METACOGNITION, MOTIVATION, AND LEARNING: A STUDY OF MIDDLE SCHOOL STUDENTS' USE AND DEVELOPMENT OF SELF-REGULATED LEARNING STRATEGIES

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Current efforts to reform schools are edified by educators' and researchers' theories of the characteristics of successful learners. Paradigms are being shaped of successful learners who are knowledgeable, self-determined, and strategic. Evidence indicates that knowledgeable learners not only know content, they use it to think, solve problems, and evaluate the worth of information. Learners, who are self-determined, use and expand their tools to engage in meaningful learning. They are motivated, and persevere in the face of difficulty. Strategic learners have a repertoire of effective strategies for learning (Fennimore & Tenymann, 1991; Jones, 1991). Powerful instructional strategies have been developed for the classroom (Weinstein and Mayer, 1986; Pressley, Goodchild, Fleet, Zajchowski, Evans, 1989). This conception of learners has important implications for the development of curricula and instructional approaches to meet the needs of students facing challenges in an increasingly competitive world where strategies for manipulating information are essential and self-controlled thoughtfulness is a prerequisite for success.

Purpose

In a suburban Texas middle school, a visionary principal played a key leadership role in the development of a new core curriculum course. The principal's goal for the sixth grade students participating in the strategic thinking course was to have them take more initiative in their own learning, and to assist the students in acquiring the tools for learning that make self-regulation possible. The principal believed that students should have opportunities to acquire, examine, analyze, and synthesize information. Students were envisioned as becoming reflective and critical thinkers who can create meaningful learning products. The course, compiled by one of the school's teachers of gifted and talented students, focused on developing all students' thinking and learning strategies. There were three objectives for this study of the middle school students' use and development of self-regulated learning strategies. First, the primary purpose of the study was to discover whether or not sixth grade students, who participated in a strategic thinking course as a required element of their academic curriculum, could be taught to use self-regulated learning strategies. Second, the relationship among the students' theory of intelligence, confidence of intelligence, and their propensity to employ self-regulated learning strategies was of interest. Third, the study investigated the difference between the experimental and control group students' theory of intelligence and confidence of intelligence.

Conceptual Framework

Research from the fields of cognitive science, philosophy, and psychology has clarified our understanding of terms such as *self-determined*, *self-directed*, or *self-regulated* learning. From a social cognitive perspective, learning involves knowledge acquisition through cognitive processing of information (Bandura, 1986). Bandura views self-regulated learning as being achieved through the triadic interaction of environmental events, cognitive and personal factors,

and behavior. The three events are separate, yet interdependent. Reciprocal determinism allows individuals the opportunity to exercise control over their destinies and set their own course of self-direction. Zimmerman (1989), contends that "students can be described as self-regulated to the degree that they are metacognitively, motivationally, and behaviorally active participants in their own learning process" (p. 329). Metacognitive, in this sense, "refers to decision-making processes that regulate the selection and the use of various forms of knowledge" (p. 329). In terms of metacognition, self-regulated learners plan, organize, self-instruct, self-monitor, and self-evaluate at various phases of the learning process. Motivationally, self-regulated learners perceive themselves as competent, self-efficacious, and autonomous. Through their behavior, these learners select, structure, and create environments that optimize learning. They initiate and direct their own efforts to acquire knowledge, rather than relying on others. All learners are self-regulated to some degree, but the awareness of how specific strategies can be utilized to influence learning outcomes and the willingness to employ the strategies to achieve academic goals identifies truly self-regulated learners. The use of these learning strategies heightens the learners' sense of self-efficacy (Zimmerman, 1990).

Additionally, there is a line of research indicating that individuals have implicit beliefs or theories about intelligence that influence learning (Dweck & Bempechat, 1983, Dweck & Leggett, 1988). Individuals holding an *entity theory* believe that intelligence is something that cannot be changed. Evidence shows that these individuals are oriented toward *performance goals* and are described as having an external locus of control. Children who maintain an *incremental theory* believe that intelligence is a malleable quality developed through individual effort. Those who view their own intelligence as expandable (incremental theorists) are concerned with *learning goals*, and tend to be intrinsically motivated (Dweck & Henderson, 1989). Research also indicates that children's theories of intelligence, manifested through goal-orientations, may predict whether they will use or fail to use learning strategies (Ames & Archer, 1988; Diener & Dweck, 1978, 1980).

Current Study

During the 1992-1993 school year, the sixth-grade students in a Texas middle school participated in a strategic thinking class. The curriculum for the course centered around four key components, modules within the components, and units within modules. Although the curriculum was written in a linear fashion, actual implementation was flexible. The teacher had the option to choose elements that matched the students' needs or elements that correlated with the units of instruction that other teaching team members emphasized. The primary components included (a) Tools for Thinking; (b) Critical Thinking; (c) Creative Thinking, and (d) Problem Solving. Various expert resources were used to design the units of instruction. Included among the resources were *Practical Strategies for the Teaching of Thinking* (Beyer, 1987), *Organizing Thinking: Graphic Organizers* (Black & Black, 1990), *Tactics for Thinking* (Marzano & Arrendondo, 1986), *Tools for Learning* (Gall, Gall, Jacobsen, & Bullock, 1990), *Creating the Thoughtful Classroom* (Udall & Daniels, 1991), and *Learning to Learn* (Frender, 1990).

Component one, Tools for Thinking, concentrated on developing conducive attitudes, behaviors, and practices for thinking. The students learned about the brain, human memory and thinking, learning modalities, and multiple intelligences. They developed a personalized study program for organizing materials at home and at school. They learned how to prioritize and manage assignments and activities. Every student had a spiral notebook called the *agenda*. The students used the agenda notebook for goal-setting and planning, tracking assignments, and designing an individualized study area and study plan. The agenda enabled students to plan and organize their thinking and materials and served as a communication tool among students, parents, and teachers. Organization for thinking was taught through the use of graphic organizers and notetaking. Component two, Critical Thinking, was introduced with a unit on metacognition derived from Marzano and Arredondo's (1986) *Tactics for Thinking*. The students learned about attention control, deep processing, memory frameworks, power thinking, goal-setting, and assuming responsibility for the essential elements of a task. The students engaged in think, pair, share activities, and used their thinking log (i.e., thinking journal) to write about their thinking. Students experienced analogical reasoning, used logic, and applied evaluative thinking skills.

Component three, Creative Thinking, focused on understanding the process of creative thought. The students applied creative thought to the invention of creative products. They learned to work together in heterogeneous, cooperative groups. They engaged in brainstorming and shared their creative thinking processes with one another through think-aloud activities. The library was utilized as a resource for information to develop products for such activities as the science fair, preparing presentations, or researching a topic. The fourth component, Problem Solving, emphasized the problem solving process. Throughout the year, real-life problems were explored. When projects were assigned in the content areas, the strategic thinking teacher took the responsibility for guiding the students through the planning and problem solving process. The newspaper was used as a source for addressing problems of world concern.

Method

Sample

The sixth-grade subjects in the experimental group in this study attended a middle school in a large suburban school district in North Central Texas. The ethnic composition of the school includes approximately 92% white, 4% Hispanic, 2% African American, and 2% other. Approximately 6% of the students are classified as economically disadvantaged and there are no students of limited English proficiency. The control sample attended a middle school in the same suburban school district. The control school was selected because the demographic data reflect a population that is comparable to the experimental school. The experimental subjects included 83 sixth-grade students (48 boys and 35 girls) taught by a team of five teachers. One instructor taught the strategic thinking course. The other four teachers were responsible for the academic disciplines of language arts, mathematics, social studies, and science. Approximately 115 minutes per week were allocated for the strategic thinking course for the duration of the 1992-1993 academic year. The control sample also consisted of 83 sixth-grade students (54 boys

and 29 girls) taught by a team of five teachers. The teaching assignments for the control group teachers were comparable to those for the experimental group, except that no strategic thinking course was included for the control group. However, both the experimental and control group teachers participated in a district-sponsored staff development program focused on creating thoughtful classroom environments. Except for the strategic thinking component at the experimental school, the textbooks and curriculum for the two middle schools were comparable.

A procedure was used to balance the groups and assure comparable experimental and control samples. The students' national percentile rank scores on the 1991-1992 Norm-Referenced Achievement Program for Texas (NAPT) were used to create pairs of high, medium, and low achieving, male and female students from the experimental and control schools. Students whose percentile rank scores on the NAPT were in the highest 25% for their school were designated as the high achievement group. For both samples, scores occurring at or above the 90th percentile were designated as high achievers. Students whose percentile rank scores fell in the central 50% of the scores were designated as the medium achievement group. For both samples, students whose percentile rank scores fell at or above the 60th percentile and below the 90th percentile were designated as the medium achievement group. Students whose scores fell in the lowest 25% for their school composed the low achievement group. Any student whose percentile rank fell at or below the 59% percentile was assigned to the low achievement group. These percentile designations fit both the experimental and control school populations within 1 to 2 percentile points. The age of students in both groups ranged from 10.8 to 12.9 years, with an experimental group mean of 11.7 years and a control group mean of 11.6 years.

Experimental and control samples were balanced to the greatest extent possible to have equal numbers of male and female students within high, medium, and low achievement groups. However, due to the constraints of parental consent and unequal male and female ratios for the intact classes, equal samples were not possible. The final experimental sample (n = 83) included: (a) high achievement (n = 27; [male, n = 19]; [female, n = 8]), (b) medium achievement (n = 30; [male, n = 14], [female, n = 16]); and (c) low achievement (n = 26; [male, n = 15], [female, n = 11]). The final control sample (n = 83) included: (a) high achievement (n = 27; [male n = 21], [female, n = 6]); (b) medium achievement (n = 30; [male, n = 14], [female, n = 16]; and (c) low achievement (n = 26; [male, n = 19]; [female, n = 7]). Students' names were randomly selected from a container when the number of students available for a designated achievement group exceeded the targeted sample number.

Instrumentation

The Self-Regulated Learning Interview Schedule (SRLIS) was developed by Zimmerman and Martinez-Pons (1986) to assess 14 classes of self-regulated learning strategies. The strategies include (a) self-evaluation; (b) organizing and transforming; (c) goal-setting and planning; (d) seeking information; (e) keeping records and monitoring; (f) environmental structuring; (g) self-consequating; (h) rehearsing and memorizing; (i) seeking peer, teacher, or adult assistance; and (j) reviewing texts, notes, and tests. One additional category of nonself-regulated

learning responses (labeled other) is included. During individual structured interviews, eight learning contexts are described to a student. The eight learning contexts (slightly modified to be meaningful for middle school students) are:

1. Assume your teacher is discussing a topic with your class, such as the civil war. Your teacher says that you will be tested on the topic. Do you have a method to help you learn and remember what was discussed in class? What if you are having trouble understanding or remembering the information discussed in class.[a]

2. Teachers often assign their class the task of writing a short paper outside of class on a topic such as your favorite pastime. Your score on this paper will affect your report card grade. In such cases, do you have any particular method to help you plan and write your paper? What if you are having difficulty with the topic?[a]

3. Teachers usually expect much accuracy with students' math home work. Many of these assignments must be completed without the help of a teacher. Is there any particular method you use when you don't understand a math problem at home? What if the assignment deals with a very difficult type of problem?[a]

4. When completing homework assignments such as science reports or English grammar exercises, do you use a particular method for checking your work after it is finished? What if it is a difficult assignment?[a]

5. Most teachers give important tests at the end of grading periods, and these tests greatly affect report card grades. Do you have a particular method for preparing for these tests in geography or history? What if you are preparing for an especially difficult test?[a]

6. When taking a test in school, do you have a particular method for obtaining as many correct answers as possible? What if it is a difficult test question?[a]

7. Many times students have difficulty completing homework assignments because there are other, more interesting things they would rather do, such as watching TV, daydreaming, or talking to friends. Do you have any particular method for motivating yourself to complete your homework under these circumstances? What if you are trying to meet a pressing deadline?[a]

8. Some students find it easier if they can arrange the place where they study. Do you have a particular method for arranging the *place* where you study? What if you are having difficulty concentrating on your school work?[a]

[a] This is a follow-up question.

After describing the learning context, the student is asked to indicate the methods that are used to accomplish the described task. If the student fails to offer an answer, he or she is asked, "What if you are having difficulty? Is there any particular method you use?" If the student fails to suggest any self-regulated learning strategies, then the next learning context is presented. If the student offers one or more learning strategies, the student is asked to rate the consistency with which the strategy is used according to a visually presented 4-point scale with categories ranging from seldom (1) to most of the time (4). See Table 1 for a comprehensive list of self-regulated learning strategies with strategy definitions and examples.

Table 1

Self-Regulated Learning Interview Schedule

Categories of Strategies	Definitions of Strategies	Examples of Strategies
1. Self-Evaluation	Student-initiated evaluations of the quality or progress of their work.	I check over my work to make sure I did it right. After I've answered the questions on a test, I go over them to make sure that I've done my best.
2. Organizing and Transforming	Student-initiated overt or covert rearrangement of instructional materials to improve learning.	I make an outline before I write my paper. I use graphic organizers.
3. Goal-Setting and Planning	Student setting of educational goals or subgoals and planning for sequencing, time, and completing activities related to those goals.	First, I start studying two weeks before exams, and I pace myself.
4. Seeking Information	Student-initiated efforts to secure further task information from nonsocial sources when undertaking an assignment.	Before beginning to write the paper, I go to the library to get as much information as possible about the topic.
5. Keeping Records and Monitoring	Student-initiated efforts to record events or results.	I took notes of the class discussion.
6. Environmental Structuring	Student-initiated efforts to select or arrange the physical setting to make learning easier.	I isolate myself from anything that distracts me.
7. Self-Consequences	Student arrangement or imagination of rewards or punishment for success or failure.	If I do well on a test, I treat myself to a movie.
8. Rehearsing and Memorizing	Student-initiated efforts to memorize material by overt or covert practice.	In preparing for a math test, I keep writing the formula until I memorize it.
9. Asking Peers for Help	Student-initiated effort to ask a peer for help.	If I have a problem with math assignments I ask a friend for help.
10. Asking Teachers for Help	Student-initiate effort to ask a teacher for help.	If I don't understand how to complete an assignment, I ask the teacher for more information.
11. Asking Adults for Help	Student-initiated effort to ask an adult for help.	When I write speeches for class, I ask my parents to be my audience so I can practice.
12. Reviewing Tests[a]	Student-initiated effort to review test materials to enhance performance.	When I study for six-weeks exams, I review my tests.
13. Reviewing Textbooks	Student-initiated effort to rehearse material that is read to enhance recall.	When I read, I highlight important information and then go through the chapter again and reread that information.
14. Systematically Reviewing Materials		When I study for final exams, I review my textbook, handouts, and notes.
15. Other	Learning behavior that is initiated by other persons, such as teachers or parents, and all unclear verbal responses.	I just do what the teacher says.

[a] The category Reviewing Tests was modified for this study.

Individual student interviews with the SRLIS require approximately 20 minutes. Through their construct validation study, Zimmerman and Martinez-Pons (1988) found that the interview procedure provides significant control for the biasing effects of student verbal expressiveness and for background knowledge not associated with self-regulated learning. The reviewing tests category was modified for the current study to consolidate all self-evaluative strategies within one category.

The Theory of Intelligence and Confidence of Intelligence instruments were developed by Henderson and Dweck (1989) for measuring students' beliefs about their own intelligence. The Theory of Intelligence measure includes three statements: (a) "You have a certain amount of intelligence, and you can't do much to change it;" (b) "Your intelligence is something about you that you can't change very much;" and (c) "You can learn new things, but you can't really change your basic intelligence" (Henderson & Dweck, 1989). Subjects are asked to indicate on a 6-point scale how much they agree with each statement. Entity theorists are operationally defined as those subjects whose mean scores across the three statements indicate agreement (lower scores). Incremental theorists are defined as those subjects whose scores reflect disagreement (higher scores). Subjects whose scores fall within one-half standard deviation above or below the grand mean are eliminated because they tend to both agree and disagree with the statements embodying the entity theory. Before administering the instrument, training items are utilized to sensitize the subjects to the demands of the task. The Theory of Intelligence instrument has a high Cronbach alpha coefficient of internal consistency of approximately .90. It is moderately stable with a test-retest correlation of .69 (Dweck & Henderson, 1989; Henderson & Dweck, 1989).

The Confidence of Intelligence measure requires students to respond to four forced choice statements: (a) "I usually think I'm intelligent--I usually wonder if I'm intelligent;" (b) "I'm not sure I'm smart enough to be successful--I'm pretty sure I'm smart enough to be successful;" (c) "When I get new material, I'm usually sure I will be able to learn it--When I get new material, I often think I may not be able to learn it;" and (d) "I'm not very confident about my intellectual ability--I feel pretty confident about my intellectual ability" (Henderson & Dweck, 1989). Confidence of intelligence (i.e., high or low) is a factor in predicting mastery-oriented or helpless behavior patterns. Entity theorists with high confidence exhibit the mastery-oriented behavior pattern. Entity theorists with low confidence exhibit the helpless behavior pattern. Incremental theorists with either high or low confidence exhibit the mastery-oriented behavior pattern. On the instrument, one statement in each pair represents high confidence and one represents low confidence. After indicating which of the two statements is most true, subjects then show on a 3-point scale whether the selected statement is "very true for me," "true for me," or "a little true for me." Subject scores range from one to six. Subjects with low confidence have lower scores, and subjects displaying high confidence have higher scores. To classify individuals as high or low confidence, a median split is used because the interest is in confidence in a relative sense. Subjects whose confidence score falls at the median are eliminated from further analysis. The Confidence of Intelligence measure has a moderately reliable internal consistency of .68. The test-retest stability (r = .60) is also moderately reliable (Dweck & Henderson, 1989; Henderson & Dweck, 1989).

Procedure

This study employed a pretest-posttest quasi-experimental control group design and encompassed the time period from September 1992 through March 1993. Both the experimental and control group were selected from five intact classes of sixth-grade students. One of the teachers at the experimental school administered the treatment, a strategic thinking course which emphasized thinking and learning strategies. In September 1992, the experimental and control group students were administered pretests, with the help of two research assistants. The research assistants received instructions regarding student interview methodology during training sessions conducted prior to the inception of the study. The students were interviewed individually in a separate room in their school at a time scheduled in coordination with the school, teacher, and student schedules. During the student interview sessions, the SRLIS was administered. The interviews required approximately 15 to 25 minutes and were tape recorded to assure accuracy. The Theory of Intelligence and Confidence of Intelligence measures were administered to small groups of six to eight students. All pretest interviewing and testing was completed during the month of September. The experimental subjects began participating in the strategic thinking class when school began on August 25, 1992. The experimental students wrote intermittently in their thinking log from November 1992 through February 1993. In March 1993, individual interview sessions were again scheduled with experimental and control group subjects within the constraints of school, teacher, and student schedules. The posttest interviews were conducted in the same manner as the sessions conducted in September 1992. Individual interviews and testing were completed by the end of March 1993.

Data Analysis

The Self-Regulated Learning Interview Schedule (SRLIS) yields three different measures of students' use of self-regulated learning strategies. Scores are derived for strategy use, strategy frequency, and strategy consistency. However, because the results for strategy frequency and strategy consistency were essentially identical, only strategy use and strategy frequency scores will be presented. The first procedure, strategy use (SU), was scored dichotomously as having occurred or not occurred during any of the eight learning contexts. For example, if a student mentioned a self-evaluating strategy during the interview, the student's score would be one; if the student did not mention a self-evaluating strategy, the student's score would be zero. The second, more comprehensive measure, strategy frequency (SF), attempted to answer the question: "How often did the strategy occur?" This measure consisted of the number of times that a particular strategy was mentioned during the course of the interview. As an example, the strategy frequency for self-evaluation ranged from zero (i.e., no strategy mentioned) to nine self-evaluating strategies mentioned.

The students' responses were scored for each of the eight learning contexts the researcher presented during interviews. For each context, the coding procedures were used to summarize the data categorically according to the 14 categories of self-regulated learning or the one non-self-regulated learning category labeled other. The protocols were coded primarily by the researcher. A second research assistant was trained in coding procedures. During training

sessions, the researchers reached an 80% level of agreement. To assess reliability, the second researcher coded approximately 20% of the protocols. Reliability was assessed using a procedure described by Withall (1949). According to this procedure, identical categorical judgments by the judge and coder are divided by the total number of strategies initially identified. Based on Withall's procedure, the agreement level for coders in this study was 84%.

For the measures related to theories of intelligence, explicit criteria were implemented to justify student inclusion in the analysis. First, for the Theory of Intelligence measure, students' mean scores were calculated for their responses to three statements. Possible scores ranged from a low of one to a high of six. The grand mean and standard deviation was determined. Subjects scoring one-half standard deviation below the grand mean were designated as entity theorists. Those scoring one-half standard deviation above the grand mean were labeled as incremental theorists. Other scores were eliminated. The second measure, Confidence of Intelligence, requires students to respond to four forced choice statements. Scores can range from a low of 1 to a high of 6. For this measure, all scores at the median ($Mdn = 5.00$) were eliminated. Scores below the median were designated as low confidence, while subjects scoring above the median were specified as high confidence. After applying the criteria, the total sample ($N = 96$), emerged evenly divided between treatment ($n = 48$) and control ($n = 48$) groups.

Results

SRLIS Pretest Scores

The SRLIS pretest means and standard deviations for each category of self-regulation are presented in Table 2 to show comparisons between the treatment and control group subjects. For the treatment group, the students' mean strategy use scores ranged from a low of 0.01 for reviewing tests to a high of 0.98 on seeking adult assistance. Since the responses were scored dichotomously, the strategy use scores could range from zero to one (i.e., as having occurred or not occurred). The control subjects' strategy use means ranged from a low of 0.02 for reviewing tests to a high of 0.98 for self-evaluation, with a closely related 0.97 mean score for seeking adult assistance. Perusal of the other strategy use mean scores, along with the total strategy use means of 8.41 and 8.36 for the treatment and control groups, respectively, indicated similar strategy use scores for both groups. Strategy frequency means can range from zero (i.e., not mentioned) to the number of times that a strategy was mentioned during the interview. Scanning the strategy frequency means in Table 2 established that for both groups the lowest means were for reviewing tests (treatment, $M = 0.01$ and control, $M = 0.02$). A similar pattern of results (i.e., as was found for strategy use) was revealed for the highest strategy frequency means. Seeking adult assistance (treatment, $M = 2.69$; control, $M = 2.67$) and self-evaluating (treatment, $M = 2.54$; control, $M = 2.81$) were both strategies that occurred frequently. Although some mean strategy frequency differences are present, overall, the strategy frequency scores for the experimental and control groups are similar. This equality is confirmed by the total treatment and control group mean scores of 15.14 and 15.25, respectively.

Table 2

Self-Regulated Learning Strategy Pretest Means and Standard Deviations for Strategy Use and Strategy Frequency

	Strategy Use		Strategy Frequency	
	Treatment	Control	Treatment	Control
Self-regulated strategy	Mean SD	Mean SD	Mean SD	Mean SD
1. Self-evaluating	0.93 0.26	0.98 0.15	2.54 1.50	2.81 1.38
2. Organizing & transforming	0.57 0.50	0.53 0.50	0.80 0.91	0.70 0.78
3. Goal-setting & planning	0.63 0.49	0.73 0.44	0.89 0.84	1.16 .94
4. Seeking information	0.51 0.50	0.39 0.49	0.70 0.84	0.53 0.77
5. Keeping records & monitoring	0.67 0.47	0.60 0.49	0.93 0.81	0.69 0.62
6. Environmental structuring	0.93 0.26	0.92 0.28	1.25 0.62	1.20 0.59
7. Self-consequating	0.42 0.50	0.34 0.48	0.52 0.69	0.41 0.63
8. Rehearsing & memorizing	0.22 0.41	0.23 0.42	0.27 0.54	0.27 0.52
9. Seeking peer assistance	0.49 0.50	0.42 0.50	0.72 0.89	0.69 0.97
10. Seeking teacher assistance	0.72 0.45	0.77 0.42	1.23 1.10	1.40 1.15
11. Seeking adult assistance	0.98 0.15	0.97 0.19	2.69 1.27	2.67 1.32
12. Reviewing notes	0.43 0.50	0.69 0.47	0.61 0.79	1.08 1.03
13. Reviewing tests	0.01 0.11	0.02 0.15	0.01 0.11	0.02 0.15
14. Reviewing texts	0.90 0.30	0.78 0.41	1.96 1.13	1.57 1.13
TOTAL	8.41 2.18	8.36 1.99	15.14 4.90	15.25 5.09
15. Other	0.77 0.42	0.77 0.42	1.80 1.59	1.78 1.63

Note. For treatment and control groups, $n = 83$. $N = 166$.

Preliminary analyses were conducted using the 15 strategy frequency categories as dependent variables to determine if differences that existed between the experimental and control groups warranted the inclusion of the pretest scores as covariates in subsequent data analyses. Univariate analysis of variance (ANOVA) tests for individual strategy frequency categories were conducted. Of the 15 self-regulated learning categories, tests revealed only three significant differences. Univariate tests showed that control students (M = 1.08) reported significantly higher use of reviewing notes than did treatment students (M = 0.61), $F(1,165)$ = 10.85, $p < .01$. Conversely, for keeping records and monitoring, the treatment group (M = 0.93) was significantly higher than the control group (M = 0.69), $F(1,165)$ = 4.53, $p < .04$. Treatment students (M = 1.96) reported significantly higher use of reviewing texts than control students (M = 1.57), $F(1,165)$ = 5.26, $p < .03$. Additional exploratory analyses were carried out using the pretest strategy frequency mean scores as covariates for the posttest strategy frequency mean scores. Results showed that the covariate did not contribute to the reduction of the within group error variance or to a reduction in bias caused by differences among experimental units; therefore, inclusion of the pretest as a covariate was deemed inappropriate (Kirk, 1992). Based on these findings, which support the contention that there were minimal group differences between the treatment and control groups, the pretest data were not included in subsequent analyses.

SRLIS Posttest Scores

In Table 3, the students' posttest means for strategy use and strategy frequency are contrasted for the treatment and control groups. For the treatment group, the students' mean strategy use scores ranged from a low of 0.02 for reviewing tests to a high of 0.98 for self-evaluation. Similarly, the control subjects' scores ranged from a low of 0.08 for reviewing tests to a high of 1.00 for seeking adult assistance. The means for goal-setting and planning (treatment, M = 0.84; control, M = 0.68) and the means for keeping records and monitoring (treatment, M = 0.81; control, M = 0.53) appear to be strikingly different. The total mean scores for the treatment (M = 9.88) and control group (M = 9.17), respectively, were comparable. The strategy frequency scores for the treatment and control groups displayed in Table 3 show that the treatment group scored higher on 11 out of the 14 categories of self-regulated learning, although some means were only minimally higher. The most dramatic differences were revealed for the treatment group over the control group, in order, for the following categories: (a) self-evaluating (M = 4.07, M = 3.18); (b) organizing and transforming (M = 1.51, M = 1.04); (c) goal-setting and planning (M = 1.49, M = 1.11), and (d) keeping records and monitoring (M = 1.39, M = 0.65). The control group (M = 1.55) reported reviewing notes more often than the treatment group (M = 1.19). It was notable that the control group (M = 2.05) reported more other (i.e., nonself-regulated learning) statements compared to the treatment group (M = 1.35). The total strategy frequency scores for the treatment (M = 21.05) and the control (M = 18.49) confirmed emerging group differences in the use of self-regulated learning strategies.

Table 3

Self-Regulated Learning Posttest Strategy Means and Standard Deviations for Strategy Use and Strategy Frequency

	Strategy Use		Strategy Frequency	
	Treatment	Control	Treatment	Control
Self-regulated strategy	Mean SD	Mean *SD*	Mean *SD*	Mean *SD*
1. Self-evaluating	0.98 0.15	0.96 0.19	4.07 1.88	3.18 1.84
2. Organizing & transforming	0.82 0.39	0.75 0.44	1.51 1.26	1.04 0.80
3. Goal-setting & planning	0.84 0.37	0.68 0.47	1.49 0.99	1.11 0.98
4. Seeking information	0.66 0.48	0.59 0.49	1.11 1.05	0.92 0.99
5. Keeping records & monitoring	0.81 0.40	0.53 0.50	1.39 0.99	0.65 0.69
6. Environmental structuring	0.98 0.15	0.95 0.22	1.99 0.83	1.76 0.84
7. Self-consequating	0.39 0.49	0.39 0.49	0.51 0.76	0.47 0.67
8. Rehearsing & memorizing	0.25 0.44	0.18 0.39	0.36 0.71	0.21 0.46
9. Seeking peer assistance	0.62 0.49	0.62 0.49	1.08 1.12	1.06 1.09
10. Seeking teacher assistance	0.86 0.35	0.81 0.40	1.75 1.30	1.69 1.22
11. Seeking adult assistance	0.94 0.24	1.00 0.00	2.57 1.33	2.84 1.29
12. Reviewing notes	0.81 0.40	0.83 0.38	1.19 0.85	1.55 1.03
13. Reviewing tests	0.02 0.15	0.08 0.28	0.02 0.15	0.08 0.28
14. Reviewing texts	0.90 0.30	0.88 0.33	2.01 1.13	1.92 1.13
TOTAL	9.88 1.57	9.17 1.87	21.05 5.06	18.49 5.36
15. Other	0.72 0.45	0.80 0.41	1.35 1.25	2.05 1.78

Note. For treatment and control groups, $n = 83$. $N = 166$.

Factorial Analysis of Variance by Group and Achievement Group on the SRLIS

This study investigated whether or not there are significant mean score differences as measured by the SRLIS for experimental and control group subjects and whether there are significant mean score differences for achievement group subjects (high, medium, and low) within the experimental and control groups. The answer to these questions were ascertained by using a 2 x 3 (Group x Achievement Group) univariate factorial analysis of variance (ANOVA) design. For this 2 (treatment, control) x 3 (high, medium, low) ANOVA, independent analyses were conducted with each of the 15 categories of self-regulated strategy frequency serving as dependent variables. Additionally, a 2 x 3 factorial multivariate analysis of variance (MANOVA) was performed with the 15 self-regulation categories serving as dependent measures. The *F*-values for the results of the 2 x 3 univariate factorial ANOVAs for the 15 categories of self-regulation using strategy frequency scores are presented in Table 4.

One of the assumptions of univariate analysis of variance is homogeneity of variance. Analogously, for multivariate analysis of variance there is an assumption of equal (homogeneous) covariance matrices that must be satisfied (Stevens, 1992). Preliminary examination of descriptive statistics for the posttest data indicated violations of the homogeneity of variance assumption. Kirk (1982) recommended a systematic transformation of a set of scores to achieve homogeneity of error variance. This is accomplished by taking the square root of each of the scores ($Y'=\sqrt{Y}$). If any Y is less than 10, a more appropriate transformation is given by adding .5 to the square root of Y ($Y'=\sqrt{Y+.5}$). The following strategy frequency variables were transformed to achieve homogeneity of variance using the latter method: (a) organizing and transforming, (b) keeping records and monitoring, and (c) other. The strategy frequency variable, reviewing notes, was transformed by the former method.

Results show there was a main effect for the treatment group against the control group for the following variables: (a) self-evaluation, $F(1,160) = 10.26$, $p < .01$, (b) organizing and transforming, $F(1,160) = 7.77$, $p < .01$, (c) goal-setting and planning, $F(1,160) = 6.53$, $p < .02$, and (d) keeping records and monitoring, $F(1,160) = 28.93$, $p < .001$. One additional significant main effect was found for the control subjects mentioning other, nonself-regulated learning strategies, significantly more often than the subjects who experienced the treatment condition, $F(1,160) = 7.56$, $p < .01$. There were no significant interactions among treatment, control, and achievement groups evident for strategy frequency scores ($\alpha = .01$). Significant achievement group main effects are reported for the categories of self-evaluating, $F(2,160) = 9.54$, $p < .001$; organizing and transforming, $F(2,160) = 8.75$, $p < .001$; self-consequating, $F(2,160) = 4.49$, $p < .02$; seeking teacher assistance, $F(2,160) = 6.39$, $p < .01$; and other, $F(2,160) = 6.45$, $p < .01$. Overall, the results for strategy frequency scores indicate that the treatment group outperformed the control group in using some effective self-regulated learning strategies and that some achievement group differences exist.

The following statements illustrate the kinds of strategies that the experimental students reported for the significant categories. As an example of self-evaluation, one treatment student reported, "When I finish, I read back over my paper to see that all the information I want is

Table 4

Means, Standard Deviations, and Univariate Analysis of Variance F-values on Self-Regulated Learning Strategy Frequency for Treatment and Achievement Group Effects

	Strategy Frequency		Strategy Frequency *F*-Values		
	Treatment	Control	*F* Treatment vs Control	*F* Achievement Group	*F* Interaction
Self-regulated strategy	Mean (SD)	Mean (SD)			
1. Self-evaluating	4.07 (1.88)	3.18 (1.84)	10.26**	9.54***	0.08
2. Organizing & transforming[a]	1.35 (0.43)	1.19 (0.34)	7.77**	8.75***	0.18
3. Goal-setting & planning	1.49 (0.99)	1.11 (0.98)	6.53*	1.40	3.24
4. Seeking information	1.11 (1.05)	0.92 (0.99)	1.36	2.03	0.51
5. Keeping records & monitoring[a]	1.32 (0.38)	1.02 (0.32)	28.93***	0.66	0.25
6. Environmental structuring	1.99 (0.83)	1.76 (0.84)	3.00	0.43	0.03
7. Self-consequating	0.51 (0.76)	0.47 (0.67)	0.13	4.49*	0.71
8. Rehearsing & memorizing	0.36 (0.71)	0.21 (0.46)	2.70	2.41	0.66
9. Seeking peer assistance	1.08 (1.12)	1.06 (1.09)	0.01	1.71	0.25
10. Seeking teacher assistance	1.75 (1.30)	1.69 (1.22)	0.05	6.39**	1.11
11. Seeking adult assistance	2.57 (1.33)	2.84 (1.29)	1.90	0.18	0.39
12. Reviewing notes[a]	0.96 (0.53)	1.11 (0.57)	3.17	0.09	0.23
13. Reviewing tests	0.02 (0.15)	0.08 (0.28)	3.00	1.12	0.51
14. Reviewing texts	2.01 (1.13)	1.92 (1.13)	0.24	0.88	0.76
15. Other[a]	1.28 (0.46)	1.50 (0.56)	7.56**[b]	6.45**	0.19

Note. Wilk's lambda multivariate criterion, Group, $F_{mult}(15,146) = 3.63$, $p < .001$. Achievement group, $F_{mult}(30,292) = 2.09$, $p < .001$. Interaction, n.s.
[a]Transformed variables as reported in text. [b]Significant difference for control vs treatment.
*$p < .05$. **$p < .01$. ***$p < .001$.

there." Describing an organizing and transforming strategy, another student replied, "I go back and find another math problem like it that we did in class. I see how the problem was worked out, then I try to do the other problem the same way." A student described her goal-setting and planning by reporting, "I plan my time. If I have to do 40 notecards, I'd do 4 a day." For keeping records and monitoring, treatment students often mentioned, "I take notes in class;" "I write down important information to remember;" or "I write it in my agenda to remember when assignments are due."

The control subjects also reported similar kinds of self-evaluating, organizing and transforming, goal-setting and planning, and recording and monitoring statements, but not with the same frequency reported by the treatment group. In contrast, the control group subjects related significantly more other, nonself-regulated learning strategies, such as "I try harder;" "I try to do the best I can;" "I try to remember;" "I usually don't study;" or "My mom makes me finish my homework."

Treatment Versus Control Group Effect Size

A vital concern in education is establishing whether or not discerned statistically significant differences can be considered to be of practical importance. To address this concern, the effect sizes were calculated for the treatment versus control group effects. Cohen (1969) defined effect size as "the degree to which a phenomenon exists" (p. 278). It requires judgment on the part of the researcher to determine when an effect appears to be of practical significance. The effect size (*ES*) used for this study is Glass's Δ. This *ES* is defined as the mean score of the experimental group minus the mean score of the control group, divided by the standard deviation of the control group [$ES = (\overline{x}_{exp} - \overline{x}_{ctrl})/s_{ctrl}$] (Glass, McGaw, & Smith, 1981).

The means, standard deviations, effect sizes, and confidence intervals for self-regulated learning strategy frequency are presented in Table 5. Asterisks by the effect sizes indicate that the *F*-values for those variables were statistically significant. Inspection of the figures in Table 5 reveals positive effect sizes favoring the treatment group for 11 of the 14 self-regulated learning variables. Notable effect sizes are evident for the treatment group on the strategies of self-evaluating (*ES* = +.48), organizing and transforming (*ES* = +.47), goal-setting and planning (*ES* = +.40), and keeping records and monitoring (*ES* = +.92). The magnitude of the effects are substantial and confirm important differences favoring the treatment group in using these strategies to improve learning. A substantially negative effect size (*ES* = -.38) was found for the control group for mentioning other, nonself-regulated learning statements. Additional negative effect sizes, though not large, seemed to characterize the control group as frequently seeking adult assistance (*ES* = -.21), reviewing notes (*ES* = -.26), and reviewing tests (*ES* = -.22).

The differentiation between the treatment and control groups' strategy use was portrayed by the positive, and several significant, effect sizes favoring the treatment group for 11 out of the 14 categories of self-regulated learning. The negative effect sizes characterized the control subjects' reliance on adult assistance, reviewing notes (e.g., notes, papers, study guides), and reviewing tests, as well as making other statements unrelated to productive learning. These findings are important because prior research links learners' strategical tendencies with academic achievement (e.g., Sink, Barnett, & Hixon, 1991; Zimmerman & Martinez-Pons, 1990).

Table 5

Self-Regulated Learning Strategy Frequency Means, Standard Deviations, Effect Sizes, and Confidence Intervals for Treatment and Control Schools

	Strategy Frequency					
	Treatment		Control			
Self-regulated strategy	Mean	*SD*	Mean	*SD*	Effect Size	95% CI
1. Self-evaluating	4.07	1.88	3.18	1.84	.48**	3.66 - 4.48
2. Organizing & transforming[a]	1.35	0.43	1.19	0.34	.47**	1.26 - 1.45
3. Goal-setting & planning	1.49	0.99	1.11	0.98	.40*	1.28 - 1.71
4. Seeking information	1.11	1.05	0.92	0.99	.19	0.88 - 1.34
5. Keeping records & monitoring[a]	1.32	0.38	1.02	0.32	.92***	1.24 - 1.40
6. Environmental structuring	1.99	0.83	1.76	0.84	.27	1.81 - 2.17
7. Self-consequating	0.51	0.76	0.47	0.67	.05	0.34 - 0.67
8. Rehearsing & memorizing	0.36	0.71	0.20	0.46	.34	0.21 - 0.52
9. Seeking peer assistance	1.08	1.12	1.06	1.09	.02	0.84 - 1.33
10. Seeking teacher assistance	1.75	1.30	1.69	1.22	.05	1.46 - 2.03
11. Seeking adult assistance	2.57	1.33	2.84	1.29	-.21	2.28 - 2.86
12. Reviewing notes[a]	0.96	0.53	1.11	0.57	-.26	0.85 - 1.07
13. Reviewing tests	0.02	0.15	0.08	0.28	-.22	0.01 - 0.06
14. Reviewing texts	2.01	1.13	1.92	1.13	.09	1.77 - 2.26
15. Other[a]	1.28	0.46	1.50	0.56	-.38**	1.18 - 1.38

Note. For treatment and control groups, $n = 83$. $N = 166$. Asterisks by the effect sizes indicate that the *F*-values for those variables were statistically significant. [a]Transformed variables as reported in text. $*p < .05$. $**p < .01$. $**p < .001$.

Figure 1 displays the effect sizes for the treatment and control schools. The substantial effect sizes found for the treatment group against the control group appear to reflect profiles of students who rely on different approaches to learning. The pattern of strategy use for the treatment and control group students, when considered as a whole, transcends the importance that each category's *ES* reflects individually.

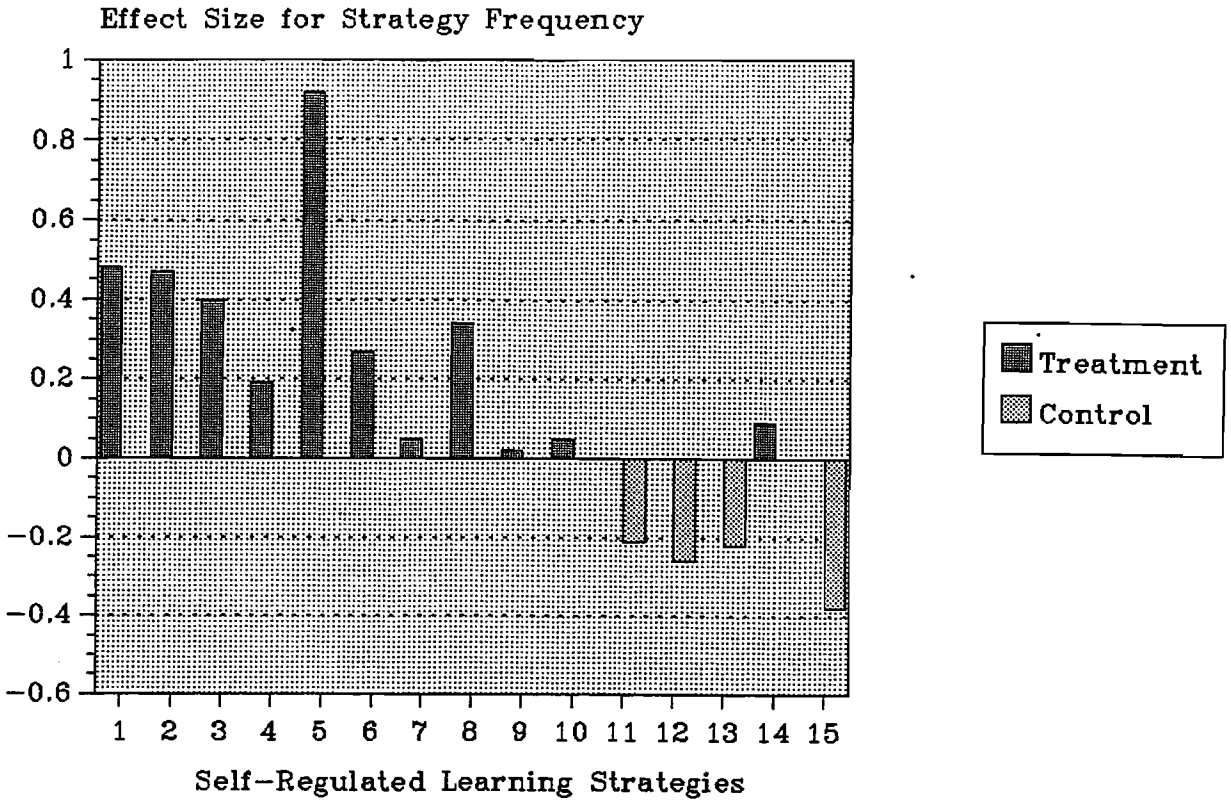

Figure 1. Effect sizes for treatment and control schools: Posttest strategy frequency scores.

Achievement Group Effects

The study also investigated whether or not there were significant mean score differences as measured by the SRLIS for achievement group subjects (high, medium, and low) within experimental and control groups. The answer to this question was derived from the 2 (control, treatment) x 3 (high, medium, low) univariate factorial ANOVA design previously discussed. Self-regulated learning strategy frequency means, standard deviations, *F*-values, and post hoc comparisons for achievement group effects are presented in Table 6. Post hoc comparisons for low, medium, and high achievement groups were conducted using the Scheffé procedure. Comparisons revealed that high achievers (M = 4.41) were more likely to use self-evaluating strategies to enhance their learning than were low (M = 2.90) or medium achievers (M = 3.55). The same trend was revealed for organizing and transforming. High achievers (M = 1.44) reported significantly greater use of organizing and transforming strategies than low (M = 1.17) or medium (M = 1.21) achievement groups. There were also achievement group differences in the tendency to impose self-consequences for success or failure. No difference was found between high (M = 0.63) and medium (M = 0.57) achievers, but the low achievement group (M = 0.25) mentioned imposing self-consequences less frequently than high achievers.

The achievement group variations for the categories of seeking teacher assistance and making other, nonself-regulated learning statements disclosed a propensity for low achievers to

Table 6

Analysis of Variance Means, Standard Deviations, *F*-Values, and Post Hoc Comparisons on Self-Regulated Learning Strategy Frequency for Achievement Group Effects

		Strategy Frequency				
		Low	Medium	High		
Self-Regulated Strategy	Group	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	*F*-value	*p*
1. Self-evaluating	Treatment	3.27 (1.59)	4.03 (1.69)	4.89 (2.04)		
	Control	2.54 (1.65)	3.07 (1.78)	3.93 (1.88)		
	Sample	2.90_{a} (1.65)	3.55_{b} (1.79)	4.41_{ab} (2.00)	9.54***	.000
2. Organizing and transforming[c]	Treatment	1.26 (0.34)	1.26 (0.38)	1.54 (0.50)		
	Control	1.09 (0.37)	1.15 (0.29)	1.35 (0.31)		
	Sample	1.17_{a} (0.36)	1.21_{b} (0.34)	1.44_{ab} (0.42)	8.75***	.000
3. Goal-setting and planning	Treatment	1.62 (0.98)	1.47 (1.14)	1.41 (0.86)		
	Control	0.85 (0.83)	0.93 (1.05)	1.56 (0.89)		
	Sample	1.23 (0.98)	1.20 (1.12)	1.48 (0.86)	1.40	.25
4. Seeking information	Treatment	0.96 (0.92)	1.10 (1.16)	1.26 (1.06)		
	Control	0.85 (1.08)	0.70 (0.75)	1.22 (1.09)		
	Sample	0.90 (0.99)	0.90 (0.99)	1.24 (1.06)	2.03	.135
5. Keeping records and monitoring[c]	Treatment	1.37 (0.35)	1.27 (0.36)	1.33 (0.44)		
	Control	1.02 (0.34)	0.99 (0.35)	1.07 (0.27)		
	Sample	1.20 (0.38)	1.13 (0.38)	1.20 (0.39)	0.66	.516
6. Environmental structuring	Treatment	1.88 (0.91)	2.07 (0.74)	2.00 (0.88)		
	Control	1.69 (0.68)	1.80 (0.96)	1.78 (0.85)		
	Sample	1.79 (0.80)	1.93 (0.86)	1.89 (0.86)	0.43	.654
7. Self-consequating	Treatment	0.23 (0.51)	0.53 (0.73)	0.74 (0.90)		
	Control	0.27 (0.45)	0.60 (0.77)	0.52 (0.70)		
	Sample	0.25_{a} (0.48)	0.57 (0.74)	0.63_{a} (0.81)	4.49*	.013
8. Rehearsing and memorizing	Treatment	0.15 (0.37)	0.40 (0.67)	0.52 (0.94)		
	Control	0.15 (0.37)	0.17 (0.38)	0.30 (0.61)		
	Sample	0.15 (0.37)	0.28 (0.56)	0.41 (0.79)	2.41	.093
9. Seeking peer assistance	Treatment	1.27 (1.15)	1.20 (1.03)	0.78 (1.15)		
	Control	1.19 (1.23)	1.07 (1.08)	0.93 (0.96)		
	Sample	1.23 (1.18)	1.13 (1.05)	0.85 (1.05)	1.71	.184
10. Seeking teacher assistance	Treatment	2.15 (1.59)	1.77 (1.22)	1.33 (0.92)		
	Control	2.27 (1.22)	1.33 (0.92)	1.52 (1.34)		
	Sample	2.21_{ab} (1.41)	1.55_{a} (1.10)	1.43_{b} (1.14)	6.39**	.002
11. Seeking adult assistance	Treatment	2.35 (1.26)	2.63 (1.45)	2.70 (1.27)		
	Control	2.88 (1.18)	2.83 (1.39)	2.81 (1.33)		
	Sample	2.62 (1.24)	2.73 (1.41)	2.76 (1.29)	0.18	.836
12. Reviewing notes[c]	Treatment	0.94 (0.52)	0.98 (0.50)	0.95 (0.57)		
	Control	1.18 (0.52)	1.08 (0.65)	1.08 (0.53)		
	Sample	1.06 (0.53)	1.03 (0.58)	1.02 (0.55)	0.09	.913

(table continues)

Self-Regulated Strategy	Group	Strategy Frequency: Low Mean (*SD*)	Medium Mean (*SD*)	High Mean (*SD*)	*F*-value	*p*
13. Reviewing tests	Treatment	0.00 (0.00)	0.07 (0.25)	0.00 (0.00)		
	Control	0.04 (0.20)	0.10 (0.31)	0.11 (0.32)		
	Sample	0.02 (0.14)	0.08 (0.28)	0.06 (0.23)	1.12	.329
14. Reviewing texts	Treatment	1.92 (1.06)	2.30 (1.29)	1.78 (0.97)		
	Control	1.88 (1.34)	1.93 (1.11)	1.93 (0.96)		
	Sample	1.90 (1.19)	2.12 (1.21)	1.85 (0.96)	0.88	.415
15. Other[c]	Treatment	1.47 (0.52)	1.22 (0.40)	1.18 (0.40)		
	Control	1.70 (0.59)	1.47 (0.54)	1.33 (0.51)		
	Sample	1.59_{ab} (0.56)	1.34_{a} (0.49)	1.25_{b} (0.46)	6.45**	.002

Note. For treatment and control groups: low, $n = 26$; medium, $n = 30$; high, $n = 27$; $N = 166$. F, $df = 2, 160$. Means with the same subscripts differ significantly, Scheffé, $p < .05$. [c]Transformed variables as described in text.

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

rely on the strategies more frequently than either high or medium achievers. Understandably, the low achievement group ($M = 2.21$) sought teacher assistance more frequently than the medium ($M = 1.55$) or high ($M = 1.43$) achievers. Low achievers ($M = 1.59$) also mentioned significantly more nonself-regulated learning strategies than did either medium ($M = 1.34$) or high ($M = 1.25$) achievement groups. The mean strategy frequency scores for high, medium, and low achievement groups are displayed in Figure 2 to show similarities and differences that existed among achievement groups.

Generally, it seems that the high achieving students relied on self-generated, personal processes to induce behaviors that produced valued outcomes. The higher achieving students often prefaced their descriptions of learning with such phrases as, "I think . . . ," "I tell myself . . . ," or "I think to myself . . . ." High achieving students often made self-evaluating statements such as, "I look at the ideas I put down on the paper and see if there are any other ideas that would help me to get a better grade," or "I read over my paper a couple of times; if I see something wrong, I change it." In terms of organizing and transforming information, high achieving students mentioned such strategies as outlining, using the process approach for writing, using scratch paper to go through the steps of a mathematics problem, or working backwards to solve a problem.

Students in both the high and medium achievement groups named assigning self-consequences more often than did students in the low group, although differences were only reliable for the high achievers. Self-consequating involved students' actual or imagined self-rewards for success or self-punishment for failure. One student reported, "I think about the money I get for good grades," while another student said, "I think, if I get all this homework done, I can do something else I want to do." One visionary student replied, "I want to make good grades so I'll be successful in the future."

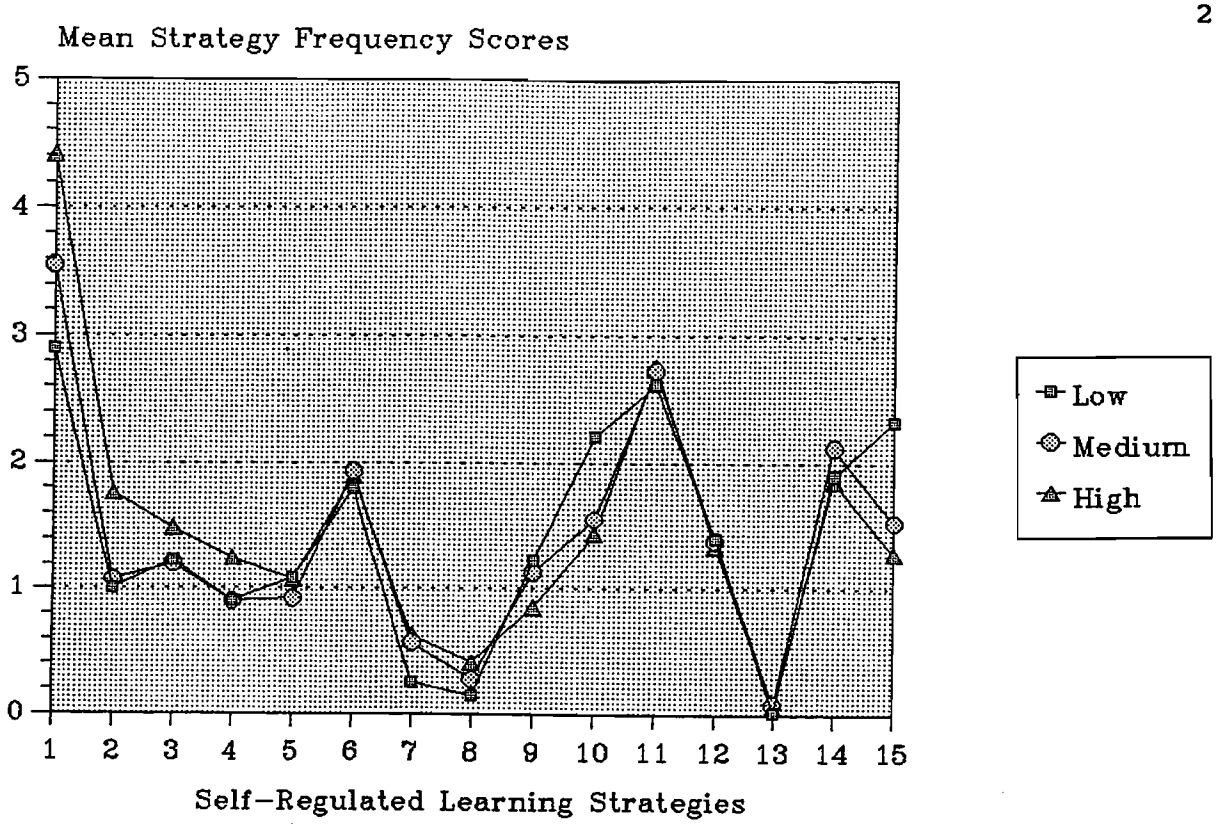

Figure 2. Self-regulated learning strategies: Mean strategy frequency scores by achievement group.

Low achieving students showed a significantly greater tendency to seek teacher assistance and to report using nonself-regulated learning strategies than did the high and medium achieving students. It is reasonable to assume that lower achieving students rely on teachers more often to improve their learning than do high or medium achieving students. However, a distinctly less-positive approach to learning was noted for the low achievement group's nonself-regulated learning behavior. Low achieving students often made such statements as, "I mark any answer to get it done," "I just try to figure it out," "I try harder," or "Mom says I have to do my homework." Many of the students' comments seemed to indicate a high level of frustration. Some revealed an imposition of will power (e.g., try harder) or reactive statements (e.g., If I don't get homework done, I'm grounded) (Zimmerman & Martinez-Pons, 1986).

It was surprising that high, compared to low, achievement group differences were significant for only 4 of the 14 categories of self-regulation. This stands in contrast to Zimmerman and Martinez-Pons' (1986) report that high achieving 10th graders reported significantly greater use of 13 of the 14 categories. A possible explanation for the disparity was revealed by examining the mean scores for the low, medium, and high achievement groups within the treatment and control schools. The mean scores showed that, in many cases, the low and medium treatment groups were outperforming their respective groups from the control school. Although there was no significant interaction among the schools and the achievement groups, it seems feasible that the low and medium treatment students' superior performance contributed to limited achievement group effects.

Theory of Intelligence, Confidence of Intelligence, and Self-Regulated Learning

For the Theory of Intelligence and Confidence of Intelligence measures, explicit criteria were implemented to justify students' inclusion in the analysis. First, for the Theory of Intelligence, students' mean scores were calculated. The grand mean and standard deviation (M = 4.27, SD = 1.16) for the posttest sample (N = 166) were determined. Subjects scoring one-half standard deviation below the grand mean (M = 3.69) were designated as entity theorists (n = 41). Those scoring one-half standard deviation above the grand mean (M = 4.85) were labeled as incremental theorists (n = 55). Other scores were eliminated. Entity theorists hold that intelligence is something that cannot be changed. Incremental theorists maintain that intelligence is expandable and can be developed through effort. For the second measure, Confidence of Intelligence, all scores at the median (Mdn = 5.00) were eliminated. Scores below the median were designated as low confidence (n = 43), while subjects scoring above the median were specified as high confidence (n = 53). After applying the criteria, the total sample (N = 96), emerged evenly divided between treatment (n = 48) and control (n = 48) groups.

The relationship among the students' theory of intelligence, confidence of intelligence, and their propensity to employ self-regulated learning strategies was ascertained by employing a 2 x 2 x 2 (Group x Theory of Intelligence x Confidence of Intelligence) factorial multivariate analysis of variance (MANOVA) design. The 15 self-regulation categories served simultaneously as dependent measures. Self-regulated learning strategy frequency means, standard deviations, and F-values are presented in Table 7 for students based on their group (treatment, control), theory of intelligence (entity, incremental), and confidence of intelligence (low, high). There was a main effect for the students' group, $F_{mult}(15,74) = 2.37, p < .01$, on the basis of Wilks's lambda multivariate criterion. There were no significant main effects for theory of intelligence, $F_{mult}(15,74) = 0.58$, n.s., or confidence of intelligence, $F_{mult}(15.74) = 1.18$, n.s. Examination of the various interaction F-values revealed there were no significant interactions among groups, theory of intelligence, and confidence of intelligence.

Univariate tests revealed that the treatment group (i.e., combined entity and incremental theorists with high and low confidence) students (M = 3.96) employed self-evaluation significantly more often than the control group (M = 2.92), $F(1,88) = 5.09, p < .03$. The treatment group students also employed organizing and transforming strategies (M = 1.38) more frequently than did the other group (M = 1.16), $F(1,88) = 6.57, p < .02$. Treatment subjects mentioned using goal-setting and planning as a learning strategy (M = 1.71) far more often than control students (M = 1.03), $F(1,88) = 8.45, p < .01$. Keeping records and monitoring was another learning strategy that the treatment group (M = 1.40) referred to with more frequency than the control group (M = 1.07), $F(1,88) = 19.64, p < .001$. These significant findings resemble previously reported results showing the treatment group subjects using self-evaluation, organizing and transforming, goal-setting and planning, and keeping records and monitoring as strategies for enhancing learning.

Although there was no significant main effect for confidence of intelligence, $F_{mult}(15,74) = 1.18$, n.s., it was interesting to observe that many students in both groups with low confidence tended to report less instances of self-evaluation than the students with high confidence, but post hoc univariate tests disclosed no significant differences between confidence groups. The univariate tests did show that for both schools, students with high confidence (M = 1.35) were significantly more likely to organize and transform information to improve learning than were students with low confidence (M = 1.18), $F(1,88) = 4.16, p < .04$.

Table 7

Means, Standard Deviations, and *F*-Values for Treatment and Control Groups by Theory of Intelligence and Confidence of Intelligence Measures for Strategy Frequency

		Strategy Frequency					
		Entity		Incremental			
		Low $n = 26$	High $n = 15$	Low $n = 17$	High $n = 38$	Group	
Self-Regulated Strategy	Group	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	Mean (*SD*)	*F*-value	*p*
1. Self-evaluating	Treatment	3.32 (1.74)	4.57 (2.22)	4.00 (1.94)	3.95 (1.90)		
	Control	2.31 (1.11)	3.13 (2.03)	2.75 (2.12)	3.49 (1.94)	5.09*	.03
2. Organizing and transforming[a]	Treatment	1.23 (0.41)	1.51 (0.65)	1.34 (0.23)	1.42 (0.44)		
	Control	1.13 (0.40)	1.23 (0.36)	1.03 (0.27)	1.25 (0.24)	6.57*	.02
3. Goal-setting and planning	Treatment	1.46 (1.27)	1.86 (0.38)	1.89 (0.78)	1.63 (1.38)		
	Control	1.31 (1.03)	0.75 (1.04)	0.88 (0.84)	1.16 (1.02)	8.45**	.01
4. Seeking information	Treatment	0.54 (0.78)	0.86 (1.07)	1.33 (1.00)	1.37 (1.30)		
	Control	1.00 (1.29)	0.88 (0.84)	1.00 (1.29)	0.79 (1.08)	1.00	.32
5. Keeping records and monitoring[a]	Treatment	1.22 (0.33)	1.69 (0.29)	1.33 (0.29)	1.37 (0.41)		
	Control	1.07 (0.37)	1.16 (0.41)	1.01 (0.35)	1.03 (0.29)	19.64***	.00
6. Environmental structuring	Treatment	1.85 (0.90)	1.86 (0.69)	1.89 (0.60)	1.95 (0.91)		
	Control	1.69 (0.75)	1.88 (0.99)	1.75 (0.71)	1.68 (0.82)	0.56	.45
7. Self-consequating	Treatment	0.46 (0.88)	0.00 (0.00)	0.89 (1.05)	0.68 (0.75)		
	Control	0.31 (0.48)	0.63 (0.52)	0.50 (0.93)	0.53 (0.70)	0.01	.92
8. Rehearsing and memorizing	Treatment	0.00 (0.00)	0.57 (0.79)	0.44 (0.53)	0.63 (0.96)		
	Control	0.15 (0.38)	0.38 (0.74)	0.00 (0.00)	0.21 (0.54)	2.87	.09
9. Seeking peer assistance	Treatment	1.23 (0.83)	1.00 (1.29)	1.44 (1.42)	0.74 (0.99)		
	Control	1.31 (1.18)	0.63 (1.06)	1.21 (1.13)	1.21 (1.13)	0.01	.92
10. Seeking teacher assistance	Treatment	1.39 (1.56)	1.29 (1.11)	1.56 (1.24)	1.84 (1.21)		
	Control	2.39 (1.76)	1.25 (1.04)	1.75 (1.17)	1.63 (1.17)	0.67	.41
11. Seeking adult assistance	Treatment	2.46 (1.56)	2.71 (1.38)	2.89 (1.05)	2.79 (1.36)		
	Control	2.77 (1.17)	2.75 (1.28)	2.25 (1.39)	3.16 (1.57)	0.01	.95
12. Reviewing notes[a]	Treatment	0.74 (0.64)	0.83 (0.60)	0.98 (0.41)	0.86 (0.48)		
	Control	1.17 (0.43)	1.06 (0.66)	1.04 (0.70)	1.01 (0.69)	2.95	.09
13. Reviewing tests	Treatment	0.00 (0.00)	0.14 (0.38)	0.00 (0.00)	0.00 (0.00)		
	Control	0.08 (0.28)	0.00 (0.00)	0.13 (0.35)	0.21 (0.52)	1.44	.23
14. Reviewing texts	Treatment	1.85 (0.90)	2.14 (1.35)	2.11 (0.93)	1.95 (1.35)		
	Control	2.00 (1.23)	1.50 (0.76)	1.50 (0.93)	1.84 (1.30)	1.41	.24
15. Other[a]	Treatment	1.32 (0.57)	1.29 (0.36)	1.36 (0.48)	1.13 (0.44)		
	Control	1.44 (0.68)	1.34 (0.73)	1.48 (0.59)	1.35 (0.53)	1.09	.30

Note. Wilks's lambda multivariate criterion, Group, $F_{mult}(15,74) = 2.37, p < .01$. There were no other significant main effects or interactions. In order, *n*'s for treatment group, 13, 7, 9, 19; *n*'s for control group, 13, 8, 8, 19. [a]Transformed variables.
*$p < .05$. **$p < .01$. ***$p < .001$.

Students from the treatment and control schools with low confidence in their intelligence (M = 0.15) were significantly less likely to report specific strategies or mnemonic devices they used to remember information than students with high confidence in their intelligence (M = 0.45), $F(1,88) = 4.94$, $p < .03$.

Experimental and Control Students' Theory of Intelligence and Confidence of Intelligence

To determine if significant mean score differences existed between the theory of intelligence and confidence of intelligence for the experimental and control group subjects, an analysis of covariance (ANCOVA) design was utilized with the students' Theory of Intelligence and Confidence of Intelligence posttest mean scores independently serving as dependent variables. The pretest scores for the Theory of Intelligence and Confidence of Intelligence measures served as covariates in their respective analyses to adjust for prior existing differences between the groups.

The treatment and control group means, standard deviations, and F-values for the Theory of Intelligence and Confidence of Intelligence measures are reported in Table 8. With regard to Theory of Intelligence, results show the pretest score for the treatment group (M = 4.31) was slightly higher than the posttest score (M = 4.22). For the control group, the opposite was true. Their pretest score (M = 4.00) was lower than their posttest score (M = 4.25). After statistically controlling for the effects of the pretest, the adjusted means for the treatment and control groups, respectively, were 4.15 and 4.32. The higher mean for the control group shows a slightly greater tendency toward the incremental theory of intelligence than the treatment group subjects indicated. Nevertheless, the results of the ANCOVA for the adjusted means show there were no significant differences between the treatment and control group students' theory of intelligence, $F(1,163) = 1.20$, n.s.

Table 8

Treatment and Control Group Means, Standard Deviations, and F-Values for Theory of Intelligence and Confidence of Intelligence Measures

	Pretest	Posttest			
Measure	Mean (*SD*)	Mean (*SD*)	Adjusted Mean	*F*-value *df*= 1,163	*p*
Theory of Intelligence					
Treatment	4.31 (1.12)	4.22 (1.19)	4.15		
Control	4.00 (1.25)	4.25 (1.14)	4.32	1.20	.28
Confidence of Intelligence					
Treatment	4.71 (0.97)	4.90 (0.97)	4.98		
Control	4.96 (0.99)	4.78 (1.10)	4.69	4.99*	.03

Note. For treatment and control groups, n = 83; N = 166. *$p < .05$.

Findings relative to the students' confidence of intelligence are also reported in Table 8. For the treatment group subjects, their pretest score (M = 4.71) reveals a lower level of intellectual confidence than their posttest score (M = 4.90). An opposite trend was evident for the control group. The students' pretest score (M = 4.96) shows a higher level of confidence in their intelligence than their posttest score (M = 4.78). After controlling for the effects of the pretest, adjusted means for the treatment group (M = 4.98) and control group (M = 4.69) were compared. ANCOVA results show that the treatment group expressed a significantly higher confidence in their intelligence on the posttest, $F(1,163) = 4.99, p < .03$. This result indicates that creating school and classroom climates that bolster students' understanding of their intelligence and confidence in their abilities may influence students' confidence, as well as their self-regulative tendencies.

Discussion

The results of this study are generally consistent with much of the previous research conducted to investigate students' use of self-regulated learning strategies. Based on the theoretical construct of self-regulation, the findings of this study portray two groups of students who reported using different strategical approaches to learning. Experimental and control group comparisons revealed that, following participation in the strategic thinking class, the treatment group students reported a significantly greater use of the vital self-regulated learning strategies of self-evaluating, organizing and transforming, goal-setting and planning, and keeping records and monitoring. Positive effect sizes favored the treatment group over the control group for 11 out of the 14 self-regulated learning categories. It was apparent that the treatment group subjects made greater use of self-processes to regulate their learning, and that the students relied on the metacognitive processes of planning, organizing, self-instructing, self-monitoring, and self-evaluating to direct their learning.

Social cognitive theorists focus on a triadic view of human self-regulation involving personal, behavioral, and environmental dimensions (Bandura, 1977, 1986; Thoresen & Mahoney, 1974). The treatment subjects' collective strategy profile appeared to exemplify the triadic interaction of personal (e.g., goal-setting and planning), behavioral (e.g., self-evaluation), and environmental (e.g., keeping records and monitoring) dimensions as put forth by theories of self-regulation (Bandura, 1977; 1986; Zimmerman, 1990). In contrast, subjects in the control group mentioned nonself-regulated learning strategies significantly more often than did the subjects in the treatment group. Negative effect sizes, though not significant, seemed to characterize the control group as frequently seeking adult assistance, reviewing notes (i.e., notes, papers, study guides), and reviewing tests. The control group's collective strategy profile seemed to reflect learners whose behavior was influenced to a greater degree by social and environmental events than by personal self-direction. The frequent mentioning of other strategies appeared to negate any contention that significant group differences are attributable to differing student verbal abilities.

These differentiations between the groups are important because of prior research linking learners' strategical tendencies with academic achievement. Advanced achievement track high school students make greater use of learning strategies (Zimmerman & Martinez-Pons, 1986). Gifted students utilize strategical knowledge for learning more so than do regular students (Zimmerman & Martinez-Pons, 1990). Planning and self-assessment are related to academic achievement (Sink, Barnett, & Hixon, 1991). Additionally, these findings indicate that an instructional intervention can alter the self-regulated learning strategies employed by students.

These conclusions substantiate the results by Lane (1992), who found that training in self-directed learning strategies significantly increased the treatment groups' use of self-regulated learning strategies. The results are also consistent with the findings of researchers who have shown that cognitive and metacognitive strategies can be taught (e.g., Weinstein & Mayer, 1986).

The comparisons for achievement group effects showed some significant variances among high, medium, and low achievement groups; however, the differentiations among the groups were not as pronounced as expected based on past research evidence. It was surprising that significant achievement group differences were noted for only 4 of the 14 categories of self-regulation. In this study, students in the high achievement group tended to rely on the self-regulated learning strategies of self-evaluation, organizing and transforming, and assigning self-consequences for success or failure. The prevalence of these strategies indicates that the students in the high achievement group relied on self-processes to monitor their learning behavior in order to achieve valued outcomes. In contrast, the low achieving students exhibited a significantly greater tendency to seek teacher assistance and to report using nonself-regulated learning strategies then did students in the high and medium achievement groups.

The results of the current study for sixth-grade students' theory of intelligence and confidence of intelligence were in contrast to prior findings suggesting an interaction among students' theories of intelligence, confidence of intelligence, and their learning behaviors (Ames & Archer, 1988; Diener & Dweck, 1978, 1980). In this study, the students' theory of intelligence and confidence of intelligence were not significant factors in determining whether or not students would employ learning strategies. On the other hand, there were some indications that students' confidence of intelligence did impact the students' proclivity to adopt personal processes to improve their learning.

One focus of the strategic thinking intervention was learning about the nature of intelligence; however, the results indicated that there was no significant difference between the experimental and control groups' theories of intelligence. In fact, the control group showed a slightly greater tendency toward the incremental theory than did the treatment group. This nonsignificant result was not unreasonable, because there has been an overall emphasis on student thinking in the school district. Additionally, the theory of intelligence grand mean (M = 4.27) for this population was somewhat higher than the grand mean reported for seventh graders (M = 3.98) in the Dweck and Henderson study (1989). On the whole, the sixth-grade students in this study generally professed to believe that intelligence could be changed (i.e., incremental theorists).

There was a different conclusion for the students' confidence of intelligence. Examination of the mean scores showed that the treatment subjects increased their level of intellectual confidence, while the control subjects showed less confidence in their intelligence in March than they had professed in September. Comparison of the treatment and control groups' mean scores, adjusted for the effect of the pretest, indicated that the treatment subjects expressed a significantly higher confidence in their intelligence than did the control subjects. These findings are provocative and suggest that participation in the strategic thinking class had a positive impact on the treatment students' level of intellectual confidence. This outcome is notable in light of past evidence that shows there is a general developmental decline in students' perceptions of their competence from the elementary grades through high school (Harari & Covington, 1981). It appears that the control subjects' decreased confidence in their intelligence

is not unusual, based on prior research results. Normative comparisons with other students often influence students' confidence in their own abilities (Ames, Ames, & Felker, 1977). There is additional evidence to suggest that many adolescents entering middle school find this a period of stress and anxiety about their competence (Henderson & Dweck, 1989).

The treatment students' increased level of intellectual confidence lends support to the contention that students' beliefs about their intelligence and their expectations for success can be influenced by instructional and environmental factors (Anderson & Jennings, 1980; Dweck, Tenney, & Dinces [cited in Dweck, 1989]). Dweck (1989) argued that for students to maintain high expectancies, they must adopt standards based on their own personal progress, and they must believe their success or failure is related to their own effort and strategy use. It is feasible that participation in the strategic thinking class enabled the treatment students to envision how effort expended on strategies would enhance their abilities and performance. As a result, the students experienced a renewed confidence in their intelligence.

Findings from this study have implications for educational practice. The strategic thinking class in which students in this study participated offers a model for how one school created a successful addition to their curriculum. The project began with a commitment by a visionary leader to the creation of a school environment where students could become effective, self-regulated learners. This curriculum was developed by a teacher who relied on various expert resources for materials and lessons. It was designed to meet the needs of the students in a particular middle school and to be an integral part of the existing school curriculum. It did not act as a separate class but as a course interrelated with the other disciplines. Although one teacher was assigned to teach the course, the entire teaching team of five teachers made a commitment to improving students' thinking and learning. The school motto, "Learning about caring and caring about learning," exemplified the prevailing belief that if students care about learning, they will set their own personal academic standards, and improved performance will follow.

An essential element of the strategic thinking curriculum was its focus on enhancing students' intellectual self-efficacy and their use of learning strategies. The strategic thinking class offered an opportunity for students to learn about the nature of intelligence and their thinking processes. Through cooperative learning experiences the students served as models of thinking strategies. High, medium, and low achieving students shared their thinking processes with one another. Additionally, the students wrote about their own thinking in thinking logs. Thinking was brought out into the open, and the students engaged in the metacognitive process of thinking about thinking.

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