	.034	.026	.042
Looking at the Textbook While the Teacher Talks About It	.119**	.127**	.113**
Trying to Solve an Example Related to the New Topic	.167**	.172**	.164**

**$p<.01$

Results from the correlation analyses of the relationships between homework activities and mathematics achievement are shown in Table 4. Four homework activities showed significant positive correlations with mathematics test scores. Students who indicated that their teachers more frequently gave them homework were more likely to earn higher mathematics test scores. More frequent discussions of students' completed homework were also significantly related to higher mathematics test scores. Further, students who indicated that they more frequently checked each other's homework and that their teachers checked homework during their mathematics lessons also tended to show higher test scores. When analyzed by student gender, the same four homework activities were significantly correlated with mathematics test scores for both male and female students and the relationships observed were similar to those seen for the entire sample.

Table 4. Correlations Between Homework Activities and Mathematics Achievement Test Scores

When We Being a New Topic in Mathematics, We Began By:	All Students	Females	Males
We Can Begin Our Homework in Class	-.014	-.007	-.021
We Discuss Our Completed Homework	.172**	.196**	.151**
We Check Each Other's Homework	.106**	.125**	.089**
The Teacher Gives Us Homework	.233**	.226**	.240**
The Teacher Checks Homework	.114**	.112**	.117**

**p<.01

Correlations between typical classroom teaching strategies and mathematics achievement are presented in Table 5. Six significant correlations were obtained. Four significant positive correlations were noted. Students who indicated that their teachers more frequently showed them how to do mathematics problems during their lessons also tended to show higher test scores. Further, more frequent use of things from everyday life for solving mathematics problems was positively associated with student achievement. Two additional teaching strategies (students working more frequently on mathematics projects and more often working from worksheets or textbooks on their own) were significantly associated with higher mathematics achievement test scores when used more frequently during mathematics lessons. In addition, two significant negative correlations were obtained. Students who reported that they more frequently used computers during their mathematics lessons and that their teachers more often used a computer to demonstrate ideas in mathematics also tended to show lower mathematics test scores. When analyzed by student gender, the same six variables were significantly correlated with mathematics test scores for both male and female students and the relationships observed were similar to those seen for the entire sample. In addition, male students who reported that they more frequently worked together in pairs or small groups during their mathematics lessons also were more likely to earn lower mathematics test scores.

Table 5. Correlations between Typical Classroom Activities and Mathematics Achievement Test Scores

How Often Does This Happen in Mathematics Lessons?	All Students	Females	Males
The Teacher Shows Us How to Do Mathematics Problems	.247**	.236**	.259**
We Work on Mathematics Projects	.150**	.162**	.139**
We Work From Worksheets or Textbooks on Our Own	.152**	.162**	.143**
We Use Things From Everyday Life in Solving Mathematics Problems	.153**	.163**	.145**
We Use Computers	-.211**	-.181**	-.238**
We Work Together in Pairs or Small Groups	-.058	-.025	.086*
We Copy Notes From the Board	.012	.035	.010
The Teacher Uses a Computer to Demonstrate Ideas in Mathematics	-.281**	-.232**	-.317**

* $p < .05$ ** $p < .01$

Results from the multiple regression analyses of the relationships between teaching strategies for new mathematics topics and mathematics achievement test scores are presented in Table 6. Considering the entire sample, all six variables significantly entered the multiple regression equation. Four variables showed significant positive associations with mathematics test scores. Students who indicated that their teachers more frequently explained the rules and definitions for new topics tended to show higher test scores. Further, students who reported that they more frequently tried to solve an example related to the new topic also showed higher mathematics scores. Two additional activities (looking at the textbook while the teacher talked about it and discussing a practical or story problem related to everyday life) were associated with higher test scores when used more frequently while introducing new mathematics topics. In addition, two instructional strategies showed significant negative associations with mathematics achievement. Students, who reported that they more frequently worked together in pairs or small groups on a

problem or project when learning new mathematics topics, tended to earn lower test scores. Students who indicated that their teachers more frequently asked them what they knew about the new topic also tended to show lower mathematics test scores.

Table 6. Multiple Regression Findings for Relationships between Teaching Strategies For New Mathematics Topics and Mathematics Achievement Test Scores

When We Begin a New Topic in Mathematics, We Begin B:	Parameter Estimate	Standard Error of Estimate	F
All Students			
Having the Teacher Explain the Rules and Definitions	32.94	2.80	138.43**
Trying to Solve an Example Related to the New Topic	15.88	1.75	82.23**
Looking at the Textbook While the Teacher Talks About It	6.49	1.59	16.60**
Discussing a Practical or Story Problem Related to Everyday Life	4.56	1.74	6.85*
Working Together in Pairs or Small Groups on a Problem or Project	-24.50	3.43	51.10**
Having the Teacher Ask Us What We Know Related to the New Topic	-5.70	2.38	5.73*
Female Students			
Trying to Solve and Example Related to the New Topic	16.75	2.17	59.34**
Having the Teacher Explain the Rules and Definitions	24.18	3.43	49.61**
Looking at the Textbook While the Teacher Talks About It	7.63	2.03	14.13**
Discussing a Practical or Story Problem Related to Everyday Life	7.97	2.25	12.59**
Working Together in Pairs or Small Groups on a Problem or Project	-23.91	4.02	35.31**
Having the Teacher Ask Us What We Know Related to the New Topic	-7.70	2.88	7.15**
Male Students			
Having the Teacher Explain the Rules in Definitions	42.90	3.21	178.83**
Trying to Solve an Example Related to the New Topic	14.70	2.90	25.61**
Looking at the Textbook While the Teacher Talks About It	5.27	2.39	4.88*
Working Together in Pairs or Small Groups on a Problem or Project	-26.07	3.89	44.88**
Having the Teacher Ask Us What We Know Related to the New Topic	-3.71	3.25	1.30
Discussing a Practical or Story Problem Related to Everyday Life	0.70	2.27	0.09

* $p < .05$ ** $p < .01$

Findings from the multiple regression analyses of the relationships between homework activities and mathematics achievement are shown in Table 7. Considering the entire sample, three variables significantly entered the multiple regression equation. Two variables showed significant positive associations with mathematics achievement test scores. Students who reported that their teachers more frequently gave them homework also tended to earn higher mathematics test scores. In addition, students who indicated that they more frequently discussed their completed homework during their mathematics lessons also tended to show higher test scores. However, students who reported that they more frequently began their homework during class were more likely to earn lower test scores.

Table 7. Multiple Regression Findings for Relationships between Homework Activities and Mathematics Achievement Test Scores

How Often Does This Happen in Mathematics Lessons?	Parameter Estimate	Standard Error of Estimate	F
All Students			
The Teacher Gives Us Homework	26.52	3.26	66.38**
We Discuss Our Completed Homework	13.17	1.92	47.01**
We Can Begin Our Homework in Class	-10.24	2.25	20.80**
The Teacher Checks Homework	-4.60	2.59	3.15
We Cheek Each Other's Homework	0.08	1.78	0.00
Female Students			
The Teacher Gives Us Homework	22.55	3.58	39.76**
We Discuss Our Completed Homework	14.91	2.48	36.07**
We Can Begin Our Homework in Class	-8.76	2.77	10.00**
The Teacher Checks Homework	-4.92	2.78	3.14
We Check Each Other's Homework	1.06	2.28	0.22
Male Students			
The Teacher Gives Us Homework	30.70	4.45	47.51**
We Discuss Our Completed Homework	11.66	2.79	17.41**
We Can Begin Our Homework in Class	-11.87	2.83	17.60**
The Teacher Checks Homework	-4.53	3.72	1.48
We Cheek Each Other's Homework	-0.08	2.35	0.12

** $p < .01$

Results from the multiple regression analyses of relationships between classroom strategies and mathematics achievement test scores are summarized in Table 8. Considering the entire sample, six variables significantly entered the multiple regression equation. Four variables showed significant positive associations with mathematics achievement. Students who reported that their teachers more frequently showed them how to do mathematics problems tended to earn higher test scores. Similarly, students who indicated that they more often used things from everyday life when solving mathematics problems also tended to show higher mathematics achievement test scores. Further,

more frequent use of two additional instructional strategies (students worked on mathematics projects and they worked from worksheets or textbooks on their own) was positively associated with mathematics test scores. In addition, students who reported that their teachers more frequently used a computer to demonstrate ideas in mathematics tended to show lower mathematics test scores. Similarly, students who indicated that they more frequently used computers in their mathematics lessons tended to show lower test scores.

Table 8. Multiple Regression Findings for Relationships between Typical Classroom Activities and Mathematics Achievement Test Scores

How Often Does This Happen in Mathematics Lessons?	Parameter Estimate	Standard Error of Estimate	F
All Students			
The Teacher Shows Us How to Do Mathematics Problems	26.98	2.15	157.39**
We Use Things From Everyday Life in Solving Mathematics Problems	15.68	1.73	81.84**
We Work on Mathematics Projects	8.42	2.39	12.38**
We Work From Worksheets or Textbooks on our own	8.00	2.33	11.85**
The Teacher Uses a Computer to Demonstrate Ideas in Mathematics	-55.00	4.39	156.87**
We Use Computers	-19.46	1.97	97.90**
We Copy Notes From the Board	-4.57	2.35	3.77
We Work Together in Pairs or Small Groups	-3.75	3.43	1.20
Female Students			
The Teacher Shows Us How to Do Mathematics Problems	26.78	3.12	73.46**
We Use Things From Everyday Life in Solving Mathematics Problems	14.19	2.00	50.36**
We Work From Worksheets or Textbooks on our own	8.79	3.06	8.26**
We Work on Mathematics Projects	8.15	3.12	6.80*
The Teacher Uses a Computer to Demonstrate Ideas in Mathematics	-54.14	7.40	53.59**
We Use Computers	-17.86	2.49	51.49**
We Work Together in Pairs or Small Groups	-3.14	3.89	0.63
We Copy Notes From the Board	-3.14	2.56	0.60
Male Students			
The Teacher Shows Us How to Do Mathematics Problems	29.15	2.76	111.80**
We Use Things From Everyday life in Solving Mathematics Problems	17.94	2.46	52.99**
We Work on Mathematics Projects	9.53	3.50	7.43**
We Work From Worksheets or Textbooks on our own	7.34	3.48	4.44*
The Teacher Uses a Computer to Demonstrate Ideas in Mathematics	-56.08	5.22	115.34*
We Use Computers	-21.89	2.70	65.74**
We Copy Notes From the Board	-7.77	3.34	5.42*
We Work Together in Pairs or Small Groups	-5.22	3.79	1.90

** $p < .01$ * $p < .05$

Discussion

There are several significant findings from this study. For instance, students who more frequently try to solve examples related to new mathematics topics and who discuss practical problems related to everyday life tend to earn higher mathematics test scores. Students whose teachers more often explained the rules and definitions for new mathematics topics tend to earn higher test scores. In addition, students who report that their teachers more often gave them homework and that they discussed their completed homework are more likely to have higher test scores. Conversely, when students more frequently began their homework in class there was a negative relationship with mathematics test scores. During typical mathematics lessons, teachers more frequently showing how to do mathematics problems are associated with higher student achievement. Further, more frequent use of active learning strategies (students working on mathematics projects and using things from everyday life when solving mathematics problems) are significantly related to higher mathematics test scores. Several of these findings are consistent with previous research. McNair (2000) has noted that participation-based approaches to mathematics learning can help students to make connections to the application of mathematics in the real world. The use of active learning strategies in the classroom enables students to apply mathematical concepts and to foster meaningful learning (Crawford & White, 1999). With respect to the effective use of homework, these results are consistent with previous findings. More frequent use of homework are shown to be associated with higher levels of mathematics achievement (Trautwein, Kooler, & Schmitz, 2002), as was the case in this study. The finding that students who more frequently began their homework during class actually earned lower test scores is also similar to previous findings.

Consequently, these results identify several instructional strategies that are significantly related to mathematics achievement and a number of the findings are similar to previous reports. An interesting finding from this study is the relationship between cooperative learning activities and mathematics achievement. In this instance, cooperative learning strategies (working together in pairs or small groups on a problem or project) are negatively related to mathematics achievement when used more frequently for introducing new mathematics topics. Further, the use of cooperative learning (working together in pairs or small groups) during typical mathematics lessons is not significantly related to student achievement when the complete set of teaching strategies is considered simultaneously. Gabriele and Montecinos (2001) found that low-achieving students with more clear learning goals tended to learn more mathematics during cooperative learning activities than students who lacked dear learning goals. The use of cooperative learning increases student motivation for working on mathematical proofs and results in improved achievement (Fidler, 1999; Webb, Farivar, & Mastergeorge, 2002). The results of this study provide further understanding of specific instructional conditions where cooperative learning may be positively related to student achievement and situations, such as learning new mathematics topics, where cooperative learning may be less effective for student performance.

For the students in this assessment, there is a significant negative relationship between the use of computers and mathematics achievement. There is a tendency for students to earn lower mathematics test scores when teachers more frequently use computers to demonstrate mathematics ideas during classroom lessons. In addition, students who report that they more frequently use computers during their lessons tend to earn lower mathematics test scores. These results differ from several previous studies, which have found that computer use is typically associated with improved mathematics achievement. For instance, it is noted that the use of algebra software contributes to improved course performance (Stephens & Konvalina, 2001). Similarly, students indicate that they

find mathematics more interesting and learn more when using a computer program for reaching geometry concepts (Hannafin & Scott, 2001). Conclusions from a recent review suggest that the appropriate use of technology can have a positive impact on mathematics learning (Wiest, 2001). Consequently, further study is needed to assess the specific types of curriculum topics and problem-solving strategies incorporated into computer applications for students in mathematics lessons in order to more dearly identify effective uses of technology.

These results have several implications for teaching practices, and several of those strategies are similar to other current recommendations for the effective design of instruction for mathematics teaching and learning. For instance, one significant finding from this study is that students who report more frequent use of things from everyday life when solving mathematics problems during their lessons also tend to earn higher achievement test scores. There are numerous examples of classroom strategies designed to build mathematical connections through the use of concrete models and activities using practical examples. Crocker and Long (2002) have described a practical exercise designed to foster understanding of exponents through the use of examples from literature. Similarly, Hines (2002) has developed a dynamic physical model of a spool-elevating system that can be used to teach students about elementary functions. Finally, concrete models using tiles of varying shapes and sizes have been used to teach eight h-grade students about polynomial topics (Chappell & Strutchens, 2001).

A second suggestion for mathematics instruction is a focus on the effective use of homework. The results of this study indicate that students who are more frequently given homework and who more often discuss their completed homework in class also tend to show higher mathematics test scores. Alexander (2002) has suggested that homework provides students the opportunity to use real examples and other contexts for their mathematics learning than those typically found in classrooms while Kliman (1999) has identified potential contexts for mathematics learning for children, such as car or bus trips, outdoors, and during household chores. Further, Tripp (1998) reported that discussions of completed homework problems during class were effective for motivating students to do their homework

Yet another implication of these findings for mathematics instruction relates to the use of active learning. Students who indicate that they more frequently try to solve examples related to the new topic also tend to show higher mathematics test scores. There is considerable research that supports the use of active learning strategies when learning new mathematics topics. Classrooms designed for active learning strategies tend to include more hands-on activities and opportunities for students to discuss their solutions with each other and to incorporate problems based on realistic situations (Crawford & White, 1999). An important role of the teacher is to choose learning problems and situations that will actively involve students and stimulate an interest in how mathematics is applied in real-world situations (Smith, 1999). However, the selection of effective active learning examples and the development of a supportive classroom environment can serve to enhance student motivation for learning mathematics (Boyer, 2002). Consequently, the results of this study have a number of implications for effective instructional strategies for mathematics teaching and learning. The results of this study identify several significant relationships between instructional practices and mathematics achievement for students in a cross-cultural setting where high levels of mathematics achievement have been noted (Gonzales, et al., 2000). Further study is needed to assess the relationships between these instructional strategies and other types of outcome measures, such as student interest in mathematics. Consequently, further study is needed to assess those relationships for students at various grade levels and from a number of cultural contexts..

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