Differentiated Curriculum Enhancement in Inclusive Middle School Science:

Effects on Classroom and High-Stakes Tests

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This investigation compared quantitative outcomes associated with classwide peer tutoring using differentiated hands-on activities vs. teacher-directed instruction for students with mild disabilities in inclusive 8th-grade science classes. Thirteen classes of 213 students (109 males; 104 females), of whom 44 were classified with disabilities, participated in 12-week sessions in a randomized field trial design. Experimental classes received units of differentiated, peer-mediated, hands-on instruction, while control classes received traditional science instruction. Results indicate that collaborative hands-on activities statistically facilitate learning of middle school science content on posttests and on state high-stakes tests for all students and that students enjoyed using the activities. Implications for practice indicate use of supplemental peer mediated hands-on activities may provide necessary review and practice for students with disabilities. Future research would help uncover additional critical instructional variables.

As students move from elementary to secondary schools, the demands on their ability to learn academic subject matter increase dramatically. For many students, access to content area curricula such as science greatly improves their understanding of the world and how it works. They can assimilate this new knowledge, apply it to further their own educational aspirations, and become better informed and more productive citizens, perhaps pursuing careers in science or science-related fields. For other students—particularly those with disabilities—increased demands on content area learning can lead to frustration, academic failure, loss of access to the general education curriculum, and loss of future opportunities in society.

A substantial body of literature documents the academic problems of students with disabilities in middle school science. Using a data set from the National Education Longitudinal Study that included 1,946 eighth-grade students from 78 schools, Anderman (1998) reported that students with learning disabilities scored nearly 1 standard deviation (*SD*) lower on science achievement tests than students without learning disabilities did. According to the 2000 *National Assessment of Education Progress* Science Assessment, students with disabilities also scored nearly 1 *SD* lower than students without disabilities did at 4th-grade, 8th-grade, and 12th-grade levels (as cited in National Center for Education Statistics, 2005).

More recent evidence at the state level paints a similarly discouraging picture. Data provided by the Virginia State Department of Education (2005) revealed that, while 72% of fourth-grade students with disabilities (compared with 86% of all students) scored at the proficient or advanced level on the state *Science Standards of Learning* test in 2004, only 66% of eighth-graders with disabilities scored at these levels (compared with 88% of all students). Such data suggest that students with disabilities fall farther behind their peers as they progress from elementary to secondary schools. In high school

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end-of-course examinations, only 48%, 56%, and 63% of students with disabilities scored at the proficient or advanced level on tests of earth science, biology, and chemistry, respectively.

Students with disabilities underachieve in science for a variety of reasons. Cawley, Hayden, Cade, and Baker-Krooczynski (2002) suggested that there is a mismatch between the curriculum and the needs of students with disabilities. Results of quantitative and qualitative investigations by Scruggs and Mastropieri (1995), Scruggs, Mastropieri, and Wolfe (1995), Mastropieri, Scruggs, and Butcher (1997), and Mastropieri, Scruggs, Boon, and Carter (2001) suggest that students with mild disabilities exhibit some relative difficulty with inductive and deductive thinking associated with scientific reasoning. These students may require additional support and practice to internalize comprehension of relevant science concepts. Further, even in effective activities-oriented science learning environments, students with disabilities experienced difficulty acquiring relevant scientific vocabulary (Scruggs, Mastropieri, Bakken, & Brigham, 1993). Such findings underscore the need for additional practice and application activities to solidify relevant knowledge and skills.

In addition, learning from science textbooks presents a problem for students with disabilities. Several researchers (e.g., Armbruster & Anderson, 1988) have analyzed science textbooks and found them to be unfriendly for students. For example, often a discrepancy exists between reading level and textbook readability for students with disabilities (Kinder, Bursuck, & Epstein, 1992). The reading level of one section of a high school chemistry textbook used in the 10th grade was written on a level substantially higher than a 12th-grade reading level (Mastropieri, Scruggs, & Graetz, 2005). Furthermore, Eylon and Linn (1988) reported that more new vocabulary and terminology were introduced in a science unit than were introduced in a comparable unit in a foreign language course. These textbook characteristics can be particularly problematic for students with disabilities, most of whom exhibit difficulties in the areas of language and literacy (Scruggs & Mastropieri, 1993; Shepard & Adjogah, 1994).

Parmar, Deluca, and Janczak (1994) found that eighth-grade students with mild disabilities—including learning disabilities and mild mental retardation—read science textbooks at only about half the fluency rate of students without disabilities. These eighth-grade students read similarly to third- or fourth-grade typically achieving students in their own schools. After reviewing the literature, Cawley and Parmar (2001) concluded that many students with disabilities lack specific literacy skills needed for learning from science textbooks (see particularly Carlisle, 1993, 1999; Cawley, Miller, & Carr, 1990). This deficiency is a significant problem because most secondary students with disabilities receive science instruction in general education science classrooms, where textbooks typically play a prominent role.

In spite of the difficulties, however, science is a content area that may be of particular relevance to students with disabilities (Patton, Polloway, & Cronin, 1994; Woodward & Noel, 1992). Students with disabilities, many of whom have had more limited life experiences, can benefit from the systematic study of the world of living and nonliving things. Students with disabilities can also benefit from the study of direct, cause-and-effect relationships in nature and from developing their deductive and inductive reasoning skills. Students with disabilities, substantially underrepresented in science careers, can also learn how to participate in science and science-related fields of endeavor (Scruggs, 2004).

Fortunately, a number of specific strategies have been identified that can be facilitative of science achievement for students with disabilities (Mastropieri & Scruggs, 1992; Scruggs & Mastropieri, 2003; Scruggs, Mastropieri, & Boon, 1998). These include vocabulary enhancements (e.g., King-Sears, Mercer, & Sindelar, 1992; Scruggs & Mastropieri, 2000; Scruggs, Mastropieri, McLoone, Levin, & Morrison, 1987), text adaptations (e.g., Bergerud, Lovitt, & Horton, 1988; Lovitt, Rudsit, Jenkins, Pious, & Benedetti, 1985, 1986), text-processing strategies (Bakken, Mastropieri, & Scruggs, 1997; Nelson, Smith, & Dodd, 1992), real-world problem-solving strategies (e.g., Gersten & Baker, 1998; Woodward, Carnine, & Gersten, 1988), and hands-on science activities (Bay, Staver, Bryan, & Hale, 1992; Dalton, Morocco, & Tivnan, 1997; McCarthy, 2005; Mastropieri et al., 1998; Scruggs et al., 1993). All these strategies intensified the learning experience in some way by carefully matching the skill level of students with the characteristics of the curriculum and instruction (Mastropieri & Scruggs, in press).

One important consideration, however, has been relatively neglected in research in science education, and that is the systematic implementation of significant classroom variables such as practice, application, and engaged time-on-task (Mastropieri & Scruggs, 2002, 2004). At a recent presentation at the Secretary's Summit on Science, Grover Whitehurst, Director of the U.S. Department of Education's Institute of Education Sciences, remarked, "there is a lot of content in science that simply has to be learned through practice and time-on-task" (as cited in Whitehurst, 2004, p. 23). It is also important to consider that much science content is very similar pedagogically to content that students are striving to learn in other academic areas, in that it involves vocabulary, concepts, and procedures, which are typically acquired through extensive practice and application over time (Whitehurst). To be effective, however, such practice must (a) be directly relevant to instructional objectives, (b) be presented on an appropriate skill level, and (c) maximize opportunities for students to respond.

Students with disabilities, as do many other students, may require significant practice, application, and generalization of relevant skills and concepts. Peer mediation, in the form of partnering or tutoring, has been suggested as one way to substantially increase academic engagement of all students in a classroom (Fuchs, Fuchs, & Kazdan, 1999; Greenwood, 1999; Greenwood, Delquadri, & Hall, 1989; Maheady, Sacca, & Harper (1988); Scruggs & Mastropieri, 1998) and may be an important way to increase learning when students lack the literacy skills needed for independent learning from science textbooks. Consider a whole-class teaching situation in which only one student may be responding at a time, compared with a peer-mediated experience in which as many as half the class may be actively responding at a time. Research in secondary special education content area classes has demonstrated that peer tutoring can produce positive academic gains in other content areas (e.g., social studies; Mastropieri, Scruggs, Boon, et al., 2001; Mastropieri, Scruggs, Spencer, & Fontana, 2003; Spencer, Scruggs, & Mastropieri, 2003). Again, such partnering can be effective only if classroom activities are on the appropriate level of difficulty for all students. Finson, Ormsbee, Jensen, and Powers (1997) reported, "by definition, [sic] full inclusion requires teachers to make their classrooms . . . and the activities/materials used in their classrooms to be relevant and functional for students possessing virtually any of a number of disabilities" (p. 220).

Differentiated Instruction in Science

Mastropieri et al. (2005) investigated classwide peer tutoring in inclusive high school classes to increase learning and comprehension of higher level chemistry content. Experimental condition students were assigned tutoring partners and tutored each other on important content from the 9-week unit, including core and valence electrons, nonpolar covalent bonding, halogens, and noble gases. The tutoring materials were differentiated, in that verbal elaborations were embedded within the materials for students who required additional support. That is, for students who quickly learned, for example, that a mole is the atomic weight in grams of an element or compound, no further support was provided. For students who had difficulty mastering this content, the tutoring partner presented an illustration of a mole (the animal) sitting on a scale next to a sign that read, "Your weight in grams is...". The tutor then instructed the tutee to think of the word and the elaborative picture to recall the information.

Tutoring pairs then asked and discussed comprehension-related information about the topic (e.g., "What else is important about moles?" and "What is an example of a mole?") Results revealed that students who had participated in the peer-mediated differentiated instruction condition scored higher on the unit test than did students who had received the same instruction without peer tutoring. Results also revealed that experimental condition students with learning disabilities outperformed their comparison peers by 42.5%, whereas experimental condition typically achieving students outperformed their comparison peers by 16.1%, although this interaction effect was not statistically significant.

In the Mastropieri et al. (2005) investigation, the differentiated material was embedded within the general tutoring materials, to be employed or not employed as the need arose. In the present investigation, we employed different, sequential levels of instructional materials to be used by all students in inclusive classrooms, to match their differential learning needs.

The present investigation draws on the concept of differentiated instruction (e.g., Gartin, Murdick, Imbeau, & Perner, 2002; Tomlinson, 2001). That is, to provide support for learning for all students, classroom instruction included a variety of approaches and strategies to address diversity in student needs, interests, experiences, and abilities. In the present investigation, we combined principles of differentiated instruction with socially mediated learning in peer groups (e.g., Scruggs & Mastropieri, 1998) to promote learning of critical academic content in inclusive eighth-grade science classes.

Objectives

The objectives of this investigation were (a) to determine whether differentiated curriculum enhancements relevant to the study of scientific methods could be developed for eighth-grade inclusive science classes; (b) to implement these materials using a classwide peer-mediated format; (c) to determine, in a randomized field trial, whether this intervention would improve classroom test scores and high-stakes testing; and (d) to determine whether students enjoyed using the materials and improved their attitudes toward science learning.

Method

Design and Participants

We selected 13 eighth-grade science classes for this investigation. Classes were matched, to the extent possible, by classroom teachers, and then randomly assigned to either an experimental or a control condition, so that each lead teacher taught at least one experimental and one control classroom (one teacher taught 5 classes, 2 of which were assigned to the experimental condition and 3 of which were assigned to the control condition). Of the 13 classes, 5 classes were cotaught by a GET and a special education teacher (SET), and 8 classes were taught by a single teacher (6 GET and 2 SET). A total of four GETs and four SETs participated as teachers in these classes.

Participants from the 13 eighth-grade science classes included 213 students, of whom 44 were classified with disabilities (37 with learning disabilities and 7 with emotional/behavioral disorders) and 35 were English language learners. Mean age was 164.2 months (SD = 5.5) for experimental students and 164.3 (SD = 5.6) for control students, of whom 109 were males and 104 were females. Forty-four percent of the sample was Caucasian, 27% was Black, 17.4% was Latino, 4.4% was Asian, and 5.2% was multiracial (percentages do not add to 100 because of rounding). These students represented 79% of the total number of enrolled students. Fifty-seven students in these classes did not participate, because of (a) declining to provide consent or assent or failing to return permission slips (n = 13), (b) moving during the course of the study (n = 17), or (c) extended absences during pre- or posttesting (n = 27).

Achievement was assessed on the available previously administered high-stakes tests, on which a 600-point scaled score is used to determine levels of proficiency: Scores of 400 to 499 are rated Pass; scores of 500 to 600 are rated Advanced. Students without disabilities scored 450.00 (SD = 59.1) on the reading test (n = 127), 438.79 (SD = 43.7) on the general math test (n = 84), and 477.07 for those students who took the algebra test (n = 43). Because of exemptions, test data were available for 66% of students with disabilities. On these measures, students without disabilities (n = 29) scored 406.45 (SD = 45.7) on the reading test and 422.67 (SD = 44.6) on the general math test; no students with disabilities took the algebra test. The average IQ score for students with disabilities was 97.59 (SD = 13.7). On the criterion pretest of unit content, students without disabilities scored 22.09 (SD = 5.5) and students with disabilities scored 17.0 (SD = 5.1).

The 13 classes were taught by 4 GETs and 4 SETs, alone or in coteaching combinations. The GETs all held licensure as science teachers, with specialty areas of biology, geology, and/or chemistry. The SETs all held licensure in special education. All 4 African American and 4 European American teachers were female, with a mean age of 30.6 (SD = 8.7), and a mean of 2.9 (SD = 2.7) years in their current position. Mean total number of years teaching was 4.9 (SD = 3.7). Teachers held bachelor of arts (3), bachelor of science (2), master of arts (1) or master of science (2) degrees.

The school was on modified block schedule such that 4 days a week were blocked with 90-min classes, with the fifth day having shortened 45-min periods. Demographic data on the special education sample placed them within a normal range of intellectual functioning, but below grade level in reading.

Materials

Both conditions used the same textbook and accompanying materials. The materials were adopted by the district for eighth-grade science. Teachers also used the high-stakes test adopted by the state for guidance in selecting the most important content to emphasize.

Control Condition. Materials in the traditional instruction condition consisted of teacher lecture, class notes, laboratory-like class activities, and supplementary textbook materials. These materials consisted of worksheets that accompanied each chapter with fill-in-the-blank, matching, vocabulary, and short-answer items. Teacher-led presentations were accompanied with questioning, note-taking (with the assistance of an overhead projector), audio- and video recordings, and class activities.

Experimental Condition. We developed experimental materials for this investigation, including curriculum enhancements that taught the "Scientific Investigation" units of instruction, covering charts and graphs, measurement, independent and dependent variables, and qualitative and quantitative research methods. For example, one set of materials focused on creating charts and graphs from different types of data. Other materials presented research scenarios and required students to identify independent and dependent variables. Another set of materials required students to engage in different types of measurement from pictorial representations.

We developed three levels of materials for each area such that differentiation of activities was possible within inclusive classes. For example, for the "Quantitative/Qualitative" activity within the Scientific Investigation unit, Level 1 materials required students to read a statement on a series of cards and identify whether it was a quantitative or a qualitative statement. Level 2 materials required students to generate three quantitative and three qualitative observations from each of a series of illustrations, with prompting when needed. Level 3 materials required students to generate quantitative and qualitative observations from illustrations, without prompting. For the "Experimental Design" activity, students were required to match independent with dependent variables (Level 1) and then produce relevant independent variables, dependent variables, and hypotheses for each given scenario, with prompts when needed (Level 2) and without prompts (Level 3). Names of all activities, with key concepts and goals, are provided in Table 1.

Each level was represented by a different color folder, so that all students could work on the same content at their particular level of instruction. Yellow represented Level 1, which required identification of science concepts from an array of alternatives and contained supports and prompts to assist students. Blue represented Level 2, which required production responses of the information and contained some prompts. Red represented Level 3, which required production responses but did not include prompts. We designed all activities to be used as many times as necessary for mastery of the content. Each activity had explicit, easy-to-follow directions, and students worked in groups of two or three to complete the activities.

Procedure

After the district, students, and parents granted us permission, we matched classes and randomly assigned them to one of the two conditions. The intervention was conducted over a period of 12 weeks and included pretesting, teacher and student training, posttesting, and administration of surveys regarding student attitudes toward the instructional materials. Teachers

TABLE 1. Differentiated Curriculum Enhancement Activities: Scientific Investigation Unit

Activity name	Key concepts	Activity goal
Experimental Design	Independent variable Dependent variable Hypothesis Constants Repeated trials	Level 1: Match independent and dependent variables Levels 2 and 3: Identify hypothesis, independent, and dependent variables within given scenarios with prompts (Level 2) and without prompts (Level 3)
Mission Possible	Chart Data set Line graph Bar graph Circle graph	Generate line, bar, and circle graphs of increasing complexity with prompts (L1 and L2) and without prompts (Level 3)
Vocabulary Challenge	Science vocabulary (e.g., meter, centimeter, Fahrenheit, repeated trials, mass)	Produce relevant vocabulary by asking and answering questions of increasing difficulty with prompts (Levels 1 and 2) and without prompts (Level 3)
Concentration	Science vocabulary (e.g., inference, control group, hypothesis, scientific method)	Match vocabulary word to definition (Level 1), produce definitions with prompts (Level 2), or produce definitions without prompts (Level 3)
Liquid Measurement	Liquid measurement in ml	Identify appropriate metric measurement from illustrations of liquids in containers; tasks range in difficulty (Levels 1–3)
Jeopardy	Science vocabulary (e.g., Celsius, line plot, properties, central tendency, validity)	Earn points by giving questions to provided definitions of vocabulary and terminology; tasks range in difficulty (Levels 1–3)
Quantitative/Qualitative	Quantitative data Qualitative data	Identify given attributes as qualitative or quantitative (Level 1), and produce qualitative and quantitative attributes from illustrations with prompts (Level 2) or without prompts (Level 3)
Measurement	Measurement Height Width	Measure height and width of objects using metric ruler, and record on record sheet; tasks range in difficulty (Levels 1–3)

informed students in all classes that they were participating in a project designed to provide information on how instructors could be better trained to teach students in science classes. While observing sessions, project staff videotaped the classes and recorded notes.

Control Condition. During the traditional instruction condition, the teachers directed all aspects of instruction. They began their lessons with a daily review, presented new information, offered guided and independent practice, and led laboratory activities. Students answered teacher questions regarding content, took notes independently, completed worksheet activities on the chapters, and performed laboratory work.

Experimental Condition. During the experimental condition, all teacher presentations were identical to those in the control condition; however, time typically spent completing worksheets was instead devoted to peer-assisted learning with differentiated science activities. Roles, rules, and materials were covered, and students worked with one another using the hands-on curriculum enhancement materials. Teachers selected dyads or groups of three based on student ability. Students requiring assistance were paired with higher achieving partners. Teachers also selected the level of materials within the differentiation (i.e., low, middle, or high) for the dyads to begin using. All lower ability level students—including all students with disabilities and many students without disabilities—were required to begin with the lowest activity level (i.e., Level 1) and proceed toward the middle and high level once proficiency was obtained. Dyads proceeded through the materials independently and recorded their performance on their recording sheets.

Dependent Measures. Quantitative data sources included pre- and posttests of science content, end-of-year high-stakes tests in science, attitudes toward science, and attitudes toward instructional activities. The science content tests were 34-item, paper-and-pencil multiple-choice tests of content covered in the Scientific Investigation unit. Experimental con-

TABLE 2. Covariate-Adjusted Means by Group and Treatment Condition

	Experimental	Control	MSE	Nondisabled student	Student w/disabilities	MSE
Posttest	23.86	21.90	17.7	23.72	22.04	17.7
High-stakes test	458.87	438.05	4620.8	460.80	436.08	462.08

Note. MSE = mean square error.

dition students were administered an 8-item survey of their attitudes toward specific activities, and teachers were interviewed regarding their perspectives.

Results

Unit Tests

Reliabilities of the unit tests were assessed at alpha = .82–.83. Descriptive information by treatment condition and group are provided in Table 2. Posttest data were entered into a 2 condition (experimental vs. control) × 2 group (special education vs. general education) ANCOVA with pretest as covariate and with classrooms treated as a nested factor within condition. Significant effects were observed for condition, $F(1192)$ = 8.93, $p = .003$. The effects for group $F(1192) = 2.73$, $p = .10$, and condition × group interaction, $F(1192) = .133$, $p = .716$, were not statistically significant, nor was the effect of classroom nested within treatment, $F(11, 192) = 1.66$, $p = .085$ (see Note 1).

State High-Stakes Test

Technical adequacy of the state high-stakes test was reported by the state department of education of the state in which the test is administered. Acceptable K-R 20 reliability coefficients of .85–.92 were reported at the third- through eighth-grade level, and somewhat higher coefficients were reported at high school end-of-course assessments. Content reliability was judged as adequate, and construct validity, as measured by correlations with the *Stanford 9* achievement tests (1996), was reported to lie within the .50–.80 region, which we considered adequate since there was not an exact content match between the two tests.

High-stakes test data were entered into a 2 condition (experimental vs. control) × 2 group (special education vs. general education) ANCOVA with pretest as a covariate (pretest unit score was correlated $r = .417$, $p = .000$, with high-stakes test score), with classrooms as a nested factor within treatment, which yielded significant effects for condition, $F(1185)$ = 6.12, $p = .014$, and for group $F(1185) = 5.56$, $p = .018$. The condition × group interaction effect was not statistically significant, $F(1, 185) = .044$, $p = .834$, nor was the effect of classroom nested within treatment, $F(11, 185) = .952$, $p = .492$ (see Note 2).

Student Attitudes and Teacher Perceptions

On the survey of attitudes toward experimental materials, students reported variable attitudes toward the individual activities, ranging from 2.2 to 3.8 on a 5-point scale of 1 (*liked very little*) to 5 (*liked very much*), with an overall mean of 3.0 (*neutral*). On the total attitude score (alpha = .73), students with disabilities reported more positive attitudes ($M = 43.0$, $SD = 9.4$) than did students without disabilities, ($M = 40.9$, $SD = 8.1$), although these differences were not statistically significant, $t(169) = 1.50$, $p = .135$. In general, students expressed greater approval for activities that were more game-oriented.

Teachers reported that they valued the experimental materials and felt they were appropriate and helpful, especially for the struggling students. Of the 8 participating teachers, 1 was unavailable for the survey. Six of the 7 reporting teachers agreed that the project had increased academic performance of their students. Six believed that the experimental materials were appropriate for their students with disabilities, 5 believed that the materials were appropriate for students at risk for academic failure or for average-achieving students, and 3 believed that the materials were appropriate for gifted students. Teachers did, however, report that it was challenging to find the time to implement the experimental materials in their classes, with the increased pressures of covering sufficient content for the end-of-year high-stakes tests. Four teachers reported that their students employed the peer-mediated activities "a lot" or "fairly often," whereas 2 teachers reported that they had employed the peer-mediated activities less often then they would have liked (2 teachers were unavailable for comment on this item).

Discussion

The present investigation supports the effectiveness of using differentiated learning activities with peer partners in middle school inclusive science classes, not only on content posttests, but also on high-stakes end-of-year tests. When using peer-mediation combined with differentiated science activities, students appear to learn more content than when taught more traditionally, without peer-mediated learning activities.

We were somewhat surprised that an enhanced 12-week learning experience could improve end-of-year total high-stakes test scores. However, this effect was possibly due, to some extent, to the fact that the target unit, the scientific method, contained generalizable information that may have been useful in learning other content information relevant to middle school science.

We were also surprised that students did not report more positive attitudes, as students did in previous peer-tutoring investigations (e.g., Mastropieri, Scruggs, Mohler, et al. (2001); Mastropieri et al., 2003). One possible explanation is that the survey in the present investigation focused exclusively on the instructional materials, whereas previous surveys have focused more on the tutoring process itself. The students' equivocal responses to the materials, then, may reflect the fact that they provided intensive practice with target content, especially as the more gamelike activities were much more popular than were more content-oriented activities. Because the more gamelike activities tend to provide less direct practice with target content, future research efforts could investigate how to make activities more enjoyable without sacrificing academic rates of engagement.

An ongoing challenge for inclusive classroom teachers is meeting the instructional needs of all learners, especially when content is challenging and when student needs are diverse. Differentiated curriculum enhancements with peer tutoring may provide one approach to helping to meet that challenge.

As students with mild disabilities progress through the grade levels to secondary school, they find less and less regular classroom time allocated to strategic instruction for learning content area information. The results of the present investigation suggest that students in inclusive science classes can work with each other in critical content area materials, and that when they do so, their content area learning improves at a rate greater than that attained through instruction that is more traditional. Future research should consider the use of differentiated curriculum enhancements with peer mediation in other subject areas and grade levels. Teachers of middle school students should consider the use of differentiated hands-on curriculum enhancements using peers as an important means of delivering high-quality instruction to all students.

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NOTES

1. Differences in posttest score by condition were also statistically significant when experimental and control class means were employed as unit of analysis. An analysis of variance applied to these posttest data with pretest as a covariate yielded a statistically significant difference, $F(1, 10) = 10.89$, $p = .008$.
2. High-stakes test data were analyzed using class means as the unit of analysis with mean pretest scores as a covariate. This analysis yielded an $F(1, 10) = 4.71$, which approached, but did not attain, statistical significance, $p = .055$.

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