

EFFECTS OF PRE-TEACHING AND RE-TEACHING ON MATH ACHIEVEMENT AND ACADEMIC SELF-CONCEPT OF STUDENTS WITH LOW ACHIEVEMENT IN MATH

JAMES P. LALLEY PhD

Assistant Professor, D'Youville College

ROBERT H. MILLER EdD

(Corresponding Author)

Assistant Professor, D'Youville College

The purpose of the present study was to examine and compare the effectiveness of pre-teaching and re-teaching on math achievement and academic self-concept of third grade students identified as low achievers. A pretest-posttest experimental design was used to conduct the study. Results indicated that both pre-teaching and re-teaching resulted in significant increases Math Concepts, Math Problems, and Math Computation. Although both were found to produce significant gains in overall math achievement, comparative analyses indicated no differences between the groups. In the area of academic self-concept, a significant within-subjects increase was found for the pre-teaching group only. Despite the significant increase in math related self-concept for the pre-teaching group, no significant between-group differences were found.

Literature Review

Despite continued concern and effort to meet their needs, low achieving students continue to represent a sizable population in schools (Manning & Baruth, 1996), with the needs of low achievers in math alone tending to represent 4% to 7% of students (Fuchs, Fuchs & Prentice, 2004). Low achievers have been identified using a variety of criteria, typically by comparing their achievement to that of their peers. For example, Fuchs et al. (2004), as well as Slavin (1989), identify low achievers as those students performing one to two years behind their same age peers.

In addition to academic difficulties, low achievers are vulnerable to lower self-concept. In broad terms, self-concept reflects

one's self-perception, as well as feelings of worth and satisfaction (Joseph, 1979). Evidence clearly indicates an interaction between self-concept and achievement, with achievement effecting self-concept and vice versa (Beane & Lipka, 1987). While the directionality of the causal relationship is not clear, research does indicate a relationship between achievement and self-concept (e.g., Hamachek, 1995; Rumbaugh & Brown, 2000).

Self-concept can also be broken down into context-specific domains (Shavelson, Hubner & Stanton, 1976). For example, Boersma and Chapmen (1992) define academic self-concept as stable attitudes and feelings one possesses involving her/his capacity to be successful on school-based

activities, and research supports this differentiation (Hamachek, 1995). Thus, it follows that low self-concept can be seen as a general factor impacting achievement; or, one or more components of self-concept may impact achievement in a particular content area(s).

Identifying effective instructional strategies for low achievers has become increasingly important. These typically take the form of supplemental programs that provide instruction outside of the classroom. For example, after-school tutoring has improved math achievement in low achievers (Hock, Pulvers, Desher, & Schumaker, 2001). Supplemental instruction approaches can be classified according to sequence of provision. Specifically, supplemental instruction can be provided before (i.e., pre-teaching) or after (i.e., re-teaching) initial exposure to academic material in the classroom. Re-teaching is a common, if not the standard, strategy for assisting students to acquire previously unattained academic objectives (Harris & Sipay, 1985; Lewis & Lynch, 1988). It is characterized by follow-up instruction and practice subsequent to classroom instruction (Collins, 1998). According to Slavin (1985), extensive studies across disciplines support the effectiveness of re-teaching as a means to increase academic achievement for students with low achievement. For example, the previously noted study by Hock et al. (2001) found post-instruction after-school tutoring (i.e., re-teaching) effectively increased math performance for low achieving students. In contrast to post-instruction approaches, pre-teaching is based on the tenet that learning is facilitated through advanced introduction of key con-

cepts and terms that serve as "cognitive anchors" upon which academic content can be organized (Ausubel, 1960). Examples of pre-teaching strategies include advanced organizers, performance objectives, and graphic organizers. According to Bassoppo-Moyo (1997), structured and organized pre-teaching tasks allow students to become familiar with what will be encountered and required, as well as the opportunity to integrate new material with previously acquired content and experiences.

Although evidence supports the effectiveness of pre-instructional strategies across a broad age range, existing research has largely focused on reading and reading-based subject content. For example, pre-teaching of critical vocabulary, as opposed to non-central vocabulary, improved students' reading comprehension by helping them identify target concepts (Wixson, 1986). Pre-teaching of vocabulary was also effective in improving comprehension of social studies content (Carney, Anderson, Blackburn, & Blessing, 1984). Although studies such as these support the efficacy of pre-teaching of vocabulary for specific academic content, much of the research has been conducted with students performing at grade level or higher.

While evidence has supported pre-teaching as an effective supplemental instructional approach, its effectiveness in the area of math has yet to be examined. Research involving the development and identification of effective math instruction has become of greater importance due to increased attention on math standards (Woodward & Baxter, 1997). Further,

existing re-teaching achievement and limitations in pre-teaching a means to increase academic achievement identified a highly novel intervention to serve as an alternative to reduce achievement to initial classroom and subsequent concept. There study was effectiveness in teaching on math self-concept in low achieving

Subjects

Subjects consisted of 24 academically low achieving third-grade students from an urban New York City school. One student was withdrawn from the sample due to illness. The sample consisted of 12 males and 12 females. The three students with the lowest scores were similar to the other students in terms of socioeconomic position.

The 24 students were randomly assigned to mathematically low achieving students on qualified students in the district for a study (i.e., AIS).

existing research on the efficacy of pre-teaching with students with low achievement is limited. Given these deficits and limitations, research is needed to examine pre-teaching, as well as re-teaching, as a means to increase math achievement and academic self-concept among students identified as low achievers. As a relatively novel intervention, pre-teaching might serve as an instructional approach that reduces academic failure upon exposure to initial classroom instructional content, and subsequently affect academic self-concept. Therefore, the purpose of the present study was to examine and compare the effectiveness of pre-teaching and re-teaching on math achievement and academic self-concept of students identified as having low achievement.

Method

Subjects

Subjects for the current study consisted of 24 academically low-achieving third-grade students from a suburban Western New York school district. While 25 students originally met inclusion criteria, one withdrew from the study. The remaining sample included 20 females and 4 males. Students in the sample were from three elementary schools in the district. The three schools were selected based on similar socio-economic and ethnic composition.

The 24 students were identified as academically low-achieving in the area of mathematics. Inclusion criteria were based on qualifications established by the school district for academic intervention services (i.e., AIS). Specifically, students demon-

strated math achievement that fell below average range on standardized classroom math assessments, and poor performance on classroom math tasks over the initial six weeks of the school year.

Instruments

Two instruments were used to assess the effects of pre-teaching and re-teaching. The Iowa Test of Basic Skills (ITBS; Hoover et al., 2001) was administered to evaluate math achievement and the Perception of Ability Scale for Students (PASS; Boersma & Chapman, 1992) to measure academic self-concept. A brief description of each follows.

Iowa Tests of Basic Skills, Form A – Level 8. The ITBS is a standardized instrument that provides a measure of student achievement across a range of academic subject areas (Hoover et al., 2001). Of the 11 achievement subtests that comprise the complete battery, which has a reliability coefficient of .87, three assess math achievement: Math Concepts (31 items)-evaluates understanding and application of a range of skills including numeration and number systems, geometry, measurement, whole numbers, currency, fractions, estimation, and number sentences; Math Problems (30 items)-assesses word problems, number sentences, and graph or table analysis for data identification, amount comparison, or generalization development; and Math Computation (30 items)-evaluates addition and subtraction skills.

Perception of Ability Scale for Students (PASS). The PASS (Boersma & Chapman, 1992) is a 70 item quantitative measure of academic self-concept and school related

perceptions for students in grades three through six, and has a reliability coefficient of .93. PASS authors define academic self-concept as, "a relatively stable set of attitudes and feelings reflecting self-evaluation of one's ability to successfully perform basic school-related tasks" (p. 1). Among its recommended uses is the evaluation of program effects related to school self-concept and achievement. Its subscales, which provide specific subject-area information involving content-related perceptions, are: General Ability, Reading/Spelling Ability, Penmanship and Neatness Skills, School Satisfaction, Confidence in Academic Ability, and Math Ability. Each subscale has 12 items except Confidence, which has ten.

The PASS can be administered by having students read items silently or having an examiner read each item aloud, with students selecting either a Yes or No response. Although items on the PASS are written at a mid-second-grade level, the authors caution that reading items aloud should be considered when learning difficulties might be present. Read aloud or silently, completion typically ranges between 15-20 minutes

Procedures

Each of the three schools implemented the two treatment conditions (pre-teaching and re-teaching). Students who met inclusion criteria were randomly assigned to one of the two intervention models implemented in each building using a stratified procedure based on gender and SES (qualifying for free lunch or no free lunch). The resulting breakdown consisted of 13 students in the pre-teaching condition and

11 students in the re-teaching condition, and six teachers (three pre-teaching and three re-teaching).

The study took place over approximately twenty-eight weeks. Teachers used the initial six weeks of the school year to assess math achievement for all third-grade students in each building. During this time, students were identified as meeting criteria for Academic Intervention Services (AIS) mandated by the New York State Education Department. Inclusion criteria consisted of below average range performance on standardized classroom math assessments and poor performance on classroom math tasks. Identified students were then assigned to treatment.

AIS teachers administered pretests over the two weeks following random assignment, with each student completing the ITBS and PASS. Following pretesting, students received AIS according to their assigned instructional methodology over the next 18 weeks, two sessions per week for 45 minutes per session after school. This resulted in a total of 90 minutes of supplemental math intervention per week. Supplemental instruction was administered to small groups that averaged four students per group.

The participating district used Everyday Math (University of Chicago School Mathematics Project, 2001) as the curriculum for third-grade students. Everyday Math was reportedly selected due to its close alignment with the New York State Learning Standards. The Everyday Math curriculum was also used for supplemental instruction and was consistent regardless of treatment condition. Participating teachers were provided with an in-service program to explain

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the experimental treatments to assure their understanding of the differences in the approaches to aid them in complying with their designated treatment. Further, AIS sessions were monitored by the researchers to be sure only the assigned method was being used. Content for the two treatments was identical, the only difference was sequence. Students who received pre-teaching were exposed to math curriculum one to three days prior to subsequent presentation of the material in the classroom by the classroom teacher. AIS teachers met with classroom teachers each week to identify upcoming math curriculum. AIS instructors then provided small group instruction on the identified math curriculum. Students in the re-teaching condition received math remediation following initial exposure to math curriculum in the classroom. Each week, AIS teachers in the re-teaching condition contacted classroom teachers to identify specific weaknesses for material taught during that week for each student. Small group instruction then targeted remediation of unmet objectives identified by the classroom teachers. Following eighteen weeks of math intervention, students in each treatment condition were retested on the ITBS and PASS by AIS teachers over a two-week period.

Results

A between-subjects, repeated measures MANOVA using the factor treatment (pre-teaching or re-teaching) was conducted to determine the effect of teaching method on the nine dependent variables. The factors of interest were time (were there changes in scores from pretest to posttest?)

and treatment \times time (if there were changes over time, was there a difference in those changes for the two groups?). The multivariate result for treatment \times time [$F(1,22)=1.22, p = .358$] was not significant, indicating no significant differences between the groups, while the effect of time [$F(1,22)=11.94, p < .001$] was significant, indicating that the entire sample had made significant gains from pretest to posttest. The univariate results indicated that those gains were limited to Math Concepts [$F(1,22)=53.83, p < .001$], Math Problems [$F(1,22)=42.14, p < .001$], Math Computation [$F(1,22)=32.55, p < .001$], Pass General [$F(1,22)=6.69, p < .05$], and Pass Math [$F(1,22)=7.23, p < .05$].

To determine if these effects for time were consistent for both treatment groups, within-subjects repeated measures were conducted for each group. For the pre-teaching group the multivariate effect for time was significant [$F(1,12)=9.133, p < .01$], the univariate effects for Math Concepts [$F(1,12)=31.58, p < .01$], Math Problems [$F(1,12)=8.85, p < .01$], Math Computation [$F(1,12)=9.13, p < .01$], Pass General [$F(1,12)=5.49, p < .05$], and Pass Math [$F(1,12)=6.18, p < .05$] were all significant. For the re-teaching group the multivariate effect for time was significant [$F(1,10)=7.15, p < .05$], as were the univariate effects for Math Concepts [$F(1,10)=22.91, p < .01$], Math Problems [$F(1,10)=39.62, p < .01$], and Math Computation [$F(1,10)=28.96, p < .001$]. The univariate effects for Pass General [$F(1,10)=1.96, p = .192$], and Pass Math [$F(1,10)=1.82, p = .21$] for the re-teaching group were not significant. Means and standard deviations are shown in Table 1.

Table 1. Means and Standard Deviations for Within-Subjects Effects

	Test One		Test Two	
	Mean	SD	Mean	SD
Pre-Teaching				
ITBS				
Concepts	20.46	3.31	25.15***	2.73
Problems	17.92	2.75	22.00**	4.28
Computation	18.23	2.52	22.15**	3.38
PASS				
General	6.85	3.48	9.38*	3.25
Math	7.77	2.95	9.85*	2.58
Reading	9.00	3.81	10.00	2.68
Penmanship	8.38	3.15	9.23	3.37
Satisfaction	7.92	2.72	8.46	2.88
Confidence	4.85	1.52	4.92	2.43
Re-Teaching				
ITBS				
Concepts	20.18	3.69	25.18***	1.78
Problems	13.82	2.89	22.36***	4.48
Computation	14.64	3.27	20.73***	3.75
PASS				
General	8.73	3.07	9.55	2.91
Math	8.64	2.29	9.27	2.69
Reading	8.55	4.18	9.45	2.62
Penmanship	9.18	2.75	9.09	2.73
Satisfaction	9.73	2.53	10.45	1.44
Confidence	4.18	2.71	3.73	2.37

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

Discussion

Results indicate that both methods of instruction, pre-teaching and re-teaching, resulted in significant increases in Math Concepts, Math Problems, and Math Computation for low achieving third-grade students. Results of the current study confirm and extend the existing research on supplemental instruction. The finding that

both pre- and re-teaching were effective in promoting achievement is consistent with previous research indicating that supplemental instruction (i.e., re-teaching and pre-teaching) effectively improves achievement among low achievers (e.g., Bassoppo-Moyo, 1997; Carney et al., 1984; Hock et al., 2001; Ruthkowsky & Dwyer, 1996; Slavin, 1985; Wixson, 1986).

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Self-concept significantly increased for the pre-teaching group but not the re-teaching group and these gains were limited to general ability and math ability. While general and math self-concept significantly improved for students in the pre-teaching group, there was no significant difference between those in the pre-teaching or re-teaching groups.

In the area of academic self-concept, results from the pre-teaching group support the assertion that self-concept is context specific (Hamachek, 1985; Shavelson et al., 1976). While subscales targeting general ability and math were affected by pre-teaching, subscales targeting perception of ability in areas of reading, neatness and penmanship were not affected. Further, while the subscales targeting satisfaction and confidence appear to be global in nature, the former has nine of 12 items related to language arts and none related to math, and the latter has six of ten related to language arts and only one related to math.

The increased self-concept for the students receiving pre-teaching may reflect its potential to prevent or minimize failure experiences. In contrast to pre-instructional strategies, re-teaching is based on the provision of instruction following initial classroom difficulty or failure. This is particularly relevant, as students who are low achievers have often learned to view themselves as incapable of academic tasks based on failure experiences (Coley & Hoffman, 1990).

Educators and administrators may find results of this study useful for developing academic interventions for students who are low achievers. However, results of the

current study were based on a small sample of predominantly female third-grade students with low achievement. While stratified random assignment was used to generate comparable groups, the small sample from a single suburban school district restricts generalizations. In addition, results involving gains made by each group should be interpreted with caution, as there was no control group. The fact that New York States mandates AIS for low achieving students precluded the inclusion of a control group in the current study, which makes interpretation of gains tenuous due to potential threats to internal validity (e.g., maturation, statistical regression). This limitation appears most relevant to math achievement as students might be expected to make gains over the course of a typical school year. However, research on students who are not achieving at grade level indicates that, over time, they are more likely to fall further behind, rather than make achievement gains. In fact, in some cases low achievers who receive remediation continue to fall behind in spite of it (Wanzek, Dickson, Bursuck & White, 2000). Further, self-concept appears less vulnerable to "typical gains" given that self-concept is conceptualized as "a relatively stable set of attitudes and feelings reflecting self-evaluation of one's ability to successfully perform basic school-related tasks" (Boersma & Chapman, 1992, p. 1) and the students were having academic difficulties in math. The weaknesses identified for the current study should be considered in future research designs addressing this topic.

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