NRC G/T

THE NATIONAL RESEARCH CENTER ON THE GIFTED AND TALENTED

University of Connecticut
University of Virginia
Yale University

The Effects of Grouping and Curricular Practices on Intermediate Students' Math Achievement

Carol L. Tieso
University of Alabama
Tuscaloosa, Alabama

February 2002
RM02154

The Effects of Grouping and Curricular Practices on Intermediate Students' Math Achievement

Carol L. Tieso
University of Alabama
Tuscaloosa, Alabama

February 2002
RM02154

THE NATIONAL RESEARCH CENTER ON THE GIFTED AND TALENTED

The National Research Center on the Gifted and Talented (NRC/GT) is funded under the Jacob K. Javits Gifted and Talented Students Education Act, Office of Educational Research and Improvement, United States Department of Education.

The Directorate of the NRC/GT serves as an administrative and a research unit and is located at the University of Connecticut.

The participating universities include the University of Virginia and Yale University, as well as a research unit at the University of Connecticut.

University of Connecticut
Dr. Joseph S. Renzulli, Director
Dr. E. Jean Gubbins, Associate Director
Dr. Sally M. Reis, Associate Director

University of Virginia
Dr. Carolyn M. Callahan, Associate Director

Yale University
Dr. Robert J. Sternberg, Associate Director

Copies of this report are available from:
NRC/GT
University of Connecticut
2131 Hillside Road Unit 3007
Storrs, CT 06269-3007

Visit us on the web at:
www.gifted.uconn.edu

The work reported herein was supported under the Educational Research and Development Centers Program, PR/Award Number R206R000001, as administered by the Office of Educational Research and Improvement, U.S. Department of Education. The findings and opinions expressed in this report do not reflect the position or policies of the National Institute on the Education of At-Risk Students, the Office of Educational Research and Improvement, or the U.S. Department of Education.

Note to Readers...

The Effects of Grouping and Curricular Practices on Intermediate Students' Math Achievement

Carol L. Tieso
University of Alabama
Tuscaloosa, Alabama

ABSTRACT

Researchers are aware that grouping students by prior knowledge may result in moderate gains in intermediate grade students' mathematics achievement. Despite this research, many teachers continue to teach the way they were taught: one curriculum for all students regardless of students' readiness. Additionally, researchers have raised concerns about the effects of flexible grouping on students' self-esteem.

Little research examined the effects of curricular enhancement and whole group instruction on student achievement. Further, less research linked ability grouping to the specific enhancement and differentiation of curriculum based on student prior knowledge. Therefore, the purpose of this study was to investigate the combined effects of grouping with appropriate curricular practices on intermediate students' mathematics achievement. A further purpose was to compare classrooms that featured whole class instruction but were distinguished by the type of curriculum implemented: regular textbook versus a modified or remodeled curriculum unit.

A pretest-posttest, comparison group-experimental group design using a purposive sample of 31 teachers and their students (N = 645) from four diverse school districts was used in this study. Teachers implemented three different types of grouping practices (whole class, Joplin Plan, and Flexible Small Groups [FSG]) and two types of curricular practices (modified and differentiated). Repeated Measures Analysis of Variance was employed to investigate the effects of different grouping arrangements and appropriate curricular design on the treatment and comparison groups.

Results indicated significant differences, $F(5, 253)=40.988$, $p < .001$ (ES = .42), between treatment groups exposed to an enhanced unit and the comparison groups after adjusting for grade level (4 or 5). Further, results indicated significant differences, $F(11, 645)=55.816$, $p < .001$ (ES = .52 for FSG, ES = .28 for Joplin), among curricular (modified or differentiated) and grouping (whole, between, and within-class) treatment groups after adjusting for grade level (4 or 5).

Qualitative procedures were used to analyze data from self-report instruments, observers' reports, interviews, and focus groups with teachers and students. Results indicated that teachers and their students preferred the between and within-class grouping arrangements

to their typical whole class grouping plan. Additionally, teachers and students enjoyed and were motivated by the enhanced or differentiated curriculum.

The Effects of Grouping and Curricular Practices on Intermediate Students' Math Achievement

Carol L. Tieso
University of Alabama
Tuscaloosa, Alabama

EXECUTIVE SUMMARY

The Grouping and Curricular Practices study was a snapshot investigation of classroom practices that may impact elementary students' math achievement. The researcher gathered data at 5 elementary schools. The researcher's findings, as well as a synthesis of quantitative and qualitative findings, are described briefly in this executive summary and are presented as separate chapters in the full research monograph.

Review of Related Literature

Recent research studies have focused on administrative, class size, or management practices that show promise for increasing student achievement (Cotton, 1995; Fullan, 1993). Additional research investigated classroom practices, (i.e., management strategies and curricular innovations that may increase achievement). Research on successful classroom practices (Feldhusen & Moon, 1992; Kulik & Kulik, 1982, 1984, 1990; Rogers, 1991; VanTassel-Baska, 1994; Westberg, Archambault, Dobyns, & Salvin, 1993) suggests that grouping students for part of their instructional day may offer one solution for increased achievement. Other research (Archambault et al., 1993; Dettmer & Landrum, 1998; Renzulli, 1994; Tomlinson et al., 1995) suggests that modified and differentiated curricula in heterogeneous classrooms may enhance the academic achievement of all students. Since it is unlikely that one strategy, operating in isolation, is as effective as multiple interventions, this research study investigated the combined effects of grouping practices and differentiated curriculum.

Ability grouping is defined as a practice that places students into classrooms or small groups based on an initial assessment of their levels of readiness or ability (Kulik, 1992). Whole group instruction is characterized by a single, set curriculum delivered at the same pace for all students. Between class, or Joplin plan grouping, involves the preassessment of specific skills and prior knowledge that necessitates assignment of students to a different teacher for instruction in that skill or content area. Within-class, or Flexible Small Grouping (FSG), is characterized by preassessment and placement of students into small groups within their regular classroom setting.

There have been over 700 studies of ability grouping and its effect on student achievement over the last century. Meta-analyses suggest that ability grouping for specific skill or content objectives may have a significant effect on student achievement if combined with appropriate curricular adjustment.

Snow (1989), among others, has described Aptitude-Treatment Interaction research which suggests that different students have very different learning needs. If teachers are able to identify those needs and pattern instruction appropriately, students may demonstrate achievement gains far beyond their previous levels. The related literature on curricular innovations includes curriculum modification and curriculum differentiation, two curricular practices that may demonstrate significant achievement gains over a similar textbook-based unit.

Curriculum modification is the critical analysis and remodeling of existing curriculum (Maker, 1982; Paul, Binker, Jensen, & Kreklau, 1990; Renzulli, 1994). Curriculum differentiation is the assessment of students' prior knowledge and the subsequent adaptation of grouping and curricular practices based on that assessment (Renzulli, 1994; Tomlinson, 1995, 1999). A comprehensive program for diverse learners must provide modified and differentiated instruction between and within mixed-ability classrooms.

Procedures

To assess the effects on students of modified or enhanced curriculum, combined with various grouping practices, a mixed-methods quasi-experimental study was devised. The following research questions were formulated to guide the data collection and analysis: (1) To what extent do schoolwide socio-economic status (SES) and textbook-based or modified curriculum units explain differences in intermediate grade students' post-unit achievement in mathematics, as measured by a curriculum-based assessment that addresses knowledge related to data representation and analysis? (2) To what extent do SES, prior knowledge, and curriculum differentiation practices, combined with either between-class or within-class grouping practices, explain differences in intermediate grade students' post-unit achievement in mathematics, as measured by a curriculum-based assessment that addresses knowledge related to data representation and analysis? (3) What are teachers' perceptions about the effects of: (a) grouping practices, (b) curricular modification and curriculum differentiation practices, (c) classroom management, (d) grouping students for instruction, and (e) the necessity and effectiveness of curriculum modification and differentiation strategies? (4) What are students' perceptions about the effects of grouping, curriculum modification, and differentiation practices on students' self-esteem, self-efficacy, and attitudes towards the experimental mathematics unit?

A quasi-experimental design using a purposive sample of teachers and students was used to collect data related to Research Questions One and Two. Qualitative methods (artifacts, focus groups, and teacher and student interviews) were used to address Research Questions Three and Four.

To address the above research questions, the researcher randomly assigned a stratified, purposive sample of 31 grade 4 or 5 teachers and their students from 4 diverse school districts to the comparison group or to 1 of 5 treatment groups.

Two factors were involved in the treatment for this study: a curriculum factor and a grouping factor. Teachers in the comparison group received training in using their regular textbook in a whole class setting. They implemented their regular, textbook-based lessons using a whole class grouping arrangement for the duration of the intervention. Teachers in the treatment groups were trained in five different facets of curriculum modification, differentiation, and grouping practice. Teachers in treatment group 1 received one hour of training in curriculum modification or remodeling techniques for use in a whole class setting. Teachers in treatment group 2 received two hours of training in curriculum differentiation techniques to be used in conjunction with flexible, within-class grouping of students (FSG) for instruction based on prior knowledge. Teachers in treatment groups 3-5 received two hours of training in curriculum modification and differentiation techniques, along with one additional hour of strategies for teaching students with low, medium, and high levels of prior knowledge. All treatment teachers received one additional hour of orientation to the mathematics unit used in the study.

Students in the comparison groups were exposed to their regular textbook unit on Data Representation and Analysis for the equivalent of a 3-week, 8-lesson unit. Students in treatment group 1 received a 3-week, 8-lesson, enhanced version of their regular textbook lessons for that unit. Students in treatment group 2 (FSG) were placed into flexible math groups within their regular classroom for mathematics and were exposed to modified and differentiated instruction based on their learning and readiness levels. Students in treatment groups 3-5 (Joplin Plan) moved between classes for mathematics instruction only. Students in treatment groups 2-5 were temporarily assigned to a small group or a different classroom based on the results of their preassessment for the unit on Data Representation and Analysis and were exposed to curriculum developed to address their unique learning needs.

Results

The data analyses were addressed with respect to the effects of the curricular and grouping practices over time, among treatment groups, between grade levels, and among diverse socio-economic schools. The following quantitative results were found in this research study:

1. An enhanced or modified mathematics unit improved the academic achievement of students when compared to a regular textbook unit.
2. An enhanced or modified mathematics unit improved the academic achievement of students with middle or high levels of prior knowledge over students in the comparable comparison groups. Those students who scored highest on the pretest experienced the greatest gains.
3. There was a significant interaction between time and treatment group (Comparison or Modification). Students who scored highest on the pretest experienced the most significant gains over time.
4. Both modified and differentiated mathematics curriculum units improved the academic achievement of students over the regular textbook unit.

5. A differentiated mathematics unit, used in combination with flexible grouping practices, improved the academic achievement of students with middle and high levels of prior knowledge when compared with the comparison subgroups.
6. Students from all socio-economic backgrounds made significant gains during implementation of the enhanced or differentiated mathematics unit.
7. There was a significant interaction between time and SES groups. Students in the lowest schoolwide SES groups experienced the greatest gains.
8. There was a significant interaction between time and treatment groups. Students in the high subgroups experienced the greatest gains over time.

The qualitative findings provided additional insights into effects of the mathematics unit, Data Representation and Analysis, and the grouping practices on teachers' attitudes towards teaching mathematics, students' self-concept and self-efficacy; and students' attitudes towards the experimental unit and various grouping practices. Data analysis from teacher and student interviews and focus groups identified the following issues as the most important aspects of the study:

1. Teachers have concerns about the logistics and classroom management aspects of different grouping arrangements, but appreciate the need for such arrangements.
2. Teachers preferred having students change classrooms for mathematics.
3. Teachers enjoyed working with the Joplin Plan grouping arrangement to reduce heterogeneity among students.
4. Students enjoyed working in a variety of different grouping arrangements, especially the Joplin Plan, without damage to students' self-esteem or self-efficacy.
5. Students who were provided with more authentic learning goals persisted and were more motivated than their peers in the comparison group.
6. Students of all ability levels can benefit from a mathematics curriculum that is authentic and meaningful.

Implications

There are two major implications of this study for students and two for teachers. First, students can become engaged, motivated, and excited about learning if the curriculum is authentic and meaningful and if appropriate learning goals are provided. It is imperative for teachers to take the time to examine their current curriculum for authentic and original learning that utilizes real-world resources and places students in the role of practicing professionals (Renzulli, 1977). Second, students can be challenged without losing their sense of self-concept or self-efficacy (Bandura, 1986). This unit was designed to meet mathematics objectives for students in grades 4 through 8. Those students who struggled with the content still had the opportunity to be motivated and engaged because the unit was differentiated to meet their specific learning needs. It is important for teachers to be aware of students' different learning styles, levels of motivation, and prior knowledge. The only true way to ascertain these differences is to assess the students prior to implementing a new curriculum unit and then to group and teach them accordingly.

The teacher's role in curriculum development becomes even more critical in light of these results. Since this research indicated that a short, 3-week enhanced curriculum unit can impact students' achievement, it is important that teachers examine their current curriculum and make important decisions about what is important to teach and what can be left out. Further, teachers must stress the need for learning goals rather than behavioral objectives; i.e., what they want the students to learn rather than what the students will do, which Schunk (1996) has shown can have a significant effect on achievement. The need for a critical analysis of existing curriculum, especially if it stems from a textbook, creates an extra imperative in these days of high-stakes state achievement testing.

References

Archambault, F. X., Jr., Westberg, K. L., Brown, S. W., Hallmark, B. W., Emmons, C. L., & Zhang, W. (1993). *Regular classroom practices with gifted students: Results of a national survey of classroom teachers* (Research Monograph 93102). Storrs, CT: The National Research Center on the Gifted and Talented, University of Connecticut.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Cotton, K. (1995). *Effective schooling practices: A research synthesis 1995 update*. Portland, OR: Northwest Regional Educational Laboratory.

Dettmer, P., & Landrum, M. (1998). *Staff development: The key to effective gifted education programs*. Washington, DC: National Association for Gifted Children.

Feldhusen, J. F., & Moon, S. M. (1992). Grouping gifted students: Issues and concerns. *Gifted Child Quarterly, 36*, 63-67.

Fullan, M. (1993). *Change forces: Probing the depths of educational reform*. Levittown, PA: The Falmer Press.

Kulik J. A. (1992). *An analysis of the research on ability grouping: Historical and contemporary perspectives* (RBDM 9204). Storrs, CT: The National Research Center on the Gifted and Talented, University of Connecticut.

Kulik, C-L. C., & Kulik, J. A. (1982). Effects of ability grouping on secondary school students: A meta-analysis of evaluation findings. *American Educational Research Journal, 19*, 414-428.

Kulik, J. A., & Kulik, C-L. C. (1984). Effects of accelerated instruction on students. *Review of Educational Research, 54*, 409-425.

Kulik, J. A., & Kulik, C-L. C. (1990). Ability grouping and gifted students. In N. Colangelo & G. A. Davis (Eds.), *Handbook of gifted education* (pp. 178-196). Boston: Allyn and Bacon.

Maker, C. J. (1982). *Curriculum development for the gifted*. Rockville, MD: Aspen Publishing.

Paul, R., Binker, A. J. A., Jensen, K., & Kreklau, H. (1990). *Critical thinking handbook: 4th – 6th grades: A guide for remodeling lesson plans in language arts, social studies, & science*. Rohnert Park, CA: The Center for Thinking and Moral Critique.

Renzulli, J. S. (1977). *The enrichment triad model: A guide for developing defensible programs for the gifted and talented*. Mansfield Center, CT: Creative Learning Press.

Renzulli, J. S. (1994). *Schools for talent development: A practical plan for total school improvement*. Mansfield, CT: Creative Learning Press.

Rogers, K. A. (1991). *The relationship of grouping practices to the education of the gifted and talented learner* (RBDM 9102). Storrs, CT: The National Research Center on the Gifted and Talented, University of Connecticut.

Schunk, D. H. (1996). *Learning theories*. Upper Saddle River, NJ: Prentice-Hall.

Snow, R. E. (1989). Aptitude treatment interaction as a framework for research on individual differences in learning. In P. L. Ackerman, R. J. Sternberg, & R. Glaser (Eds.), *Learning and individual differences* (pp. 13-59). New York: W. H. Freeman.

Tomlinson, C. A. (1995). *How to differentiate instruction in mixed-ability classrooms*. Alexandria, VA: Association for Supervision and Curriculum Development.

Tomlinson, C. A. (1999). *The differentiated classroom: Responding to the needs of all learners*. Alexandria, VA: Association for Supervision and Curriculum Development.

Tomlinson, C. A., Callahan, C. M., Moon, T. R., Tomchin, E. M., Landrum, M., Imbeau, M., Hunsaker, S. L., & Eiss, N. (1995). *Preservice teacher preparation in meeting the needs of gifted and other academically diverse students* (Research Monograph 95134). Storrs, CT: The National Research Center on the Gifted and Talented, University of Connecticut.

VanTassel-Baska, J. (1994). *Comprehensive curricula for gifted learners*. Boston: Allyn and Bacon.

Westberg, K. L., Archambault, F. X., Jr., Dobyns, S., & Salvin, T. (1993). *An observational study of instructional and curricular practices used with gifted and talented students in regular classrooms* (Research Monograph 93104). Storrs, CT: The National Research Center on the Gifted and Talented, University of Connecticut.

Table of Contents

Table of Contents (continued)

List of Tables

The Effects of Grouping and Curricular Practices on Intermediate Students' Math Achievement

Carol L. Tieso
University of Alabama
Tuscaloosa, Alabama

CHAPTER 1: Introduction

> The problem of curriculum is to economize scarce learning potential by making the most judicious and appropriate selection of study content. Human intelligence is too rare and precious a thing to squander on a haphazard program of instruction. (Phenix, 1958)

This research study was predicated on three assumptions. The first assumption presumed a trend toward a global economy and a corresponding demand for increased academic achievement for individuals to retain their place on the competitive world stage (National Commission on Excellence in Education, 1983; National Education Goals Panel, 1991). The technology and global interaction of the current era requires that students are able to gather information and resources to create new information (Kennedy, 1994). The second assumption was that diversity is the norm in today's classrooms. Teachers work with students whose interests, learning styles, and cognitive abilities span the continuum. Classrooms are filled with students of diverse backgrounds to create a heterogeneity unheard of in previous years (Archambault et al., 1993). The third assumption was that, despite this diversity, many teachers continue to use large group instruction and a common set of resources, learning activities, and assignments for all students, regardless of students' prior knowledge or levels of motivation (Cuban, 1984; Goodlad, 1984). A 1993 National Research Center on the Gifted and Talented (NRC/GT) Classroom Observation Study suggested that whole group instruction dominates and that students with varying interests, strengths, and levels of prior knowledge are working on virtually the same activities as their peers throughout most of the school day (Westberg, Archambault, Dobyns, & Salvin, 1993).

Research indicates moderate gains occur in students' academic achievement when teachers adopt practices from gifted education pedagogy, such as ability grouping (Kulik & Kulik, 1990; Slavin, 1987), curriculum modification (Wiggins & McTighe 1998), differentiation (Renzulli, 1994; Tomlinson, 1995, 1999), strategies to enhance higher level thinking skills, concept-based instruction (Erickson, 1998), problem-based learning (Delisle, 1997), and constructivist pedagogy (Brooks & Brooks, 1995), to improve student achievement (Bechtol & Sorenson, 1993; Bloom, 1976; Feldhusen, 1989; Kaplan, 1986; Renzulli, 1988, 1994; VanTassel-Baska, 1986; Walberg, 1985).

Recent research studies have focused on administrative, class size, or management practices that show promise for increasing student achievement (Cotton, 1995; Fullan, 1993). Additional research investigated classroom practices, (i.e., management strategies and curricular innovations that may increase achievement). Research on successful classroom practices (Feldhusen & Moon, 1992; Kulik & Kulik, 1982, 1984, 1990; Rogers, 1991; VanTassel-Baska, 1994; Westberg et al., 1993) suggests that grouping students for part of their instructional day may offer one solution for increased achievement. Other research (Archambault et al., 1993; Dettmer & Landrum, 1998; Renzulli, 1994; Tomlinson et al., 1995) suggests that modified and differentiated curricula in heterogeneous classrooms may enhance the academic achievement of all students. Since it is unlikely that one strategy, operating in isolation, is as effective as multiple interventions, this research study investigated the combined effects of grouping practices and differentiated curriculum.

CHAPTER 2: Review of the Literature

Related literature provides background information that focuses on three grouping practices (whole class, between class, and within-class flexible groups) and two curricular practices (modification and differentiation) that have demonstrated moderate to impressive achievement gains for diverse learners.

Common Grouping Practices

Ability grouping has been defined as a practice that places students into classrooms or small groups based on an initial assessment of their levels of readiness or ability (Kulik, 1992). Kulik (1992) found that grouping practices have different effects on student achievement based on the type of grouping practice and the subsequent curriculum developed for those groups. He suggested that there are three different kinds of grouping practices: programs in which all groups follow the same curriculum (whole class instruction), programs in which each group follows curriculum based on its specific needs (between-class), and programs that make curricular adjustments for groups of students within their regular classroom (within-class, flexible).

Whole Class Instruction

Whole class instruction is characterized by the utilization of a traditional, textbook-dominated curriculum (Bagley, 1931; Goodlad, 1984; Reis et al., 1993), movement through the curriculum at the same pace using the same methods and materials (Cuban, 1984; Goodlad, 1984), and instruction for the entire class at the same time (Good & Brophy, 1994).

According to Archambault et al. (1993), classroom teaching has not evolved much from its infancy early this century. Teachers still follow a lock-step curriculum with traditional grade-level divisions, subject-matter divisions of classroom time and resources, and a sequential model that has the teacher introducing a new lesson, followed in rapid succession by recitation or group practice, additional seatwork, and finally, homework to allow students to practice the skill on their own (Good & Brophy, 1994). Goodlad (1984) observed that a great deal of what goes on in the classroom is like painting-by-number.

The major advantage of whole group instruction is that more students can be educated within a graded classroom in which the teacher prepares lessons based on a single ability or readiness level (Goodlad, 1984). The major disadvantage is that students move through the curriculum without regard to their prior knowledge, interests, or levels of readiness (Good & Power, 1976). This practice has been the dominant grouping arrangement since the mass industrialization of the American economy in the late eighteenth century (Grinder & Nelsen, 1985) and continues to dominate the educational landscape today (Archambault et al., 1993; Cuban, 1984; Gardner, 1999; Good & Brophy, 1994; Goodlad, 1984).

Between-class Grouping

The best-known of the between-class grouping plans is the Joplin Plan, devised by Cecil Floyd, the assistant superintendent of schools in Joplin, Missouri (Floyd, 1954). The earliest version of this plan included the cross-grade grouping of elementary students in reading. During the time reserved for reading, students in grades 4, 5, and 6 would proceed to different classrooms to receive instruction geared to their readiness levels. After the hour was over, students would return to their regular classrooms. This grouping arrangement was later expanded to include arithmetic instruction.

Joplin Plan

There are three major advantages to the Joplin Plan grouping arrangement. The first advantage is the temporary nature of the grouping arrangement. The majority of modern cross-grade grouping plans are single-subject and closely tied to a specific skill. This allows students to move in and out of groups based on their current demonstrated achievement (Kulik & Kulik, 1982; Slavin, 1987). Students are preassessed in one or two subjects and grouped according to their actual performance in these areas. Students will generally attend another classroom for instruction in reading or mathematics then return to their regular classroom or homeroom for the remainder of the school day.

A second major advantage of the Joplin Plan is the curricular adjustment made among groups. The teacher must develop curriculum according to the unique needs of the group, rather than utilize a "one-size fits all" approach to curriculum development. Students use textbooks from different grades based on their level of readiness (Kulik, 1992). According to Kulik and Kulik (1992), students in different ability groups work with different materials and different methods. Hence, the match between grouping arrangement and curriculum is enhanced.

A third major advantage of between-class, cross-grade grouping plans is the admirable goal of reducing heterogeneity in the classroom without adversely affecting the self-esteem of those students in the lowest achieving groups (Begle, 1975; Goodlad, 1966; Slavin, 1987). By regrouping for a single subject, teachers are more likely to reduce the heterogeneity within the classroom, while assuring that they are meeting the appropriate curricular needs of each student.

Within-class Grouping

Another important type of grouping arrangement is within-class or flexible grouping (Benbow, 1998; Davis & Rimm, 1994; Feldhusen & Moon, 1992; Kulik, 1992; Kulik & Kulik, 1990; Renzulli 1994; Slavin, 1987; Tomlinson, 1995, 1999; Westberg et al., 1993). This practice groups students within the same "class into smaller groups for specific activities and purposes" (Kulik & Kulik, 1992). Typically, the teacher presents a lesson to the whole class and then places students into small groups based on demonstrated performance, interests, levels of prior knowledge, etc. (Renzulli, 1994). Kulik and Kulik (1992) identified several facts about within-class grouping plans. First, for within-class grouping practices to be successful, teachers must differentiate instruction. It would not be an expedient use of resources and time to preassess students, place them into small groups, and make the same presentation to two or three separate groups. Second, students should remain within their regular classroom for the entire school day. This can alleviate the potential scheduling problem (inherent in the Joplin Plan for between-class grouping) of having all teachers teaching the same subject at the same time. According to Slavin (1987), the major advantage of flexible grouping is the temporary nature of the groups. Students are assessed frequently for growth and reassigned to different groups based on that assessment.

A major disadvantage of within-class grouping is that teachers are required to learn a new form of classroom management to create a learning environment sensitive to individual levels of readiness and manageable in terms of student behavior (Arlin, 1982; Tomlinson, 1999). Due to this concern about classroom management, many teachers who attempt to utilize different learning tasks for different small groups concentrate on extensive drill and practice, especially for students with lower levels of readiness. Though this drill and practice approach may facilitate classroom management, it deprives students of the opportunity to work with higher level concepts, resources, and methodologies (Newman & Schwager, 1992). Kulik and Kulik (1992) suggested that when within-class grouping is successful, teachers differentiate instruction for the different groups and students remain within their regular classroom.

Research on Grouping Practices

Research on ability grouping has continued for over half a century. In an early summary of ability grouping practices, Passow (1962) suggested that the results of numerous studies on ability grouping depended less on the "fact of grouping itself than upon the philosophy behind the grouping, the accuracy with which grouping is made for the purposes intended, the differentiations in content, method, and speed, and the technique of the teacher" (p. 284). Kulik (1992) reviewed early studies of research on ability grouping (i.e., 1900's-1950's) and applied meta-analytic techniques (Glass, 1976) to these studies. He found nontrivial average effects (ES = .14) for students grouped for mathematics by ability, *without any curricular adjustment*, when compared to whole class instruction.

Modern meta-analytic studies suggest that average effect sizes for student achievement in classes grouped according to the Joplin Plan (with curricular adjustment) is .33, a small but nontrivial effect size (Kulik & Kulik, 1982). Kulik and Kulik (1982) investigated 16 controlled studies of the Joplin Plan for cross-grade grouping in one or two subjects. Twelve of those studies found higher achievement levels in the Joplin Plan classes. Two Joplin Plan studies reported effect sizes for different ability levels separately. A median effect size of .12 was reported for the high achieving group, -.01 for the middle group, and .29 for the low achieving group (Kulik & Kulik, 1982). Slavin

(1987) found a median effect size of .45 for Joplin Plan grouping, while Rogers (1993) noted average effect sizes of .34. Additionally, Mills, Ablard, and Gustin (1994) found large effect sizes (ES = 2.4 SD) for fifth graders enrolled in a Joplin-like, flexibly-paced mathematics course with appropriate and specific curricular adjustment.

Finally, Slavin (1987) found significant, moderate effect sizes (ES = .41) and Kulik (1992) small average effect sizes (ES = .25) for within-class (flexible) grouping. Nine of Kulik's eleven studies reported higher overall achievement levels with flexible grouping arrangements (average ES = .25) over whole class instruction. Lou et al. (1996) found average effect sizes of +.17 in a meta-analysis of within-class grouping versus no grouping. In comparisons of heterogeneous versus homogeneous within-class grouping, they found average effect sizes of +.12 for homogeneous grouping. Slavin argued that research on within-class grouping in mathematics "consistently supports this practice in upper elementary grades" (p. 320). He also contends "there is no evidence to suggest that achievement gains due to within-class ability grouping in mathematics are achieved at the expense of low achievers" (p. 320). Little research, however, exists that compares whole class, between-class, and within-class flexible grouping arrangements in terms of student achievement.

Concerns About Grouping Practices

Ability grouping practices have come under attack the past two decades due to concerns over issues of social and economic equity (Oakes & Goodlad, 1986; Slavin, 1990) and potential damage to students' self-concept and self-efficacy. However, Kulik and Kulik (1982) and Marsh and Parker (1985) have found little evidence to substantiate these concerns.

In aptitude-treatment interaction research (ATI), Snow (1989) found that different ability learners learn best in different types of environments. He suggested that more able learners learn better in less structured environments and benefit from indirect, unstructured teaching methods. Snow further suggested that "the very scaffolding that helps raise the threshold of less able learners lowers the threshold of more able ones" (p. 49). He suggests that less able learners have very different learning needs.

Feldhusen and Moon (1992) proposed that educators must be responsive to the reality that students begin new units of study with differing abilities, learning styles, and motivation levels. They continued, "some [students] are ready for fast-paced, high-level, very abstract instruction; for others instruction must be adjusted to fit their particular needs or deficiencies" (p. 64). Special grouping arrangements may be necessary to meet the ever-varying achievement levels of students in heterogeneous classrooms.

Summary

Whole group instruction is characterized by a single, set curriculum delivered at the same pace for all students. Between class, or Joplin grouping, involves the preassessment of specific skills and prior knowledge that necessitates assignment of students to a different teacher for instruction in that skill or content area. Within-class, or flexible small grouping, is characterized by preassessment and placement of students into small groups within their regular classroom setting. Researchers are divided on the effects of such grouping arrangements, but most agree that some form of temporary ability grouping, based on a specific aptitude in a skill or content, when complemented by appropriate instruction, may have significant effects on student achievement.

While researchers are aware of classroom practices that may significantly affect student achievement, teachers still face the challenge of meeting the needs of diverse ability students within the heterogeneous classroom. Grouping practices alone will have only small to moderate effects on achievement if they are not complemented with appropriately modified and differentiated curricula (Kulik & Kulik, 1992; Rogers, 1993; Slavin, 1987).

Curriculum Modification and Differentiation

At least two classroom-based practices appear to hold promise for increasing student achievement: curriculum modification and differentiation. Current research suggests that textbook-based curriculum units suffer from a lack of variety and in-depth presentation of the major principles and concepts within a discipline (Erickson, 1998; Flanders, 1987; Renzulli, 1994). Curriculum modification is the critical analysis and remodeling of existing curriculum (Maker, 1982; Paul, Binker, Jensen, & Kreklau, 1990; Renzulli, 1994). Curriculum differentiation is the assessment of students' prior knowledge and the subsequent adaptation of grouping and curricular practices based on that assessment (Renzulli, 1994; Tomlinson, 1995, 1999). A comprehensive program for diverse learners must provide modified and differentiated instruction within mixed-ability classrooms.

Textbook-based Curriculum

Goodlad (1966, 1984), in his critical studies of America's classrooms, has criticized educational policymakers for failing to modify or improve classroom organization and instruction. He mused that if students from the early 1900s were magically transported to the classroom of the 1990s, they would recognize virtually every facet of the school day (1966). Even more critical, in this era of high-stakes standardized testing, one curriculum, geared to drill and practice prior to the test, dominates the modern classroom.

Curriculum Modification

Curriculum modification includes the analysis and removal of unchallenging and repetitive content; the enhancement of existing curricular units through the use of advance organizers, higher level questioning strategies, and critical thinking skills (Burns & Reis, 1991; Halpern, 1996; Paul et al., 1990); the connection of the unit of study to the disciplines (Bruner, 1975; Gardner, 1999; Phenix, 1964; Renzulli, 1988), and the design of units of study based on interdisciplinary concepts (Erickson, 1998; Jacobs, 1989; Kaplan, 1986).

Remodeled Curriculum

Paul et al. (1990) defined curriculum "remodeling" as the process whereby teachers critique their lesson plans and formulate new ones based on that critical process. They suggest creating new lesson plans utilizing the major strategies of critical thinking. The major guiding premise is that students will become autonomous, precise, and fair-minded thinkers. Using Paul et al.'s method, lesson plans are remodeled or enhanced to address higher order critical thinking processes.

Essential Understandings

Erickson (1998) proposed a curriculum development plan that develops sophistication in knowledge, understanding, and the ability to perform. She suggested that this systems approach should address four critical components: (a) student outcomes: what students should know, understand, and be able to do based on the identified knowledge, skill, and abilities they will need for the 21st century; (b) the critical content, key concepts, and essential understandings that frame the knowledge base of different areas of study; (c) the major process and skill abilities that ensure quality performance; and (d) quality assessments for measuring standards-driven performance. Teachers can facilitate students' essential understandings by constructing curriculum that focuses on the "big ideas" or key concepts and principles of a discipline, rather than a series of random, unconnected, and usually, unlearned, facts and skills.

The Structure of the Disciplines

Bruner (1960) suggested that if students could grasp the structure of a subject, they could relate other ideas to it meaningfully. The study of a field within the context of the disciplines includes the location of that subject within the history of knowledge, the methodologies employed by those who are the practicing professionals in the discipline, the major principles and concepts of the field, and the connections that field has with others in the history of knowledge.

Additionally, Cuoco, Goldenberg, and Mark (1995) offered a mathematics curriculum based around "habits of mind," in which students learn to become the makers rather than simply the users of mathematics. Their laundry list of expectations include students should take on the role of pattern sniffers, experimenters, describers, tinkerers, inventors, visualizers, conjecturers, and guessers (pp. 3-8).

Gardner (1999) added that when an individual truly understands a concept, skill, theory, or domain of knowledge, she is capable of applying that knowledge appropriately in a new context. He scolded purveyors of the *cultural literacy* approach to learning (Hirsch, 1987), "with its promise of five minutes on every topic" (p. 118). He contended that without a disciplinary way of thinking, "cultural literacy lacks an epistemological home; it amounts to a hodgepodge of concepts and facts wanting to be used somehow, somewhere, sometime. Moreover, absent such disciplinary treatment and glue, the facts are likely to be soon forgotten" (p. 118). This problem becomes more acute in the global technological age in which teachers cannot possibly teach students all of the facts and skills that multiply exponentially on a daily basis.

Curriculum Modification and the Multiple Menu Model

Renzulli (1994) offered curricular modification as a vehicle to address issues of redundancy and a lack of challenge in curriculum resources. Curriculum modification includes the "triaging" of curriculum (the analysis and surgical removal of unchallenging and repetitive content), the extensive use of advance organizers, higher level questioning strategies, connecting the unit of study to the disciplines, curriculum compacting (Reis et al., 1993) and designing units of study based on interdisciplinary concepts (Kaplan, 1986; Renzulli, 1988).

Renzulli, Leppien, and Hays (2000) also introduced a method of advanced curriculum development for teachers and curriculum developers in the upper elementary and secondary grades entitled the Multiple Menu Model. This model provides a guide for curriculum development that proceeds from several menus of curriculum techniques. These menus include a knowledge menu (i.e., the structure, definition, and location of the topic within the fields of knowledge, as well as the major concepts and principles of the field and the facts, conventions, and trends of the field of study). The instructional techniques menu includes a list of objectives and instructional strategies used in the study, a sequential list of the actual teaching and learning activities, and a section that allows for "artistic modification" based on teacher talents, interests, and particular knowledge. Finally, the guide includes an instructional products menu, which allows students to create new knowledge and information and demonstrate that knowledge in the form of abstract (e.g., values, appreciations, and cognitive structures) and concrete (e.g., written, spoken, or artistic) products to be presented to an authentic audience. In utilizing this model for curriculum development, teachers and developers are able to combine the most important aspects of each unit with the effective enrichment techniques of authentic learning; (i.e., authentic resources, products, and audiences).

Summary

Curriculum modification serves as the first step along the road to an enhanced, authentic, and stimulating curriculum. Curriculum modification allows educators the opportunity to examine and escalate their objectives, introductory teaching and learning activities, resources and products in a whole group setting. Curriculum differentiation allows educators to then add depth and breadth to their curriculum to enhance the match between learner characteristics and the curriculum (Burns, Gubbins, Reis, & Westberg, 1997).

Curriculum Differentiation

Introduction

Bechtol and Sorenson (1993), Kaplan (1986), Passow (1962), Renzulli (1994), Tomlinson (1995, 1999), and Wang and Walberg (1988) have proposed models for curriculum differentiation that include the extensive use of pre-assessment to determine students' strengths and interests; flexible grouping practices based on those pre-assessed areas; and the differentiation of existing curriculum, which suggests increasing the breadth (interest, choices, and learning style variation) and depth (lessons for different ability levels) of the curriculum. Passow (1962) defined "differentiated curriculum as that which embodies the recognition of differing learning rates, styles, interests, and abilities" (p. 6), while Ward (1980) explained the need to provide appropriate instruction at students' ability levels. The goal of curriculum differentiation is to elicit learners' responses commensurate with their gifts or talents.

Principles of Differentiated Curriculum

Tomlinson (1999) suggested four principles that should guide educators as they create a differentiated classroom: (a) teachers focus on the essential concepts, principles, and skills of each subject; (b) teachers attend to student differences that are guided by their experiences, culture, gender, genetic code, and neurological wiring; (c) teachers realize that assessment and instruction are inseparable; and (d) teachers modify content, process, and products to meet individual students' levels of prior knowledge, and learning, thinking, and expression styles. In a differentiated classroom, teachers are attuned to student differences and attempt to align their curriculum to address those differences.

Tomlinson (1995) also offered a continuum for planning differentiated curricula. One key feature involves moving from basic and unchanging skills toward information, ideas, materials, and applications that transcend time (e.g., conflict and change). Other major aspects of differentiated instruction include moving from concrete to abstract representations; simple to complex concepts; small to great leaps in application and insight; structured solutions to greater independence in planning, designing and monitoring; and finally, a quicker pace of study and thought. By utilizing this continuum of features, teachers are able to adjust their teaching and assessment to meet the individual needs of students.

Wang and Walberg (1985) identified the basic premises underlying curriculum differentiation: individuals learn in different ways and at different rates; it is the major responsibility of schools to accommodate these differences to maximize each student's education. Rather than assuming that all students can and do learn in the same way and at the same rate, it is imperative for educators to acknowledge those differences, assess them, and create curricula that addresses those differences. In accepting that students demonstrate many individual differences, the researcher must be prepared to isolate and study those effects that may exist within schools rather than between them.

Finally, Tomlinson et al. (2002) have synthesized the literature on curriculum differentiation and created "parallel curriculums." In developing curriculum, teachers focus on the Core Curriculum, (i.e., the essential content to be taught in a unit); interject the Curriculum of Connections, (i.e., the ways in which the core content can be taught across time and time periods, across disciplines, across locations, across cultures, and through varied perspectives); establish the Curriculum of Practice, (i.e., the curriculum that helps students grasp the core curriculum and make connections by assuming the role of the practicing professional); and introduce the Curriculum of Identity, (i.e., the curriculum that allows students to see themselves reflected in the core curriculum and the disciplines).

Summary

To summarize, curriculum modification is the critical analysis and remodeling of existing curriculum to enhance curricular units through the use of advance organizers, higher level questioning strategies, and critical thinking skills; connecting the unit of study to the disciplines; and designing units of study based on interdisciplinary concepts. Curriculum differentiation is the assessment of students' prior knowledge and the subsequent adaptation of grouping and curricular practices based on that assessment. A comprehensive program for diverse learners must provide modified and differentiated instruction between and within mixed-ability classrooms.

Socio-economic Status

Coleman et al. (1966), in his seminal study of the complex relationship between socio-economic status (SES) and achievement, indicated that

> schools bring little influence to bear on a child's achievement that is independent of his background and general social context; and that this very lack of an independent effect means that the inequalities imposed on children by their home, neighborhood, and peer environments are carried along to become the inequalities with which they confront adult life at the end of school. (p. 325)

Boocock (1972) added that

> the family characteristic that is the most powerful predictor of school performance is socio-economic status (SES): the higher the SES of the student's family, the higher his academic achievement. This relationship has been documented in countless studies and seems to hold no matter what measure of status is used (occupation of principal breadwinner, family income, parents' education, or some combination of these). (p. 32)

Other researchers disagree with the predominance attached to SES in its effect on academic achievement. Previous research examining the relationship between SES and academic achievement has suggested that the correlations between SES and academic achievement vary from .100 to .800 (White, 1982). In his meta-analysis of 101 studies of the relationship between SES and academic achievement, White (1982) found that the average correlation between SES and academic achievement was .251. He suggested that there are two major explanations for this discrepancy in reported correlations. First, SES is typically a variable that is an aggregate of many other variables: parents' income, occupation, and level of education. In other studies, SES is composed of variables that may better be defined as Home Environment variables, (i.e., variables associated with quality and quantity of time spent with children, time spent reading to children, etc.). When these additional factors are introduced into one's definition of SES, the relationship becomes much stronger. An additional problem is created when the units of analysis used in SES and achievement data are confounded (i.e., aggregated versus individual as the unit of analysis). White (1982) found that when the unit of analysis is the aggregate school or district, the relationship is strengthened (.544), while when the unit of analysis is the individual student, the effects of SES are diminished (.318). White also suggested that when the units of analysis are confounded (i.e., the SES is an aggregated variable while student achievement is an individual variable), the correlation averages .338 for all studies. When researchers recognize that the variables that represent SES are vastly different from study to study while the units of analysis are also inconsistent, it is easier to see why there is such a discrepancy in reporting the actual correlation and relationship between SES and academic achievement.

Statement of the Problem

Previous research on practices that enhance student achievement suggest that practices such as between-class grouping (Kulik & Kulik, 1982; Rogers, 1991) and flexible, within-class grouping (Slavin, 1988) can create substantial achievement gains for able learners and nontrivial gains for average and struggling learners when instruction is tailored to students' readiness levels. Several research studies (Cawelti, 1999; Kulik & Kulik, 1984, 1990; Slavin, 1988; Walberg, 1985) have described curricular practices that also have significant effects on student learning and achievement. Little research, however, compares the effects of the various grouping practices with curriculum modification and differentiation practices on student achievement.

Additionally, current social and educational discussions and debates (e.g., inclusion, heterogeneous classrooms) have raised concerns over these potential gains, citing student self-esteem as a potential victim of such grouping practices. Due to these concerns, many teachers hesitate to address the diverse learning needs of students for fear of causing harm to students' self-esteem (George, 1988; Oakes & Goodlad, 1986; Slavin, 1987).

Mathematics instruction was the focus of this study due to two factors: national concerns over students' achievement in mathematics and technology, and the existence of an identified, national set of standards for mathematics instruction. The TIMSS report (National Center for Education Statistics, 1997) warned that the top 1% of mathematics students in the United States are not achieving at the same levels as students in Europe and Asia. Further, the National Council of Teachers of Mathematics (NCTM) has proposed standards that reflect the needs of a technologically advanced society (NCTM, 1989, 2000). Elementary students must be well-versed in the tools and methods of mathematics, rather than simply the algorithms.

These challenges make it imperative that researchers investigate the effectiveness of innovative practices (i.e., grouping and curricular) that may succeed in increasing the depth and breadth of student learning. Little research to date has explored the combined effects of various grouping practices with modified and differentiated curricula. The focus of this study was an assessment of classroom grouping practices and curricular modification and differentiation practices that may meet the needs of today's diverse learners, while advancing their individual levels of achievement.

Research Questions

The following questions were addressed in this research study:

1. To what extent do schoolwide socio-economic status (SES) and textbook-based or modified curriculum units explain differences in intermediate grade students' post-unit achievement in mathematics, as measured by a curriculum-based assessment that addresses knowledge related to data representation and analysis?
2. To what extent do socio-economic status, prior knowledge, and curriculum differentiation practices, combined with either between-class or within-class grouping practices, explain differences in intermediate grade students' post-unit achievement in mathematics, as measured by a curriculum-based assessment that addresses knowledge related to data representation and analysis?
3. What are teachers' perceptions about the effects of: (a) grouping practices, (b) curricular modification and curriculum differentiation practices, (c) classroom management, (d) grouping students for instruction, and (e) the necessity and effectiveness of curriculum modification and differentiation strategies?
4. What are students' perceptions about the effects of grouping, curriculum modification, and differentiation practices on students' self-esteem, self-efficacy, and attitudes towards the experimental mathematics unit?

Methods and Procedures

Research Design

A quasi-experimental design using a purposive sample of teachers and students was used to collect data related to Research Questions One and Two. Qualitative methods (artifacts, focus groups, and teacher and student interviews) were used to address Research Questions Three and Four.

Sample

The researcher randomly assigned, using standard procedures, a stratified, purposive sample of 31 grade 4 or 5 teachers and their students from 4 New England school districts to the comparison group or to 1 of 5 treatment groups (further subdivided into high, middle, and low levels of prior knowledge). Schools were selected by examining published lists of Economic Reference Groups (EGR); a categorization of schools based on such variables as parental income, education, and occupation; percentage of single-parent families; and home language (i.e., ERG A represents the wealthiest communities and ERG I represents the poorest districts*; Hartford Courant*, 1999). The researcher used the ERG data to provide near-equal representation of students from low, low-mid, and middle socio-economic groups. Schools were chosen in an attempt to provide approximately equal sample sizes (*N*=11 teachers, *N*=200 students) for each of three socio-economic groups (low, low-mid, and middle). Teachers and principals who previously solicited technical assistance from the University of Connecticut were invited to participate in the study. Teachers within each school were randomly assigned to one of six groups: treatment 1, 2, 3, 4, 5, or the comparison group. Parental permission was sought for student participation in the research study.

To address Research Question One, a stratified, purposive sample of 12 teachers and their respective students were randomly assigned to either the comparison group or to treatment group 1. Grade level was controlled by selecting only teachers from grades 4 or 5. To address Research Question Two, a stratified, purposive sample of 31 teachers and their students were randomly assigned to either treatment group 2, 3, 4, or 5 or the comparison group. Grade level was controlled by selecting only teachers from grades 4 or 5. To address Research Question Three, a maximum variation (Patton, 1990) sample of teachers, who work in schools that serve students at each level of SES and each type of treatment, were interviewed at the conclusion of the mathematics unit. To address Research Question Four, a maximum variation sample of students (representing diverse SES schools and varied levels of prior knowledge), from among the total sample of 645 students, was interviewed at the conclusion of the mathematics unit.

Treatment

Two factors were involved in the treatment for this study: a curriculum factor and a grouping factor. Teachers in the comparison group received training in using their regular textbook in a whole class setting. They implemented their regular, textbook-based lessons using a whole class grouping arrangement. Students in the comparison group were exposed to the regular, 3-week, 8-lesson, textbook curriculum unit normally provided by their school.

Teachers in the treatment groups were trained in five different facets of curriculum modification, differentiation, and grouping practice. Teachers in treatment group 1 received one hour of training in curriculum modification or remodeling techniques for use in a whole class setting. Teachers in treatment group 2 received two hours of training in curriculum differentiation techniques to be used in conjunction with flexible, within-class grouping of students (Flexible Small Groups [FSG]) for instruction based on prior knowledge. Teachers in treatment groups 3-5 (Joplin Plan between-class grouping) received two hours of training in curriculum modification and differentiation techniques, along with one additional hour of strategies for teaching students with low, medium, and high levels of prior knowledge based on their treatment group assignment. For example, teachers who taught students with high levels of prior knowledge (Joplin-high) received training on teaching students with high levels of mathematics ability or prior knowledge. All treatment teachers received one additional hour of orientation to the mathematics unit used in the study. Training in curriculum modification and differentiation was provided to treatment group teachers prior to the onset of the student treatment. The theoretical background of the training was based on the work of Burns et al. (1997), Renzulli (1994) and Tomlinson (1995, 1999) and related to strategies for modifying and differentiating curriculum for diverse learners. Key concepts included techniques for analyzing and modifying existing curriculum units to reduce repetition and increase challenge (Renzulli, 1994), managing flexible between and within-class grouping practices, and the use of alternative or tiered activities to create units that meet the needs of diverse levels of readiness. In addition, teachers were provided an overview of the contents of the experimental mathematics unit designed for the student treatment (Table 1).

Table 1

Comparison and Treatment Teacher Training

Treatment Group	Regular Textbook	Modificatio n	Differentiatio n	Management	Math Unit
Comparison	1 hour	None	None	None	1 hour
Modification	None	1 hour	None	None	1 hour
FSG	None	1 hour	1 hour	1 hour	1 hour
Joplin	None	1 hour	1 hour	1 hour	1 hour

Students in treatment group 1 received a 3-week, 8-lesson, enhanced version of their regular textbook lessons for that unit. The modified unit included enhanced learning objectives, carefully aligned with constructivist teaching and learning activities, authentic resources and assessment techniques; engaging lesson introductions, and an emphasis on the major principles and concepts of the discipline. Students in treatment group 2 (FSG) were placed into flexible math groups within their regular classroom for mathematics and were exposed to modified and differentiated instruction based on their learning and readiness levels. Students in treatment groups 3-5 (Joplin Plan) moved between classes for mathematics instruction only. Students scoring in the top 33% on the preassessment were assigned to treatment group 3; those students scoring in the middle

34% were assigned to treatment group 4, and those students scoring in the lowest 33% were assigned to treatment group 5. Students in treatment groups 2-5 were temporarily assigned to a small group or a different classroom based on the results of their preassessment for the unit on Data Representation and Analysis and were exposed to curriculum developed to address their unique learning needs. Students in the Comparison and Modification groups were further subdivided into high, middle, and low levels of prior knowledge using the same criteria as the FSG and Joplin groups to facilitate comparisons. Teachers in treatment groups 1-5 maintained a checklist of completed components in the mathematics curriculum unit in addition to samples of student work to verify implementation of the experimental unit (Table 2).

Table 2

<u>Treatment Groups and Their Abbreviations</u>

Group	Levels of Prior Knowledge	Abbreviation	Treatment Group Number
Comparison	Low	Comp-low	1
Comparison	Middle	Comp-mid	2
Comparison	High	Comp-high	3
Modification	Low	Mod-low	4
Modification	Middle	Mod-mid	5
Modification	High	Mod-high	6
FSG*	Low	FSG-low	7
FSG	Middle	FSG-mid	8
FSG	High	FSG-high	9
Joplin	Low	Joplin-low	10
Joplin	Middle	Joplin-mid	11
Joplin	High	Joplin-high	12

*<u>Note.</u> FSG represents Flexible Small Groups.

All of the modified and differentiated curriculum units used in this study were based on local mathematics standards for students in grades 4 and 5, the National Council of Teachers of Mathematics (NCTM) standards, and the Association for Supervision and Curriculum Development (ASCD) standards. The researcher developed all aspects of the experimental mathematics curriculum for groups 1-5 for a unit on Data Representation and Analysis that required eight lessons and 16 hours of student contact time. The lesson topics for the 3-week unit are summarized in Table 3.

Table 3

Modified/Differentiated Mathematics Unit Outline

Week One	Introduction to the field of Statistics	Interpreting, Estimating, and Predicting with Graphs	Interpreting, Estimating, and Predicting with Graphs	Analyzing Information from Graphs and Charts	Analyzing Information from Graphs and Charts
Week Two	Stem and Leaf Plots	Stem and Leaf Plots	Mean, Median, and Mode	Mean, Median, and Mode	Mean, Median, and Mode
Week Three	Sampling	Probability	Probability	Probability	Final Project

Data Collection

To address Research Questions One and Two, the researcher designed and the teachers administered pre- and post-assessments that measured students' acquisition of unit objectives. Student achievement information was gathered by a 35-item, curriculum-based assessment in Data Representation and Analysis. Prior to implementation of the mathematics unit, student SES information was gathered through strategic school profiles. To assess treatment fidelity, teachers maintained a checklist of completed, experimental curriculum components and collected examples of student work to verify implementation of the unit. Data from teachers who did not complete a minimum of six lessons were eliminated from the analysis. To address Research Questions Three and Four, the researcher used artifacts of student work, semi-structured interviews, and focus groups with teachers and students to triangulate data sources.

Instrumentation

To address Research Questions One and Two, students were administered identical pre and posttest forms of a curriculum-based assessment in mathematics for the unit on Data Representation and Analysis. This instrument was developed with the assistance of university professors, mathematics resource teachers, and classroom teachers based on published standards of various state and professional education organizations. Readability and appropriateness of grade level objectives were verified by six mathematics teachers from grades 4 and 5. Original alpha reliability estimates on the 30-item test from a sample of 240 intermediate students indicated a need for a 35-item test to reach alpha reliability estimates of .80. The instrument was modified to address this need.

Data Analysis

Research questions were investigated using multivariate and qualitative methods. Student was the unit of analysis in this study as different students within intact classrooms were exposed to different instruction and grouping arrangements (Burstein, 1980). The unit of analysis is a controversial issue in the research, so correlated effects within and between groups were investigated using techniques of Repeated Measures Analysis of Variance (Hopkins, 1982; Kashy & Kenny, 1990; Kenny & Judd, 1996).

To address Research Question One, a Repeated Measures Analysis of Variance (ANOVA) was used (Tabachnick & Fidell, 1996). The focus of the study was to identify variables that explain differences over time in students' posttest scores on the curriculum-based assessment. The predictor variables for Research Question One were SES and group membership (textbook or modified curriculum unit). Grade was entered into the analysis as a covariate due to pretest differences between students in grades 4 and 5 (i.e., students in grade 5 scored higher than students in grade 4 across treatment groups). A Bonferroni adjustment was made to control for inflated Type I error rates (multiple group comparisons). The significance ($p < .05$) of the group mean differences was assessed and the effect sizes reported. The criterion variable was student posttest scores on the curriculum-based assessment.

To address Research Question Two, a Repeated Measures Analysis of Variance was used. Predictor variables included SES and group membership (between or within-class grouping). Grade was entered into the analysis as a covariate due to pretest differences between students in grades 4 and 5. A Bonferroni adjustment was made to control for inflated Type I error rates. The significance ($p < .05$) of the group mean differences was assessed and the effect sizes reported. The criterion variable was student posttest scores on the curriculum-based assessment.

To address Research Question Three, qualitative analyses were employed using interviews with teachers and focus groups at the conclusion of the unit. Data from interviews and focus groups were coded and analyzed for patterns and themes and organized categorically and chronologically (Cresswell, 1994; Strauss & Corbin, 1998).

To address Research Question Four, students were interviewed at the conclusion of the unit to provide information about their self-efficacy, motivation, and attitudes towards the grouping and curricular practices and experimental math unit. Data from interviews and focus groups were coded and analyzed for themes (Cresswell, 1994; Strauss & Corbin, 1998). Generalizability was not inferred due to the descriptive uses of statistical methods.

CHAPTER 3: Research Findings

In this section, the major findings of the study and their implications are discussed. Limitations of the study and suggestions for future research are also presented. Research findings and implications are discussed in three sections. First, the findings and implications related to the effects of enhanced curricular practices on students' mathematics achievement are reviewed. Second, the findings and implications related to the effects of grouping and curricular practices on students' mathematics achievement are discussed. Finally, the qualitative findings of teachers' and students' reactions to the implementation of the mathematics unit are explained.

Research Question One

> To what extent do socio-economic status (SES) and textbook-based or modified curriculum units, after adjusting for initial differences between grade levels, explain differences in intermediate grade students' post-unit achievement in mathematics, as measured by a curriculum-based assessment that addresses knowledge related to data representation and analysis?

Repeated Measures Analysis of Variance

Repeated Measures (pretest to posttest) Analysis of Variance (RM-ANOVA) was conducted to evaluate the effects of SES (lower, middle-lower, or middle) on the dependent variable, students' posttest mathematics scores for the unit, Data Representation and Analysis. Research has suggested that SES is the single largest contributor to students' academic achievement (*Hartford Courant*, 1999). Further, students in grade 5 would be expected to perform significantly better than students in grade 4 due to their more extensive experience with math concepts. Additionally, students with higher levels of prior knowledge are expected to achieve at higher levels than their less ready peers.

Differences Among Groups

To examine the effects of the different treatment groups on posttest scores, a 3-way Repeated Measures (pretest to posttest) Analysis of Variance (ANOVA) was conducted to evaluate the effects of grade (4 or 5), school SES (lower, lower-middle, and middle), treatment group membership (Comparison or Modification) on the dependent variable, students' posttest mathematics scores for the unit, Data Representation and Analysis. Research has supported the use of enhanced or modified curriculum to advance student achievement (Cawelti, 1999; Erickson, 1998; Flanders, 1987; Gardner, 1999; Levin, 1987; Maker, 1982; Paul, Binker, Jensen, & Kreklau, 1990; Renzulli, 1988, 1994; Wiggins & McTighe, 1998).

The results indicated that there were significant differences between students enrolled in different grade levels (4 or 5), among SES groups (lower, lower-middle, and middle), and between treatment groups (Comparison or Modification) on the posttest. Effect sizes ranged from small to medium (Cohen, 1988).

Grade

There were significant differences in posttest achievement between students enrolled in grade 4 or 5, $F(1, 253) = 38.419$, $p < .001$. The objectives used in the study were derived from NCTM standards for students in grades 4 through 8 (NCTM, 1989, 2000). Therefore, based on the similarity of mathematics curriculum in grades 4 and 5 and the grade level makeup of the sample (intermediate schools), a decision was made to administer identical treatments to students in grades 4 and 5. Teachers and resource specialists indicated that posttest mean differences between students in grades 4 and 5 may be due to the developmental level of the students; (i.e., students in grade 5 had more experience with the mathematics concepts of the experimental unit, thereby suggesting that they would demonstrate higher pretest and posttest scores). Therefore, the decision was made to use grade as a covariate to adjust posttest scores based on initial mean differences between students enrolled in grade 4 or 5 (students in grade 5 had higher pretest scores than students in grade 4 across all treatment groups).

School Socio-economic Status

There were significant differences on the posttest among different school socio-economic classifications, $F(2, 253) = 129.951$, $p < .001$. Students who attended schools that were categorized as a lower-middle socio-economic level scored higher on the posttest ($M = 21.42$, $SD = 4.56$) than students in either the lower ($M = 10{,}52$, $SD = 5.65$) or middle ($M = 17.02$, $SD = 4.56$) socio-economic categories. SES explained approximately 50% of the variation in students' posttest scores. These results are consistent with White's (1982) findings that when SES is an aggregated variable (i.e., district level) and academic achievement is measured at the individual level, the relationship indicated is stronger than when both variables are measured as individual units of analysis.

Previous research on the relationship between SES and academic achievement has suggested that the amount of variance explained by SES varies from 1% to 64% (White, 1982). Research suggests that the middle level SES group would have the highest pre and posttest mean scores, however, this did not occur in this study. There are three factors that could explain these results. First, schools in the lower-middle level had higher pretest scores prior to implementation of the mathematics unit. Second, these schools had substantially smaller class sizes than schools in the lower or middle socio-economic categories. Finally, these results could be due to sampling bias, as one of the schools in the lower-middle category was a gifted magnet school, while the other two schools were located in a small, diverse school district that is experiencing an economic boom and an influx of young, college-educated residents. Consequently, these results should be interpreted cautiously.

Treatment Groups

There were significant differences between treatment groups (Comparison or Modification) on the dependent variable, student posttest score on the curriculum-based assessment in mathematics, $F(5, 253) = 40.988$, $p < .001$. Effect sizes ranged from -.17 SD for the Modification-low group, .02 SD for the Modification-middle group, to .41 SD for the Modification-high group, when compared to their corresponding Comparison subgroup (low, middle, or high); all within the range of small to medium effects (Cohen, 1988). Effect sizes calculated from unadjusted means indicated greater gains for the three Modification subgroups: .17, .27, and .81 for the low, middle, and high groups, respectively (Table 4). Research on Aptitude-Treatment Interaction has indicated that certain types of curricula and instructional strategies are preferred by different types of students and teachers (Cronbach & Snow, 1981; Snow, 1989).

Table 4

Means, Standard Deviations, and Effect Sizes by Treatment Groups

Treatment Group	*N*	Pretest *M*	Pretest *SD*	Posttest *M* *Unadj*	Posttest *SD*	Adj *M*	ES (*SD*) *Adj*	ES (*SD*) *Unadj*
Comp-Low	31	10.32	3.93	14.65	4.50	13.02		
Comp-Middle	37	13.04	3.96	16.14	5.22	15.10		
Comp-High	42	17.05	4.95	17.43	5.41	17.28		
Mod-Low	43	10.48	3.70	15.44	4.91	12.27	-.17*	.17**
Mod-Middle	47	14.60	3.31	17.36	4.55	15.19	.02*	.27**
Mod-High	53	18.79	3.43	21.21	3.87	19.18	.41*	.81**
Overall	253	14.17	4.94	17.34	5.18			

*Adjusted for initial grade level differences.
**Unadjusted.

Differences Over Time

There were no significant omnibus differences among groups over time, however, there were significant interactions between time (pretest to posttest) and school SES, $F(2, 253) = 3.620$, $p < .05$, and between time and treatment groups, $F(5, 253) = 4.234$, $p < .01$. Students enrolled in schools in the lower and middle socio-economic groups demonstrated the most significant gains over time, while students in the Modification-high group experienced the greatest gains among treatment groups (ES = .49 with adjustment for covariate; ES = .81 without adjustment).

Summary of Results

The results of this study indicate that students in the Modification Groups (treatment subgroups 4-6) demonstrated significantly higher posttest scores than comparable students in the Comparison Groups (treatment subgroups 1-3) without adjustment for grade level differences. Students who scored highest on the pretest (placed into the high subgroups) made the most significant gains among the three groups (ES = .49 SD): low, middle, and high. In conclusion, there were significant differences among SES groups (lower, lower-middle, and middle) with students in the lower and middle socio-economic levels experiencing the greatest gains. There were also significant differences between fourth and fifth graders. The curriculum treatment was effective when compared to the regular textbook unit for both grades, all socio-economic levels, and middle and high treatment subgroups, with an average gain of approximately one-half standard deviation over the comparison group, after adjusting for initial differences based on grade level.

Research has indicated that textbooks lack sufficient depth and complexity to engage students in authentic learning processes (Flanders, 1987; Reis et al, 1993). Further, textbooks focus on behavioral and skill objectives rather than overall learning goals, (i.e., goals that reflect the "big ideas" or main principles and concepts of a discipline: "what are the big ideas students should know and understand when they've finished this unit?") (Schunk, 1996); and activities, rather than authentic resources and products. For example, each lesson plan introduced a list of major concepts and principles to be addressed as well as essential questions to be answered by students upon completion of the experimental unit. Additionally, the culminating unit project was introduced early in the teaching of the unit and provided a curricular lens through which students could focus their attention and learning. In this study, teachers in the Comparison Groups suggested the textbook did not have sufficient coverage of data representation and analysis and that they needed to supplement their regular textbook unit with additional resources. Lou et al. (1996) suggested that effective and authentic whole group instruction can demonstrate significant gains without the additional need for ability grouping. These results support the research of Lou et al. (1996) and suggest that students who receive an enhanced and remodeled curriculum can demonstrate gains in student achievement over students who receive instruction from a comparable textbook unit without additional grouping practices.

Implications for Teaching

The teacher's role in curriculum development becomes even more critical in light of these results. Since this research indicated that a short, 3-week enhanced curriculum unit can have an impact on students' achievement, it is important that teachers examine their current curriculum and make important decisions about what is important to teach and what can be left out. Further, teachers must stress the need for learning goals rather than behavioral objectives; i.e., what they want the students to learn rather than what the students will do, which Schunk (1996) has shown can have a significant effect on achievement. The need for a critical analysis of existing curriculum, especially if it stems from a textbook, creates an extra imperative in these days of high-stakes state achievement testing.

Research Question Two

> To what extent do socio-economic status (SES), grade, and curriculum differentiation practices, combined with either between-class or within-class grouping practices, explain differences in intermediate grade students' post-unit achievement in mathematics, as measured by a curriculum-based assessment that addresses knowledge related to data representation and analysis?

Repeated Measures Analysis of Variance

Repeated Measures Analysis of Variance (ANOVA) was conducted to evaluate the effects of grade (4 or 5), SES (lower, lower-middle, or middle), and treatment group membership (Comparison, Modification, FSG, or Joplin) on students' post-assessment mathematics scores. The dependent variable was posttest score on the curriculum-based assessment in mathematics for the unit, Data Representation and Analysis. The results indicated that there were significant differences between fourth and fifth graders, among socio-economic levels, and among treatment groups.

Grade

There were significant differences between fourth and fifth graders ($F(1, 645) = 54.619$, $p < .001$), on the posttest. Fifth graders ($M = 20.07$, $SD = 4.31$) were more successful than fourth graders ($M = 16.72$, $SD = 5.51$) on the posttest. Due to initial differences between pretest means, grade was used as a covariate in these analyses.

School Socio-economic Status

There were significant differences among students in different socio-economic schools ($F(2, 645) = 266.238$, $p < .001$), on the posttest. In this study, students in the lower-middle socio-economic level had higher levels of prior knowledge and higher posttest scores ($M = 20.86$, $SD = 4.17$) for the mathematics unit than did students from the low ($M = 10.52$, $SD = 5.65$) or middle ($M = 18.02$, $SD = 4.67$) socio-economic levels. Research suggests that the middle-level socio-economic group would have the highest pre and posttest scores, however, this did not occur in this study. These results could be due to the factors indicated under Research Question One.

Treatment Groups

Research on ability grouping has consistently demonstrated significant results for high-achieving students enrolled in between or within-class grouping arrangements (Kulik & Kulik, 1992; Rogers, 1993; Slavin, 1987). Results have been more controversial with respect to normal-achieving and low-achieving students. The results of this study support the research on high-achieving students, indicating that grouping by ability for specific instruction may result in significant achievement gains. These results also suggest that other students (those with middle or average levels of prior knowledge) can sustain significant growth as well. There were significant differences among treatment groups ($F(11, 645) = 55.816$, $p < .001$). Significance tests of the differences among comparable groups within each treatment effect were assessed. The Modification-high ($p < .01$), FSG-high ($p<.001$), and Joplin-high ($p < .001$) treatment groups had significantly higher posttest means than their corresponding Comparison-high groups, after adjusting for inflated Type I error rates (Bonferroni adjustment). Effect sizes ranged from .29 SD for the FSG-low and -.13 SD for the Joplin-low groups; .42 SD for the FSG-middle and .10 SD for the Joplin-middle groups, .83 SD for the FSG-high and .30 SD for the Joplin-high groups; all within the range of small to medium effects (Cohen, 1988) (see Table 5).

Table 5

Effect Sizes for Treatment Groups on Curriculum-based Post-Assessment for Mathematics Unit on Data Analysis and Representation

Treatment Group	Sub group ID	*M* (*Unadj*)	*SD*	ES (*SD*) (*Unadj M*)	*M* (*Adj*)	ES (*SD*) (*Adj M*)*	Variance Explained (η^2)
Comp-Low	1	14.65	4.50		12.79		
Comp-Mid	2	16.14	5.22		14.83		
Comp-High	3	17.43	5.41		17.04		
Mod-Low	4	15.44	4.91	.18	12.33	-.10	.03
Mod-Mid	5	17.36	4.55	.25	15.32	.10	.03
Mod-High	6	21.21	3.87	.81	19.32	.49	.17
FSG-Low	7	15.83	4.22	.26	14.07	.29	.10
FSG-Mid	8	17.69	4.23	.32	16.83	.42	.14
FSG-High	9	21.32	4.34	.73	21.09	.83	.28
Joplin-Low	10	14.00	4.61	-.11	12.20	-.13	.04
Joplin-Mid	11	17.44	4.40	.28	15.31	.10	.03
Joplin-High	12	19.78	5.23	.48	18.62	.30	.10

*Means adjusted for initial differences between students in grades 4 and 5.

Between and Within-class Grouping

Results were mixed, however, when comparing the Modification groups to the FSG and Joplin groups, effect sizes ranged from -.31 for the Joplin-high versus Modification-high to .09 for the FSG-low versus the Modification-low. FSG-mid (ES = .08) and Joplin-mid (ES = .02) both had positive, trivial gains over the Modification-mid group. This could simply be due to selection bias as principals and resource specialists suggested that some of the Modification teachers were among the most proficient math teachers in their schools. The trivial effect sizes of the FSG-middle and Joplin-middle versus the Modification-middle are interesting considering all groups received the same mathematics unit. This effect could indicate that when student heterogeneity within the classroom is reduced, students are able to make more significant achievement gains than their peers in the comparable, whole group, modification classroom.

Summary of Results

As suggested earlier, these results indicate that an enhanced or differentiated mathematics unit can create significant achievement gains over the students' regular textbook unit. The research on ability grouping has failed to address the issue of grouping versus curriculum due to the difficulty of separating the effects of the grouping from the effects of the curriculum (Lou et al., 1996; Slavin, 1988). The results of this study support the use of enhanced or differentiated curriculum over the standard textbook unit, however, the effects of the grouping practices above and beyond the curricular adjustments are unclear.

Research Question Three

> What are teachers' perceptions about the effects of: (a) grouping practices, (b) curricular modification, and/or curriculum differentiation practices, (c) classroom management, (d) the grouping of students for instruction, and (e) the necessity and effectiveness of curriculum modification and differentiation strategies?

Qualitative Analysis

The qualitative findings provided additional insights into effects of the mathematics unit, Data Representation and Analysis, and the grouping practices on teachers' attitudes towards teaching mathematics and students' self-concept and self-efficacy. Data analysis from teacher interviews and focus groups identified the following issues as the most important aspects of the study: the degree and type of differences between this experimental mathematics unit and the regular textbook unit; the effectiveness of the grouping procedures on teachers and students; and the effects of the grouping practices on the self-concept and self-efficacy of students. A comparison of the textbook, modified, and differentiated units is found in Table 6.

Table 6

Comparison of Textbook, Modified, and Differentiated Units

Lesson Component	Textbook	Modified	Differentiated
Introduction	Introduce concept; provide examples. Cooperative groups explore examples of graphs (data) in newspapers or magazines. Demonstrate how to calculate probability of single event.	Pose problem or controversy to spark students' interest. Discuss importance of topic in real-world situations.	Pose problem or controversy to spark students' interest. Discuss importance of topic in real-world situations.
Teaching Activities	Demonstrate sample problems in data analysis. Demonstrate how to create different graphs (line, bar, pictograph). Discuss why certain graphs (data) would be used in certain examples. Demonstrate examples of probability of single event.	Lead discussion of issues involved in problem or controversy raised. Demonstrate how to graph, calculate statistics, calculate probability using hands-on, interactive examples. Vary grouping arrangements during discussion and demonstration (whole class, pairs, small groups).	Same as Modification plus: target differentiated questions to students with different levels of prior knowledge; i.e., provide more information/ scaffolding to less-ready students; more complex, abstract questions that may ask for generalizations to more-ready students.
Learning Activities	Students complete graphs or tables of data in textbook. Work in cooperative groups to graph newspaper data. Students use manipulatives to calculate probability of single event.	Students complete journal prompts that connect activities to concepts; complete hands-on activities that demonstrate concept; create tables and graphs to publish their results; share original hypotheses and results orally with class; work in various grouping arrangements (whole class, pairs, small groups, individuals).	Same as Modification plus: students with different levels of prior knowledge will work on leveled materials. Less-ready students will complete fewer problems at less complex level. More-ready students will work with materials from higher grade level. Some students may be accelerated into more complex work; e.g., probability of multiple events or factorials; double bar or stem and leaf graphs.
Resources	Textbook, graph paper, newspaper, calculators, manipulatives for probability.	Textbook, graph paper, supplementary materials, calculators, video clips, computer program, manipulatives.	Textbook, graph paper, supplementary materials, calculators, video clips, computer program, manipulatives, learning centers.
Products	Worksheet or homework pages.	Journal prompts, original graphs, worksheets, original survey instrument with hypotheses, graphs, and conclusions.	Tiered journal prompts, original graphs, worksheets, original tiered survey instrument with hypotheses, graphs, and conclusions.
Assessment	Skill quiz; end-of-unit multiple choice test.	Students use research rubric to complete original survey research project.	Students use tiered research rubric to complete original survey research project.

Effectiveness of Mathematics Unit

After the initial two lessons, teachers felt more confident about the materials and understood the flow and organization of the mathematics unit. Some teachers struggled with the concept of the first lesson, Introduction to the Fields of Statistics and Probability. In the first lesson, teachers were asked to display a picture and article that had appeared in the local newspaper regarding a "juiced baseball." In the article, the author displayed a chart that demonstrated that more home runs were hit in the last 10 years than at any time during the 20th Century. Students were shown pictures of the inside of a baseball and probed as to causes of this phenomenon. The typical response is that, somehow, the baseball is lighter and will carry farther than in past years. The idea was to introduce students to the field of statistics by relaying the idea that those who interpret statistics often do so with their own agenda. Students were introduced to the field of statistics through the window of baseball statistics. After the initial introduction, students were questioned as to their reaction and explanation for fact that more home runs are being hit today. Students in one class used this discussion as an impetus to further explore the physics of a baseball. One student found an old baseball in the street near his house, took it to school, where his classmates decided to dissect it to verify for themselves that the baseball was not "juiced."

Teachers indicated that the unit was very different from comparable textbook units they had taught in the past. For example, in Lesson 3: Analyzing Information from Graphs and Charts, students were engaged in a discussion of the most popular Disney film of all time. Teachers described the discussions that followed the introduction, adding that students suggested polling their classmates to find out what exactly was their favorite film. Prior to collecting the data, students were asked to write a journal entry to predict what film would be most popular and why. Students used the data they collected to graph and display their results. Some students were surprised that boys and girls differed distinctly in their choice of films. Students were then asked to add another journal entry that would explain this puzzling phenomenon.

Teachers suggested that the unit was more comprehensive, emphasized active, open-ended questioning, included activities that were motivating and engaging to the students, required students to use skills of critical analysis, infused writing into the mathematics unit, and offered students more choices in projects and presentations. Additionally, teachers thought that all students, regardless of their levels of prior knowledge, had meaningful and interesting work to complete. When students were asked to graph their results from lesson three, they chose many and varied approaches to representing the data. Some students chose to create a pie chart, but they realized they did not have the requisite skills in calculating percentages to complete the task. The teacher called an impromptu mini-skill lesson with those students who felt they needed extra help. Students then returned to their groups and completed their pie charts. The teacher indicated that she would have never thought to do that prior to implementing the experimental unit. Because the lessons had overall learning goals that were meaningful to the students, they approached their activities in a purposeful manner.

Overall, students and teachers stated that they liked the hands-on aspect of the activities, the infusion of writing into the mathematics curriculum, the numerous opportunities for students to work collaboratively, and the comprehensive and authentic nature of the final project.

Ability Grouping for Mathematics

There have been numerous studies over the past two decades that related ability grouping to students' self-concept and self-efficacy, with mixed results. Bandura (1986) suggested that one modeling cue that may activate student self-efficacy is "similarity to others." He suggested that "similarity to others" was an important cue for students to gauge their own self-efficacy for a task. If students see successful models who are more like themselves, they gain in self-efficacy. If the model is someone who is perceived to be more successful at a task, student self-efficacy may be reduced. With this in mind, it is important to study the effects of reduced heterogeneity in the classroom on students' self-concept and self-efficacy for mathematics.

The majority of teachers interviewed had favorable opinions regarding grouping students by prior knowledge for this mathematics unit. They overwhelmingly thought their students enjoyed the variety of grouping arrangements, especially the Joplin Plan, between class grouping. The vast majority of teachers interviewed, including a math resource teacher, enjoyed working in the Joplin Plan and argued that the reduced heterogeneity in the classroom allowed them to set the pace of the mathematics unit without fear of moving too fast for the struggling learners or too slow for the more able learners. The only concern expressed by the teachers was in having fifth graders report to fourth grade classrooms for math.

Teachers in the FSG classrooms had positive reactions to the grouping arrangement, despite the challenging classroom management issues that arose. Some teachers suggested that students did not always have the skills to work independently with their peers. Other teachers found they needed to more precisely estimate the time needed for different activities, as they reported that students in the higher groups often finished their tasks sooner than expected.

Several teachers indicated that they liked the differentiation that was embedded within the whole group discussions. For example, during whole class discussions, prior to placing students into small, flexible groups, teachers were instructed to pinpoint specific lesson questions to specific students (questions were color-coded for different levels of prior knowledge). Teachers used preassessment materials to identify students with different levels of prior knowledge. Since teachers were aware of which students possessed higher levels of experience with the content, they were able to target the higher level questions toward those students and scaffold more difficult questions for struggling learners. Teachers in the FSG classrooms also indicated that they liked having their own students in the classroom. They didn't feel the pressure of finishing the lesson at a certain time so the students could return to their homeroom classes. The most difficult aspect of teaching with the FSG, within-class grouping arrangement, was the planning and management of the group activities. Again, teachers found that some students completed their group work sooner than expected, while others took longer. Teachers must feel free to experiment with different types of tiered assignments to ascertain the best fit for each group of students.

Each teacher responsible for flexible small groups within the classroom indicated that they should have spent more time in advance preparation, not only with the mathematics unit, but preparing additional "anchor" activities that one group of students could use while others received instruction. Those teachers who already had interest or learning centers within their classrooms, had daily journal-writing exercises, or routine tasks to complete, found that they were better able to manage the small groups than their colleagues who had not prepared such "anchor" activities.

Teachers at each school expressed excitement and surprise at the reactions of some students to the mathematics unit on Data Representation and Analysis. They provided anecdotal evidence of the impact of the unit on their students (e.g., increased motivation, task persistence, and cumulative learning). Other teachers admitted that they were concerned when they first read through the mathematics unit. Some of the activities within the unit were geared to middle school students and a few teachers expressed doubts that their students would be able to master the activities and concepts. For example, Lesson 7: Probability, was geared for students in middle school mathematics, including topics such as factorials, the Basic Counting Principle, Permutations, and Combinations. One enterprising teacher used her students as place cards in a hands-on demonstration of calculating a simple factorial. Teachers were consistently surprised at how capable all of their students were with the experimental unit, especially those who were more able.

Implications for Teaching

The teacher's role in curriculum design and development becomes even more critical in light of these findings. This research study demonstrated that a modified or enhanced curriculum unit alone, with appropriate learning goals (Schunk, 1996) and authentic resources and products (Renzulli, 1977) can create substantial interest, motivation, a perceived value in learning, and increased achievement for students. Further, when curriculum enhancement is blended with flexible or temporary grouping for specific content or skills, achievement gains may be more substantial. The major implication of these results is that teachers can no longer leave curriculum decision-making to textbook publishers.

Research Question Four

> What are students' perceptions about the effects of grouping, curriculum modification, differentiation practices, and the social dynamics of the grouping practices, on their self-esteem, self-efficacy, and attitudes towards the experimental mathematics unit?

Qualitative Analysis

The researcher interviewed students from all treatment groups and found several significant results: students enjoyed the hands-on nature of the unit activities, they enjoyed participating in a variety of small groups, and they enjoyed and learned from the final original projects they created.

Mathematics Unit: Lessons

Students suggested that the experimental mathematics unit was more complex, engaging, challenging, and fun than their regular textbook unit. Research has suggested that when students are challenged, with appropriate assistance or scaffolding, their own sense of intrinsic motivation for learning can be enhanced (Amabile, 1983; Schunk, 1996; Vygotsky, 1978). Schunk (1996) suggested that intrinsic motivation helps students focus on their own competence for completing a difficult task. He further suggested that in developing a sense of intrinsic motivation, students can develop their own perceived competence by mastering difficult situations.

Students spoke enthusiastically of the hands-on nature of the activities in the mathematics unit. In Lesson 2: Interpreting, Estimating, and Predicting with Graphs, students were engaged in manipulations of a hand-made parachute. At the conclusion of the parachute jump trials, students collected, graphed, and explained their results in a culminating activity. In Lesson 4: Stem and Leaf Plots, students were engaged in an experiment to determine if they could calculate simple mathematical solutions while being distracted by the teacher. Students predicted the results of the experiment and posed reasons for the discrepancy in scores during quiet and noise. They were also able to express conceptual understanding when interviewed by their teacher or the researcher. The students reiterated the major ideas of the unit and were able to make predictions and test those predictions with their final projects.

Between and Within-class Grouping

Students in all groups had positive reactions to the grouping arrangements. All of the students interviewed enjoyed changing classes or working in small groups for math even though they understood that they might be working on different assignments. The students also believed that all of their peers liked the grouping as well. Several fifth grade students expressed mild concern at moving to a fourth grade classroom for mathematics, but this was not a general concern.

Final Project

All of the students in each school expressed enjoyment and pride in completing the final, culminating project. Students were required to complete an original survey instrument; identify a sample (random or convenience); administer the instrument, collect data; and graph and interpret the results. Students were required to make predictions prior to data collection, verify or refute their predictions, and explain their results.

Because teachers assigned the final project while the mathematics unit was in progress, students were attentive to the contents of the unit as they knew the content and skills would be necessary to complete the final project. Students working in small groups demonstrated high levels of motivation. They spent many hours outside of class completing their projects. One student from a diverse school district was so highly motivated that she made personal phone calls, and collected information and resources for her final project, a survey of the most popular playground equipment among her schoolmates.

All students interviewed were able to reiterate the major concepts involved in their projects (e.g., why they used median instead of mean or their surprise at their findings). Additionally, students assimilated the jargon of the field and spoke as if they were real survey researchers; (e.g., one student suggested he "surveyed" the class for their opinions. Another student suggested she chose a "random sample" by drawing names from a hat).

Implications

The implications of this study for students are twofold. First, students can become engaged, motivated, and excited about learning if the curriculum is authentic and meaningful and if appropriate learning goals are provided. It is imperative for teachers to take the time to examine their current curriculum for authentic and original learning that utilizes real-world resources and places students in the role of practicing professionals (Renzulli, 1977). Second, students can be challenged without losing their sense of self-concept or self-efficacy (Bandura, 1986). This unit was designed to meet mathematics objectives for students in grades 4-8. Those students who struggled with the content still had the opportunity to be motivated and engaged because the unit was differentiated to meet their specific learning needs. It is important for teachers to be aware of students' different learning styles, levels of motivation, and prior knowledge. The only true way to ascertain these differences is to assess the students prior to implementing a new curriculum unit and then to group and teach them accordingly.

Conclusions

The following conclusions emerged from this study:

- The quantitative analyses indicated that an enhanced or modified mathematics unit improved the academic achievement of students when compared to a regular textbook unit.
- The quantitative analyses indicated that an enhanced or modified mathematics unit improved the academic achievement of students with middle or high levels of prior knowledge over students in the comparable comparison groups. Students in the Modification group who scored highest on the pretest experienced the greatest gains.

- The quantitative analyses suggested that there was a significant interaction between time and treatment group (Comparison or Modification). Students in the Modification-high subgroups experienced the most significant gains over time.
- The quantitative analyses indicated that both modified and differentiated mathematics curriculum units improved the academic achievement of students over the regular textbook unit.
- The quantitative analyses indicated that a differentiated mathematics unit used in combination with flexible grouping practices improved the academic achievement of students with middle and high levels of prior knowledge when compared with the comparison subgroups (middle or high). Students who scored highest on the pretest experienced the greatest gains in the Modification and FSG treatment groups. Students who scored in the FSG-high group experienced the greatest gains among all treatment subgroups.
- The qualitative results indicate that teachers must look beyond the bindings of their regular textbook to create authentic and meaningful curriculum for students and to have a more lasting effect on student learning.
- The quantitative analyses suggested that students from all socio-economic backgrounds made significant gains during implementation of the enhanced or differentiated mathematics unit.
- The quantitative analyses suggested that there was a significant interaction between time and SES groups. Students in the lowest schoolwide SES groups experienced the greatest gains.
- The quantitative analyses suggested that there was a significant interaction between time and treatment groups. Students in the high subgroups experienced the greatest gains.
- The qualitative analyses suggested that teachers have concerns about the logistics and classroom management aspects of different grouping arrangements, but appreciate the need for such arrangements.
- The qualitative findings suggested that teachers preferred having students change classrooms for mathematics.
- The qualitative results indicated that teachers enjoyed working with the Joplin Plan grouping arrangement to reduce heterogeneity among students.
- The qualitative findings suggested that students enjoyed working in a variety of different grouping arrangements, especially the Joplin Plan, without damage to students' self-esteem or self-efficacy.
- The qualitative findings indicated that students who were provided with more authentic learning goals persisted and were more motivated than their peers in the comparison group.
- The qualitative findings indicated that students of all ability levels may benefit from a mathematics curriculum that is authentic and meaningful.

Summary

Results of the data analysis were presented in this section. Students in all socio-economic levels experienced significantly higher mathematics achievement than students exposed to their regular textbook unit on Data Representation and Analysis from pretest to posttest. Students in the middle and high subgroups of all treatment groups (Modification, FSG within the classroom, and Joplin Plan groups between classrooms) demonstrated significantly higher mathematics achievement than students in the comparison groups who completed their regular textbook unit after three weeks of instruction. It is difficult to assess the gains made by the low groups as the Comparison-low groups had higher preassessment scores than their peers in the treatment groups, however, the negative effect sizes would be consistent with the literature on grouping and less-ready students. Students in the highest three groups, Modification-high, FSG-high, and Joplin-high, all experienced significant gains over the 3-week mathematics unit. There were significant differences over time between fourth and fifth graders and among schools from diverse socio-economic backgrounds.

There were only slight differences between the Modification and the FSG and Joplin groups. This suggests that modified or enhanced curriculum, within a whole class setting, can create significant gains provided that the instruction is geared to students' levels of prior knowledge. Students within the FSG classes made slight gains over both the Modification and Comparison Groups. Teachers indicated that having their own students in the classroom, without the added time constraints of the Joplin Plan, was a successful way to flexibly group students for instruction.

Teachers were mainly favorable towards the mathematics unit, despite initial organizational problems, and suggested they would use the questioning strategies, activities, and pretesting features in the future. They also suggested that this unit was more comprehensive and challenging for themselves and their students than those they had taught in the past. Finally, they did not observe any problems with students' self-esteem or self-efficacy in the grouping practices; instead they felt the students enjoyed the experience. Students indicated they enjoyed the grouping arrangements and were challenged and motivated by the projects they completed and suggested that they enjoyed the mathematics unit as a whole.

References

Amabile, T. (1983). *The social psychology of creativity*. New York: Sperlag-Verlag.

Archambault, F. X., Jr., Westberg, K. L., Brown, S. W., Hallmark, B. W., Emmons, C. L., & Zhang, W. (1993). *Regular classroom practices with gifted students: Results of a national survey of classroom teachers* (Research Monograph 93102). Storrs, CT: The National Research Center on the Gifted and Talented, University of Connecticut.

Arlin, M. N. (1982). Teacher responses to student time differences in mastery learning. *American Journal of Education, 90,* 334-335.

Bagley, W. (1931). The textbook and methods of instruction. In G. Whipple (Ed.), *The textbook in American education, Thirtieth yearbook of the National Society for the Study of Education* (part 2, pp. 7-26). Bloomington, IL: Public School Publishing.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Bechtol, W. M., & Sorenson, J. S. (1993). *Restructuring schooling for individual students*. Boston: Allyn and Bacon.

Begle, E. J. (1975). *Ability grouping for mathematics instruction: A review of the empirical literature* (Tech. Rep. No. SMESG-WP-17). Palo Alto, CA: Stanford Mathematics Education Study Group, Stanford University.

Benbow, C. P. (1998). Grouping intellectually advanced students for instruction. In J. VanTassel-Baska (Ed.). *Excellence in educating gifted and talented learner* (pp. 279-294). Denver, CO: Love Publishing.

Bloom, B. S. (1976). *Human characteristics and school learning*. New York: McGraw-Hill Book.

Boocock, S. S. (1972). *An introduction to the sociology of learning*. Boston: Houghton-Mifflin.

Brooks, J. G., & Brooks, M. G. (1995). *The case for constructivist classrooms*. Alexandria, VA: Association for Supervision and Curriculum Development.

Bruner, J. S. (1960). *The process of education*. Cambridge, MA: Harvard University Press.

Bruner, J. S. (1975). *Toward a theory of instruction*. Cambridge, MA: Harvard University Press.

Burns, D. E., Gubbins, E. J., Reis, S. M., & Westberg, K. L. (1997). *Extending gifted education pedagogy to regular classrooms*. Storrs, CT: The National Research on the Gifted and Talented, University of Connecticut.

Burns, D. E., & Reis, S. M. (1991). Developing a thinking skills component in the gifted education program. *Roeper Review, 72*, 72-79.

Burstein, L. (1980). Issues in the aggregation of data. In D. C. Berliner (Ed.), *Review of Research in Education*, (Vol. 8, pp. 158-233). Washington, DC: American Educational Research Association.

Cawelti, G. (1999). *Handbook of research on improving student achievement*. Arlington, VA: Educational Research Service.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Lawrence Erlbaum.

Coleman, J. S., Campbell, E. Q., Hobson, C. J., McPartland, J., Mood, J. A., Weinfeld, F. D., & York, R. L. (1966). *Equality of educational opportunity*. Washington, DC: U.S. Government Printing Office.

Cotton, K. (1995). *Effective schooling practices: A research synthesis 1995 update*. Portland, OR: Northwest Regional Educational Laboratory.

Cresswell, J. W. (1994). *Research design: Qualitative & quantitative approaches*. Thousand Oaks, CA: Sage.

Cronbach, L., & Snow, R. E. (1981). *Aptitudes and instructional methods*. New York: Irvington.

Cuban, L. (1984). *How teachers taught: Constancy and change in American classrooms 1890-1980*. New York: Longman.

Cuoco, A., Goldenberg, E. P., & Mark, J. (1995). *Habits of mind: An organizing principle for mathematics curriculum*. Newton, MA: Education Development Center.

Davis, G. A., & Rimm, S. A. (1994). *The education of the gifted and talented*. Boston: Allyn and Bacon.

Delisle, R. (1997). *How to use problem-based learning in the classroom*. Alexandria, VA: Association for Supervision and Curriculum Development.

Dettmer, P., & Landrum, M. (1998). *Staff development: The key to effective gifted education programs*. Washington, DC: National Association for Gifted Children.

Erickson, H. L. (1998). *Concept-based curriculum and instruction: Teaching beyond the facts*. Thousand Oaks, CA: Corwin Press.

Feldhusen, J. F. (1989). Program models for gifted education. In J. F. Feldhusen, J. VanTassel-Baska, & K. Seeley, (Eds.). *Excellence in educating the gifted* (pp. 263-289), Denver, CO: Love Publishing.

Feldhusen, J. F., & Moon, S. M. (1992). Grouping gifted students: Issues and concerns. *Gifted Child Quarterly, 36*, 63-67.

Flanders, J. R. (1987). How much of the content in mathematics textbooks is new? *Arithmetic Teacher, 35*(1), 18-23.

Floyd, C. (1954). Meeting children's reading needs in the middle grades: A preliminary report. *The Elementary School Journal, 55*, 99-103.

Fullan, M. (1993). *Change forces: Probing the depths of educational reform.* Levittown, PA: The Falmer Press.

Gardner, H. (1999). *The disciplined mind: What all students should understand.* New York: Simon & Schuster.

George, P. S. (1988). *What's the truth about tracking and ability grouping really???* Gainesville, FL: Teacher Education Resources.

Glass, G. V. (1976). Primary, secondary, and meta-analysis of research. *Educational Researcher, 5,* 3-8.

Good, T. L., & Brophy, J. E. (1994). *Looking in classrooms*. New York: Harper & Row.

Good, T. L., & Power, C. N. (1976). Designing successful classroom environments for different types of students. *Journal of Curriculum Studies, 8*, 1-16.

Goodlad, J. L. (1966). *School, curriculum, and the individual*. Waltham, MA: Blaisdell Publishing.

Goodlad, J. L. (1984). *A place called school: Prospects for the future*. New York: McGraw-Hill.

Grinder, R. E., & Nelsen, E. A. (1985). Individualized instruction in American pedagogy: The saga of an educational ideology and a practice in the making. In M. C. Wang & H. J. Walberg, (Eds.). *Adapting instruction to individual differences* (pp. 24-43). Berkeley, CA: McCutchan Publishing.

Halpern, D. F. (1996). *Thought & knowledge: An introduction to critical thinking*. Mahwah, NJ: Lawrence Erlbaum.

Hartford Courant. (1999, February). Connecticut mastery test scores: Grade 4 – ERG. Retrieved from ftp://ftp.courant.com/news/special/cmt98

Hirsch, E. D. (1987). *Cultural literacy*. Boston: Houghton Mifflin.

Hopkins, K. D. (1982). The unit of analysis: Group means versus individual observations. *American Educational Research Journal, 19*, 5-18.

Jacobs, H. H. (1989). *Interdisciplinary curriculum: Design and implementation*. Alexandria, VA: Association for Supervision and Curriculum Development.

Kaplan, S. N. (1986). The grid: A model to construct differentiated curriculum for the gifted. In J. S. Renzulli, (Ed.), *Systems and models for developing programs for the gifted and talented* (pp. 180-193). Mansfield Center, CT: Creative Learning Press.

Kashy, D. A., & Kenny, D. A. (1990). Analysis of family research designs: A model of interdependence. *Communication Research, 17*, 462-482.

Kennedy, P. (1994). *The coming of the twenty-first century*. New York: Cambridge University Press.

Kenny, D. A., & Judd, C. M. (1996). A general procedure for the estimation of interdependence. *Psychological Bulletin, 119*(1), 138-148.

Kulik J. A. (1992). *An analysis of the research on ability grouping: Historical and contemporary perspectives* (RBDM 9204). Storrs, CT: The National Research Center on the Gifted and Talented, University of Connecticut.

Kulik, C-L. C., & Kulik, J. A. (1982). Effects of ability grouping on secondary school students: A meta-analysis of evaluation findings. *American Educational Research Journal, 19*, 414-428.

Kulik, J. A., & Kulik, C-L. C. (1984). Effects of accelerated instruction on students. *Review of Educational Research, 54*, 409-425.

Kulik, J. A., & Kulik, C-L. C. (1990). Ability grouping and gifted students. In N. Colangelo & G. A. Davis (Eds.), *Handbook of gifted education* (pp. 178-196). Boston: Allyn and Bacon.

Kulik, J. A., & Kulik, C-L. C. (1992). Meta-analytic findings on grouping programs. *Gifted Child Quarterly, 36*, 73-77.

Levin, H. M. (1987). Accelerated schools for disadvantaged students. *Educational Leadership, 52*(3), 19-21.

Lou, Y., Abrami, P. C., Spence, J. C., Poulsen, C., Chambers, B., & d'Apollonia, S. (1996). Within-class grouping: A meta-analysis. *Review of Educational Research, 66*, 423-458.

Maker, C. J. (1982). *Curriculum development for the gifted*. Rockville, MD: Aspen Publishing.

Marsh, H. W., & Parker, N. (1985). Self-concepts: Their relationship to age, sex, and academic measures. *American Educational Research Journal, 22*, 422-444.

Mill, C. J., Ablard, K. E., & Gustin, W. C. (1994). Academically talented students' achievement in a flexibly paced mathematics program. *Mathematics Achievement, 25*, 495-509.

National Center for Education Statistics. (1997). *Common Core of Data Survey* [Electronic database]. Washington, DC: U.S. Department of Education.

National Commission on Excellence in Education. (1983). *A nation at risk: The imperative for educational reform*. Washington, DC: Author.

National Council of Teachers of Mathematics. (1989). *1989 Principles and standards for school mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *2000 Principles and standards for school mathematics*. Reston, VA: Author.

National Education Goals Panel. (1991). *The national education goals report: Building a nation of learners*. Washington, DC: U.S. Government Printing Office.

Newman, R. S., & Schwager, M. T. (1992). Student perceptions and academic help-seeking. In D. H. Schunk, & J. L. Meece, (Eds.), *Student perceptions in the classroom* (pp. 123-148). Hillsdale, NJ: Lawrence Erlbaum.

Oakes, J., & Goodlad, J. I. (1986). *Keeping track: How schools structure inequality*. New Haven, CT: Yale University Press.

Passow, A. H. (1962). *Differentiated curricula for the gifted/talented*. Ventura, CA: Leadership Training Institute on the Gifted and Talented.

Patton, M. Q. (1990). *Qualitative evaluation and research methods*. Newbury Park, CA: Sage.

Paul, R., Binker, A. J. A., Jensen, K., & Kreklau, H. (1990). *Critical thinking handbook: 4th – 6th grades: A guide for remodeling lesson plans in language arts, social studies, & science*. Rohnert Park, CA: The Center for Thinking and Moral Critique.

Phenix, P. H. (1958). *Philosophy of education*. New York: Hold and Company.

Phenix, P. H. (1964). *Realms of meaning*. New York: McGraw-Hill.

Reis, S. M., Westberg, K. L., Kulikowich, J., Caillard, F., Hébert, T., Plucker, J., Purcell, J. H., Rogers, J. B., & Smist, J. M. (1993). *Why not let high ability students start school in January? The curriculum compacting study* (Research Monograph 93106). Storrs, CT: The National Research Center on the Gifted and Talented, University of Connecticut.

Renzulli, J. S. (1977). *The enrichment triad model: A guide for developing defensible programs for the gifted and talented*. Mansfield Center, CT: Creative Learning Press.

Renzulli, J. S. (1988). The multiple menu model for developing differentiated curriculum for the gifted and talented. *Gifted Child Quarterly*, *36*, 298-309.

Renzulli, J. S. (1994). *Schools for talent development: A practical plan for total school improvement*. Mansfield, CT: Creative Learning Press.

Renzulli, J. S., Leppien, J. H., & Hays, T. S. (2000). *The multiple menu model: Practical guide for developing differentiated curriculum*. Mansfield Center, CT: Creative Learning Press.

Renzulli, J. S., & Reis, S. M. (1985). *The schoolwide enrichment model: A comprehensive plan for educational excellence*. Mansfield Center, CT: Creative Learning Press.

Rogers, K. A. (1991). *The relationship of grouping practices to the education of the gifted and talented learner* (RBDM 9102). Storrs, CT: The National Research Center on the Gifted and Talented, University of Connecticut.

Rogers, K. A. (1993). Grouping the gifted and talented: Questions and answers. *Roeper Review, 16*, 8-12.

Schunk, D. H. (1996). *Learning theories*. Upper Saddle River, NJ: Prentice-Hall.

Slavin, R. E. (1987). Ability grouping and student achievement in elementary schools: A best-evidence synthesis. *Review of Educational Research, 57*, 293-336.

Slavin, R. E. (1988). Synthesis of research on grouping in elementary and secondary schools. *Educational Leadership, 46*, 67-76.

Slavin, R. E. (1990). Achievement effects of ability grouping in secondary schools. *Review of Educational Research, 57*, 293-336.

Snow, R. E. (1989). Aptitude treatment interaction as a framework for research on individual differences in learning. In P. L. Ackerman, R. J. Sternberg, & R. Glaser (Eds.), *Learning and individual differences* (pp. 13-59). New York: W. H. Freeman.

Strauss, A., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Thousand Oaks, CA: Sage.

Tabachnick, B. G., & Fidell, L. S. (1996). *Using multivariate statistics*. New York: HarperCollins College Publishers.

Tomlinson, C. A. (1995). *How to differentiate instruction in mixed-ability classrooms*. Alexandria, VA: Association for Supervision and Curriculum Development.

Tomlinson, C. A. (1999). *The differentiated classroom: Responding to the needs of all learners*. Alexandria, VA: Association for Supervision and Curriculum Development.

Tomlinson, C. A., Callahan, C. M., Moon, T. R., Tomchin, E. M., Landrum, M., Imbeau, M., Hunsaker, S. L., & Eiss, N. (1995). *Preservice teacher preparation in meeting the needs of gifted and other academically diverse students* (Research Monograph 95134). Storrs, CT: The National Research Center on the Gifted and Talented, University of Connecticut.

Tomlinson, C. A., Kaplan, S. A., Renzulli, J. S., Purcell, J., Leppien, J., & Burns, D. E. (2002). *The parallel curriculum: A design to develop high potential and challenge high-ability learners*. Thousand Oaks, CA: Corwin Press.

VanTassel-Baska, J. (1986). Effective curriculum and instructional models for talented students. *Gifted Child Quarterly*, *30*, 164-169.

VanTassel-Baska, J. (1994). *Comprehensive curricula for gifted learners*. Boston: Allyn and Bacon.

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Walberg, H. J. (1985). Instructional theories and research evidence. In M. C. Wang & H. J. Walberg, (Eds.), *Adapting instruction to individual differences* (pp. 3-23). Berkeley, CA: McCutchan Publishing.

Wang, M. C., & Walberg, H. J. (1985). *Adapting instruction to individual differences*. Berkeley, CA: McCutchan Publishing.

Ward, V. S. (1980). *Differential education for the gifted*. Ventura, CA: Ventura County Superintendent of Schools Office.

Westberg, K. L., Archambault, F. X., Jr., Dobyns, S., & Salvin, T. (1993). *An observational study of instructional and curricular practices used with gifted and talented students in regular classrooms* (Research Monograph 93104). Storrs, CT: The National Research Center on the Gifted and Talented, University of Connecticut.

White, E. R. (1982). The relation between socioeconomic status and academic achievement. *Psychological Bulletin, 91*, 461-481.

Wiggins, G., & McTighe, J. (1998). *Understanding by design*. Alexandria, VA: Association for Supervision and Curriculum Development.

Research Monograph

The National Research Center on the Gifted and Talented
University of Connecticut
2131 Hillside Road Unit 3007
Storrs, CT 06269-3007
www.gifted.uconn.edu

Editor
E. Jean Gubbins

Production Assistant
Siamak Vahidi

Reviewers
Jean McGivney-Burrell
Sara Moore
Meghan Murray
Julia Roberts

Also of Interest

State Policies Regarding Education of the Gifted as Reflected in Legislation and Regulation
A. Harry Passow and Rose A. Rudnitski

Residential Schools of Mathematics and Science for Academically Talented Youth: An Analysis of Admission Programs
Fathi A. Jarwan and John F. Feldhusen

The Status of Programs for High Ability Students
Jeanne H. Purcell

Recognizing Talent: Cross-Case Study of Two High Potential Students With Cerebral Palsy
Colleen Willard-Holt

Also of interest from the

Research Monograph Series

The Prism Metaphor: A New Paradigm for Reversing Underachievement
Susan M. Baum, Joseph S. Renzulli, and Thomas P. Hébert

Attention Deficit Disorders and Gifted Students: What Do We Really Know?
Felice Kaufmann, M. Layne Kalbfleisch, and F. Xavier Castellanos

Gifted African American Male College Students: A Phenomenological Study
Fred A. Bonner, II

Counseling Gifted and Talented Students
Nicholas Colangelo

E. Paul Torrance: His Life, Accomplishments, and Legacy
Thomas P. Hébert, Bonnie Cramond, Kristie L. Speirs Neumeister, Garnet Millar, and Alice F. Silvian

NRC G/T

The National Research Center on the Gifted and Talented Research Teams

University of Connecticut

Dr. Joseph S. Renzulli, Director
Dr. E. Jean Gubbins, Associate Director
Dr. Sally M. Reis, Associate Director
University of Connecticut
2131 Hillside Road Unit 3007
Storrs, CT 06269-3007
860-486-4676

Dr. Del Siegle

University of Virginia

Dr. Carolyn M. Callahan, Associate Director
Curry School of Education
University of Virginia
P.O. Box 400277
Charlottesville, VA 22904-4277
804-982-2849

Dr. Mary Landrum
Dr. Tonya Moon
Dr. Carol A. Tomlinson

Yale University

Dr. Robert J. Sternberg, Associate Director
Yale University
Center for the Psychology of Abilities, Competencies, and Expertise
340 Edwards Street, P.O. Box 208358
New Haven, CT 06520-8358

Dr. Elena L. Grigorenko