NRC G/T

THE NATIONAL RESEARCH CENTER ON THE GIFTED AND TALENTED

University of Connecticut
University of Virginia
Yale University

The Effects of Dynamic Pedagogy on the Mathematics Achievement of Ethnic Minority Students

Edmund W. Gordon
Eleanor Armour-Thomas
Institute for Urban and Minority Education
Teachers College, Columbia University
New York, New York

December 2006
RM06224

The Effects of Dynamic Pedagogy on the Mathematics Achievement of Ethnic Minority Students

Edmund W. Gordon
Eleanor Armour-Thomas
Institute for Urban and Minority Education
Teachers College, Columbia University
New York, New York

December 2006
RM06224

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, Institute of Education Sciences, 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. Elena L. Grigorenko, 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 R206R000001-05, as administered by the Institute of Education Sciences, U.S. Department of Education. The findings and opinions expressed in this report do not reflect the position or policies of the Institute of Education Sciences or the U.S. Department of Education.

Note to Readers...

Acknowledgments

A research project of this scope could only be achieved with the support of many important people. On behalf of the *Dynamic Pedagogy* Research Team, we would like to express our sincere appreciation to Jason Friedman, the former Superintendent of the East Ramapo School District, David Fried, Assistant Superintendent, Curriculum and Instruction; Rhoda Fischer, Director, Curriculum and Instruction and the school principals for their enthusiastic support for the *Dynamic Pedagogy* Project. We are most indebted to the teachers who participated in the study. Their efforts and cooperation made this project possible. We are also deeply appreciative of the students for their participation and to their families who supported the project. We would also like to extend a special thanks to a number of School District personnel: Ian Coyne, Senior Network Specialist, Mathematics Coordinators, Florence Manoff and Terry Goldfischer and the Instructional Facilitators for the strong support that they provided. We would like to also thank the District Office staff, Elizabeth Medina, Lorraine Procopio, and Janet Stueck, for their assistance in so many ways.

A very special thank you goes to the core members of the research team: Erica N. Walker and Brenda X. Mejia both of whom have participated in every phase of the project. Special thanks is also extended to Madhabi Chatterji who served as consultant to the project during its pilot year and to Brenda for preparation of the final report. We are grateful to both Erica's and Madhabi's students at Teachers College for helping with the analysis of some of the data during the pilot year of the project. To other students at Teachers College, Brianna Moore, Victoria Obe, and Maritsa Toro, we extend our heartfelt appreciation for their assistance in the data management and analysis. To Maritsa, a special thank you for creating the colorful graphs and charts for representing the data and Ezekiel Dixon-Roman for his measurement and statistical guidance. There are also many other individuals whom we thank for their support at different phases of the project: Coleen Clay, Katherine Kovarik, Regine Philippeaux, Adam Goldberg, Eric Hurley, Luz Maldonado, Zoon Naqvi, Annmarie Nava, and Renate E. Thomas.

We would be remiss if we did not acknowledge Paula Russell, for her administrative guidance and support over the duration of the project.

Edmund W. Gordon
Eleanor Armour-Thomas

The Effects of Dynamic Pedagogy on the Mathematics Achievement of Ethnic Minority Students

Edmund W. Gordon
Eleanor Armour-Thomas
Institute for Urban and Minority Education
Teachers College, Columbia University
New York, New York

ABSTRACT

The research monograph that follows describes the implementation of an intervention called *Dynamic Pedagogy* and its effects on the academic achievement of ethnic minority students in the third grade during the first year and the third and fourth grades during the second year. For the first year 10 third grade teachers participated in the study, 2 from each of 5 schools. For the second year, 8 third grade teachers (2 returning teachers and 2 new teachers) from 2 schools and 2 fourth grade teachers participated in the study.

The results regarding the impact of *Dynamic Pedagogy* on the academic achievement of students at the third and fourth grade levels were mixed. The pilot year data showed significant school effects of *Dynamic Pedagogy* on a third grade mathematics achievement test and district assessments in target mathematics units. The second year data showed significant effects of *Dynamic Pedagogy* on a fourth grade mathematics achievement test but the results on the district assessments were not significant. These results were obtained for a sample of students who were exposed to the *Dynamic Pedagogy* treatment the previous year. Similarly, the results were mixed for a new cohort of students at the third grade level. Although there were school effects, as in the previous year on the third grade mathematics achievement test, the results showed no significant differences between students in the *Dynamic Pedagogy* and non-*Dynamic Pedagogy* groups on the district assessments. These results should be read with caution since there were clear limitations to the study, including non-random sample and significant interaction between the covariate and grouping variables. Our analyses of race/ethnic comparisons on mathematics achievement were also mixed, indicating that *Dynamic Pedagogy* had a differential impact on different race/ethnic groups.

The Effects of Dynamic Pedagogy on the Mathematics Achievement of Ethnic Minority Students

Edmund W. Gordon
Eleanor Armour-Thomas
Institute for Urban and Minority Education
Teachers College, Columbia University
New York, New York

EXECUTIVE SUMMARY

The research monograph that follows describes the implementation of an intervention called *Dynamic Pedagogy* and its effects on the academic achievement of ethnic minority students in the third grade during the first year and the third and fourth grades during the second year. For the first year 10 third grade teachers participated in the study, 2 from each of 5 schools. For the second year, 8 third grade teachers (2 returning teachers and 2 new teachers) from 2 schools and 2 fourth grade teachers participated in the study.

For each year, the research monograph describes the method used for selecting the experimental and comparison groups followed by a description of the components of the intervention that was delivered. First, a series of professional development sessions for participating teachers included the following: discussions about the principles of *Dynamic Pedagogy,* provision of templates for recording preplanning thoughts and lesson plans, and a measure of self assessment of teachers' experiences with the *Dynamic Pedagogy* model. In addition, the intervention consisted of the actual implementation of *Dynamic Pedagogy* lessons plans in the classroom in 4 target mathematics units, and the collection of portfolios after teaching each lesson and the transcriptions of observed *Dynamic Pedagogy* lessons.

A case is made for the efficacy of the intervention*, Dynamic Pedagogy* through the analysis of teacher portfolios, actual lessons that were implemented, reactions of teachers who participated in the study about their views about the professional development that was delivered and their use of *Dynamic Pedagogy* principles in their lesson planning and classroom practice. For the most part, the results showed that teachers prepared their lessons and implemented them in ways consistent with the principles of *Dynamic Pedagogy*. In general, teachers had positive views about the professional development in which they participated and reported high frequency of use of *Dynamic Pedagogy* principles in their classroom practice.

The results regarding the impact of *Dynamic Pedagogy* on the academic achievement of students at the third and fourth grade levels were mixed. The pilot year data showed significant school effects of *Dynamic Pedagogy* on a third grade mathematics achievement test and district assessments in target mathematics units. The

second year data showed significant effects of *Dynamic Pedagogy* on a fourth grade mathematics achievement test but the results on the district assessments were not significant. These results were obtained for a sample of students who were exposed to the *Dynamic Pedagogy* treatment the previous year. Similarly, the results were mixed for a new cohort of students at the third grade level. Although there were school effects, as in the previous year on the third grade mathematics achievement test, the results showed no significant differences between students in the *Dynamic Pedagogy* and non-*Dynamic Pedagogy* groups on the district assessments. These results should be read with caution since there were clear limitations to the study, including non-random sample and significant interaction between the covariate and grouping variables. Our analyses of race/ethnic comparisons on mathematics achievement were also mixed, indicating that *Dynamic Pedagogy* had a differential impact on different race/ethnic groups. Again, caution is urged in the interpretation of these findings because of the small sample size of Asian and White students in the experimental and comparison groups.

And, finally, we disaggregated the data on student achievement into levels (1, 2, 3, and 4) and examined the number and percentage of students scoring at the lowest (1) and highest (4) levels in both the *Dynamic Pedagogy* and non-*Dynamic Pedagogy* conditions. The results showed a higher percentage of *Dynamic Pedagogy* students than non-*Dynamic Pedagogy* students scored at the highest level of achievement on both the third and fourth grade achievement tests and district wide assessments. In contrast, a lower percentage of them when compared to their non-*Dynamic Pedagogy* peers, performed at the lowest level on these mathematics measures.

There are at least three implications of this work for future research. The first is to refine and improve our research methods. For example, we would need to modify our teacher-interaction observation protocol to capture student-student and teacher-student conversations in small groups. We would also need to develop additional measures of student academic engagement beyond samples of their work and observation of their learning behaviors in the classroom. In terms of the research design we would need to identify measures that would more accurately account for differences in student achievement prior to the intervention and to figure ways to ensure equivalent samples for treatment and comparison groups. And, finally, we would need to ensure adequate representation of race/ethnic groups for the treatment and comparison groups.

A second line of inquiry will be to explore the efficacy of *Dynamic Pedagogy* to increase the number of African American, Hispanic, and Native American children who perform at the highest level of achievement. Recent reports have documented that one reason for the achievement gap is the underrepresentation of African American, Hispanic, and Native American children among our highest achieving students (*A Report of the National Task Force on Minority High Achievement*, 1999) and a *Report of the National Study group for the Affirmative Development of Academic Ability* (2004). To address this concern, future studies of *Dynamic Pedagogy* would need to be designed in ways that maximize reliable and valid comparisons of its effects among different race/ethnic groups. But, as these reports cautioned, it's unlikely that any school intervention, no matter how effective, would be sufficient to raise a critical mass of students from these underrepresented groups to the ranks of our highest achieving students. For these students, more sustained exposure to *Dynamic Pedagogy* beyond the classroom would need to be supplemented with their access to other educationally-relevant capital, a strategy consistent with the recommendation of Gordon and his colleagues, (Gordon, 2001; 2002; Gordon, Bridglall, & Meroe, 2004) and the *Report of the National Study Group for the Affirmative Development of Academic Ability* (2004).

Finally, a third line of research is to examine the use of *Dynamic Pedagogy* principles and concepts among novice and more experienced teachers and to ascertain whether differences are obtained in their teaching, before, during, and after classroom practice. The growing recognition that teacher knowledge is an important marker of teacher effectiveness has led to serious interest among education administrators and policy makers seeking to ensure that teachers in every classroom have the kinds of knowledge that contribute to effective teaching and improved student outcomes. Continuing research with the *Dynamic Pedagogy* model holds promise for not only adding to our knowledge base about the multidimensionality of teacher pedagogical content knowledge but also for contributing to our understanding of the mechanisms by which such knowledge impacts student motivation, learning, and achievement.

References

Gordon, E. W. (2001). Affirmative development of academic abilities. *Pedagogical Inquiry and Praxis, No. 2*. New York: Institute for Urban and Minority Education, Teachers College, Columbia University.

Gordon, E. W., Bridglall, L., & Meroe, A. S. (2004). (Eds.). *Supplementary education: The hidden curriculum of high academic achievement*. New York: Rowman & Littlefield Publishers.

National Study Group for the Affirmative Development of Academic Ability. (2004). *All students reaching the top: Strategies for closing academic achievement gaps*. New York: The College Board.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

List of Tables

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

List of Figures

List of Figures (continued)

List of Figures (continued)

The Effects of Dynamic Pedagogy on the Mathematics Achievement of Ethnic Minority Students

Edmund W. Gordon
Eleanor Armour-Thomas
Institute for Urban and Minority Education
Teachers College, Columbia University
New York, New York

Introduction

Rationale for the Study

Improving the academic achievement of children from certain ethnic/racial groups (e.g., African Americans, Latino/a Americans, and Native Americans) is perhaps the most serious educational challenge for the United States. Some would argue that for a society committed at least in principle to the dual ideals of equity and social justice for all, the challenge is a moral one as well.

There is good reason for concern since on virtually every measure of academic achievement, African American, Latino, and Native American students score significantly lower than that of their European and Asian American peers. In following the trajectory of these disparities in achievement, Phillips, Crouse, and Ralph, 1998; and The National Task Force on Minority High Achievement, 1999 report that gaps are first manifested early in school, broadened during the elementary school years, and remain relatively fixed during the secondary school years. In recent years this phenomenon has been dubbed the "achievement gap."

In 1999, The National Task Force on Minority High Achievement, in its report, titled *Reaching the Top*, cautioned about the serious consequences for our society of the underachievement of minority students: "Until many more minority students from disadvantaged, middle class, and upper middle class circumstances are very successful educationally, it will be virtually impossible to integrate institutions completely, especially at the leadership levels" (p. 2).

For more than 20 years, despite numerous efforts to seeking to eliminate or narrow the achievement disparities between minority and non minority groups, the gap persists. Edmund W. Gordon who co-chaired the National Task Force on Minority High Achievement and who has written extensively on issues related to minority achievement argues that closing the achievement gap will require simultaneous interventions in the home, school, and communities directed toward the affirmative development of academic ability and intellective competence. In Gordon's vision, the ultimate purpose of learning and the teaching by which it is enabled is to acquire knowledge, techniques, understanding, and values in the service of the development of adaptive human intellect, which he later defined as *intellective competence*—the effective orchestration of affective, cognitive, and situative mental processes directed toward what we want learners to become (Gordon, 2002). To be clear, Gordon does not undervalue the importance of improving students' discipline-based knowledge and skills, but he sees these academic achievements as instrumental to more purposive ends—the development of student ability and disposition to adaptively and efficiently use knowledge, technique and values in mental processes to engage and solve both common and novel problems. In short, Gordon is convinced that the end goal of learning is less about what learners are expected to know and be able to do in any academic discipline of interest but more about our expectations of what they should become—autonomous, intentional learners who are sensitive, compassionate, thinking and productively cooperative members of human communities (2001).

What are the expectations for teaching and learning that are conducive to high academic achievement and intellective competence? Our own reading of the research literature on teaching effectiveness, child development, learning, and cognitive science lead us to the thesis that these dual outcomes are likely to be enabled when students consistently show active and sustained responsiveness to the learning experiences that teachers make available for them in the classroom. These learning experiences, though, must be informed by teacher knowledge and decisions about curriculum, instruction, and assessment that are uniquely tailored to students' strengths, interests, and needs. In the current intervention study we call this teaching approach *Dynamic Pedagogy* and examine its efficacy to impact student mathematics achievement and intellective competence among ethnic minority children at the elementary school level.

Theoretical Background of Study

Dynamic Pedagogy is a socio-cognitive approach to teaching in which assessment, curriculum, and instructional processes are united in the service of student learning. The term "dynamic" is used to emphasize the continuing adjustments that teachers make in their decisions about curriculum, instruction, and assessment in response to the learning strengths and needs of students. Their responsiveness to these adaptations adds a labile quality to the construct.

The *Dynamic Pedagogy* model is informed by theoretical and empirical research on teaching, learning, and cognitive development. What follows is a discussion of this work and how it shaped the conceptualization of the model.

Curriculum

The curriculum strand of *Dynamic Pedagogy* consists of the full range of materials (e.g., text, media, and workbooks) that embody the concepts, principles, and procedures of a discipline. How well students learn the content of a discipline depends in large measure on whether tasks have the attributes to motivate students to learn and use their minds well. For example, do tasks allow students to make connections to their prior knowledge and skills and to build new knowledge? Are tasks open to multiple representations and multiple ways of knowing the content? Are tasks relevant to students' personal interests and do they arouse and sustain their motivation in them until successful completion? Do tasks engage students in metacognitive and cognitive thinking about a discipline's concepts and its underlying principles? We have selected Artzt and Armour-Thomas (2002) recommendations to teachers about designing tasks that are relevant for helping students to actively engage in meaningful problem solving: (a) set tasks at the appropriate level of difficulty; (b) sequence tasks in ways that students can progress in their cumulative understanding of a particular content area; (c) select tasks with attributes that initially attract, sustain their attention, and emotional investment over time; (d) design tasks that allow students to make connections between concepts and principles earned in the past and those that they will learn in the future; (e) select appropriate modalities for representing tasks.

The curriculum strand was also informed by Sternberg's theory of intelligence (1985, 1988) that posits that, along with memory, there are three kinds of abilities, analytic, creative, and practical that draw upon a common set of information processing components—metacomponents, performance components, and knowledge-acquisition components. What distinguish these abilities are the experiences and contexts to which these information processing components are applied. Thus, analytical ability drawn upon information processing components for relatively familiar tasks that require the individual to analyze, judge, evaluate, compare, and contrast; information processing components for creative ability (e.g., ability to discover, invent, create, explore) are applied to relatively novel tasks or familiar tasks conceptualized in a novel way. And, finally, information processing components for practical ability (e.g., ability to put into practice, apply, use, and implement) are applied to either familiar or novel tasks in everyday contexts or settings. We argue that if students are exposed to tasks that require them to think about concepts and procedures in these multiple ways, they are likely to learn more deeply about the content of a discipline. But even more importantly, we think that consistent and prolonged use of these kinds of cognitive and metacognitive processes for solving common and novel problems are crucial for the development of intellective competence.

Assessment

The assessment strand of *Dynamic Pedagogy* functions within the actual implementation of a lesson and has two components. The first one is a type of "*on-line probe*" that is used to assess: (a) students prior knowledge and skills in readiness for new learning; (b) students emerging understanding of new concepts and procedures; (c) how well they have consolidated their new learning, and (d) how well they are able to transfer new learning to other contexts. The term has a similar meaning to Campione's (1989) "on-line diagnosis" or Slavin's (2001) "learning probes" or Gickling and Havertape's (1981) "curriculum-embedded assessments." On-line probes provide iterative dynamic feedback that is used to inform adaptive instruction.

Some on-line probes may take the form of questioning and may serve many purposes throughout the lesson. For example, questions may be used to elicit clarification on students' thinking, encourage elaboration of their ideas, or to help them make a mental bridge to another idea. Other probes may require students to demonstrate their understanding in written form, verbally, pictorially, or kinesthetically. Needless to say, questions don't operate in a vacuum and the amount of time given to students to respond to a question, the nature and quality of the feedback given in response to a question, the follow-up hints and prompts after student's incomplete answers—must all be included with effective questioning strategies.

The second component of assessment consists of *Metacognitive Probes*. These probes describe the variety of ways the teacher assesses the extent to which students are aware of effective learning strategies and know when and how they are to be applied. In describing this form of self-assessment, some researchers use the term higher order thinking (Armour-Thomas & Szczesiul, 1989; Frederiksen & Collins, 1989; Stiggens, 1997); metacognition (Flavell, 1979); regulation of cognition (Schraw, 2001); metacomponents (Sternberg, 1986); talk-aloud problem solving (Whimbey & Lochhead, 1982); or self-regulated learning (Zimmerman, 1989). Many studies have found that highly competent students are aware of and use these higher-level cognitions in their learning (Paris & Newman, 1990; Schunk & Zimmerman, 1997; Winne, 1997). Examples of these probes include teacher questions such as: "What is this problem asking you to do?" "Why did you select this strategy?" "How do you know your answer is correct?" "How do you know you are on the right track?"

Instruction

The instruction strand of *Dynamic Pedagogy* focuses on a multiplicity of strategies that are adaptive to the learning strengths and needs of the student revealed, in part, through assessment. This is not an easy task for the teacher for, along with their differences in developing expertise, students bring a vast array of differences to the classroom: developed intellectual/intellective abilities, prior knowledge and skills, response tendencies (cognitive style, temperamental style, and cultural style). How well students' potential to learn gets developed depends, in part, upon the judicious use of instructional strategies in adapting to these learner differences to meet the expected learning outcomes. In some instances, strategies more closely associated with behavioral principles (e.g., direct instruction) may be necessary, whereas in other instances strategies more in line with constructivist principles (scaffolding, metacognition) may be warranted. We have selected an eclectic blend of instructional strategies in an effort to be adaptive to the learning strengths and needs of the students. A discussion of these strategies follows.

Direct Instructional Strategies

Direct Instruction is an instructional approach in which information is transmitted directly to the student and class time is structured to enable students to acquire basic knowledge and skills. Numerous studies have found a positive relationship between elements of direct instruction and student achievement (Gage & Needels, 1989; Weinert & Helmke, 1995). Some studies of computer-assisted instruction that used elements of direct instruction found positive effects particularly for low-achieving students in elementary schools (Adams & Engelmann, 1996; Meyer, 1984). Although we know that high academic achievement requires more than mastery of basic knowledge and skills, we think that achievement of automaticity of these competencies facilitates the acquisition, consolidation, and transfer of more complex knowledge and skill. For this reason we have included some of Slavin's (2001) direct instruction strategies in the instructional strand of the *Dynamic Pedagogy* model: (a) State learning objectives explicitly and orient students to the lesson; (b) Review perquisites; (c) Provide independent practice; (d) Provide distributed practice and review; and (e) Provide feedback.

Mediated Learning and Social Scaffolding Strategies

The concept of mediated learning was first used by Feuerstein, Rand, and Hoffman (1979) to describe an interactive clinical involvement during dynamic assessment in which the examiner teaches the child how to find and use the rules underlying a task. During this socially interactive relationship, the examiner behaves like a teacher in selecting examples for clarifying the task, asking for and giving explanation, summarizing progress, etc. The outcome of mediated learning is change in cognitive functioning.

Vygotsky's (1978) concept of social scaffolding is similar in function to mediated learning in that it involves the guidance and support a more competent peer or able adult provides the child while working in his/her "zone of proximal development," i.e., the cognitive space wherein the child's learning and problem solving abilities are just beginning to develop. Working with the child in his/her zone of proximal development, the adult models the behaviors he/she expects the child to be able to do on his/her own, directs the child's attention to alternative procedures for the task, and encourages the child to try out his /her embryonic skills on some portion of the task. As the child gains confidence, the competent peer or adult diminishes support and encourages the child to take on increasing responsibility for completing the task without help. It is this type of social scaffolding that Vygotsky (1978) claims as the mechanism for bringing about cognitive change. Both Vygotsky and Feuerstein reported success in using these cognitive strategies with children who experience serious difficulties in schoolwork.

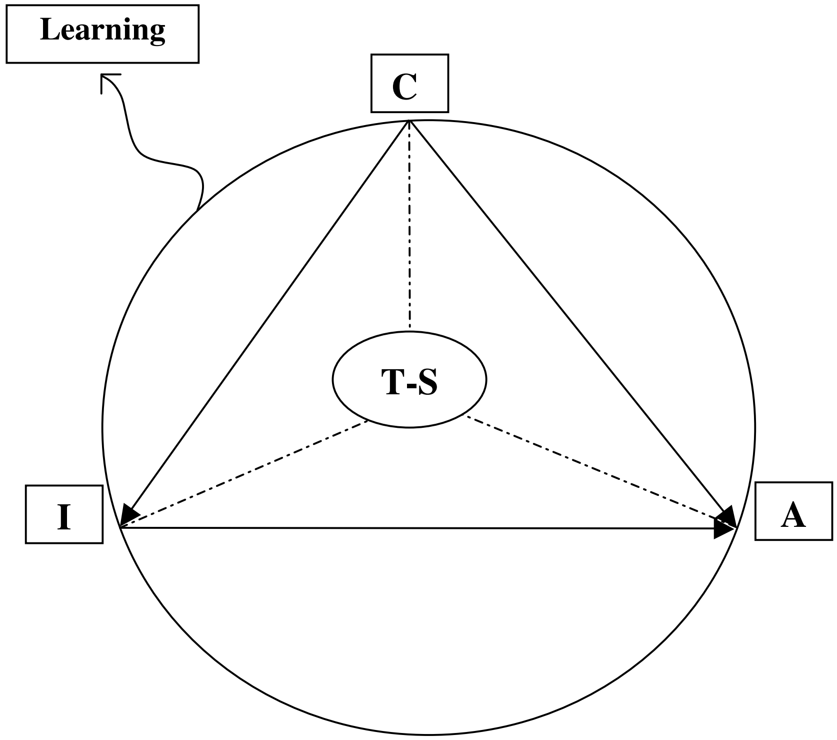
In a recent study, Meyer and Turner (2002) identified 3 ways that teachers can use scaffolding strategies to support student self-regulation: (a) helping students build competence through increased understanding; (b) engaging students in learning while supporting their socioemotional needs; and (c) helping students build and exercise autonomy.

We have included these dimensions of scaffolding into the instructional strand of the *Dynamic Pedagogy* model because we think that these are the kinds of supports for learning that are conducive to high academic achievement and the nurturance of intellective competence.

Unit of Analysis

We share the position of many educational researchers and policy makers that what teachers know and do can have a profound impact on what students are enabled to know and do (Darling-Hammond & Ball, 1997; National Commission on Teaching and America's Future, 1996). Indeed, many years ago, Shulman and his colleagues (Shulman, 1986; Wilson, Shulman, & Richert, 1987) in their groundbreaking work called attention to the importance of pedagogical content knowledge among accomplished teachers. In *Dynamic Pedagogy* we expect teacher knowledge about curriculum, instruction, and assessment to be centered around student learning and evidenced in their thoughts and decisions before, during, and after classroom practice. We also expect that students will be responsive to the learning experiences that teachers make available for them and that their responsiveness would be evidenced in the quality of engagement in these experiences as well as in their performance on mathematics achievement measures. Thus, the unit of analysis in *Dynamic Pedagogy* consists of four related components: (a) knowledge teachers use in planning for teaching a lesson; (b) knowledge teachers use during actual teaching of a lesson; (c) knowledge teachers use in evaluating their planning and actual teaching of the lesson; and (d) the nature and quality of student response to teacher knowledge. We consider these types of knowledge and their relationship to student learning to be consistent with Shulman's (1986) conception of pedagogical content knowledge, which he described as the integration of knowledge of the subject matter with knowledge of how to teach that subject matter in ways that enable student understanding. Our *Dynamic Pedagogy* model is also consistent with Jackson's (1968) and Artzt and Armour-Thomas's (2002) conceptual distinction of preactive, interactive, and postactive stages of teaching. The *Dynamic Pedagogy* Model is illustrated next.

The *Dynamic Pedagogy* Model



C= Curriculum; I = Instruction; A = Assessment; T-S = Teacher-Student Interactions

Figure 1. The *Dynamic Pedagogy* model.

Goals of the Study

The short-term goal of this project is to improve the mathematics performance of students at the third and fourth grade levels. The long-term goal of *Dynamic Pedagogy* is the development of *Intellective Competence*.

Context of the Study

We were fortunate to conduct the study in a school district committed to improving mathematics achievement of all its students, many of whom were African American and Hispanic from low income backgrounds. There were at least 4 types of district-wide resources and processes that, in our judgment, facilitated the easy implementation and evaluation of our intervention project, *Dynamic Pedagogy*: professional development, curriculum maps, other curriculum supports and resources, and teacher qualifications and experience. Each will be considered in turn.

Professional Development

The East Ramapo School District's approach to professional development was to utilize research-based job-embedded strategies in promoting professional growth among its teachers. They created positions such as teacher leaders, instructional facilitators, and subject area coordinators to support the implementation of its professional development initiative in every school in the District. In addition, the School District encouraged schools to schedule time for teachers and support staff to work collaboratively to develop and implement strategies acquired through professional development. The District developed a professional development plan with goals for its teachers that were in alignment with the National Board of Professional Teaching Standards. The plan also delineated capacity-enhancing goals for all educators to be able to help all students meet or exceed the New York State Learning Standards, irrespective of their ethnicity, gender, socioeconomic status, or native language. Moreover, in terms of objectives, teachers were expected to align them to student learning and achievement and to adjust their classrooms practices based on knowledge about their students' knowledge, skills and interests. And, finally, the District's professional development plan set forth various strategies/activities for enabling teacher growth (e.g., collaborative planning, examination of student work, and peer coaching) and methods for evaluating their own teaching (e.g., analysis of student achievement data, supervisory evaluation, and reflective logs).

Mathematics Curriculum Maps

The curriculum maps are resources provided by the District to help teachers implement the Mathematics Curriculum. More specifically, the maps are based on the East Ramapo Grade level Mathematics Objectives that are themselves in alignment with the New York State Core Curriculum in Mathematics. The maps served as an instructional guide to teachers in many ways including the listing of the district-level performance objectives for mathematics units at each grade level and the identification of the embedded concepts that students were expected to understand if they were to achieve the objectives. And, finally, the maps provided an approximate time sequence that functioned as a guide to teachers as to the District's expectations of coverage of necessary objectives within a school year.

Other Curriculum Supports and Resources

The District developed tests for each mathematics unit that teachers were required to administer after each unit of instruction. The District's staff provided an item analysis of the performance of each student in a given class and further disaggregated the data in terms of number and percentage of children scoring within achievement levels (1, 2, 3, and 4). The District scheduled a number of mandatory professional development days for district-wide activities and, at each grade level, district-supported instructional facilitators and mathematics coordinators carried out on-site professional development services with teachers at their respective schools.

Teacher Qualifications and Experience

The teachers who participated in the study held certification and license in K-6 General Education. Their years of teaching experience ranged from 6-24 years with some of them holding graduate degrees at the Master's level.

Research Questions

For the first year (pilot year) of the study the research questions were as follows:

1. How well was the intervention, *Dynamic Pedagogy* implemented?
2. Did students in *Dynamic Pedagogy* classrooms do better on standardized achievement tests than students in non-*Dynamic Pedagogy* classrooms at the third grade level?
3. Did students in *Dynamic Pedagogy* classrooms do better on district-wide assessments in target units of instruction than students in non-*Dynamic Pedagogy* classrooms at the third grade level?

For the second year of the study the research questions were as follows:

1. How well was the intervention *Dynamic Pedagogy* implemented?
2. Did students in *Dynamic Pedagogy* classrooms do better on mathematics achievement tests and district assessments than students in non-*Dynamic Pedagogy* classrooms at the third grade level?
3. Did students in *Dynamic Pedagogy* classrooms do better on mathematics achievement tests and district assessments than students in non-*Dynamic Pedagogy* classrooms at the fourth grade level?
4. Were there differences in third and fourth grade mathematics achievement among different race/ethnic groups?

Limitations of the Study

One limitation of this study relates to the groups into which the sample was assigned. Random assignment of subjects to experimental and control conditions was not feasible in the school district in which the study was undertaken. To obtain equivalent samples for treatment and comparison groups, subjects were matched according to their race/ethnic group membership and standardized test performance from the previous year. This quasi-experimental design limited the confidence with which we were able to make valid comparisons about the academic performance of experimental and comparison groups.

A related second limitation was that random assignment of teachers to experimental and control group was also not feasible in the school district in which the study was done. Teachers for the treatment condition were either self-selected for the study or were recommended by their principals. It was also not possible to ensure that teachers in the control condition were equivalent to those in the treatment condition.

Since teachers were not matched in both conditions, treatment effects must be interpreted with caution.

A third limitation has to do with the race/ethnic composition of the sample (70% African American and Hispanic; 30% White and Asian). Since the numbers were so small, we grouped White and Asian together as one race/ ethnic group and African American and Hispanic as the other group. Even then, the number of White and Asian students who were assigned to experimental and comparison groups was small thereby making interpretation of the results of race/ethnic comparisons less than robust.

Section 1: *Dynamic Pedagogy* Intervention—Year I

Study Design

Sample

The *Dynamic Pedagogy* project was piloted in 5 K-3 elementary schools in the suburban district of New York during the 2003-2004 academic year. Because random assignment was not logistically feasible in a field setting, matching helped create equivalent groups for comparison on variables relevant to the targeted program outcome (a quasi-experimental design). To obtain equivalent samples for treatment and comparison groups, subjects were matched according to their race and standardized test performance from the previous year (California Test of Basic Skill [CTB-4], TerraNova Mathematics Subtest levels 1-4, one being the lowest range and 4 being the highest range). After matching students by these criteria, the sample size amounted to 136 matched pairs of students in treatment and comparison conditions nested in 5 schools. Table 1 shows the achievement levels and race/ethnicity characteristics of the sample and Table 2 shows these characteristics by school.

Experimental Condition

There were 10 experimental classrooms 2 in each of 5 schools. All students in the experimental condition were taught by teachers with experience ranging from 6-24 years and with certification and license in K-6 General Education. These teachers received professional development and on-site follow-up coaching sessions in the principles of *Dynamic Pedagogy*. They planned and implemented lessons consistent with *Dynamic Pedagogy* lessons on topics in 4 mathematical units at the third grade level: Number Sense and Numeration, Fractions/Decimals/Money, Measurement, and Geometry. They taught other units of mathematics: Problem solving, Patterns and Functions, Graphing, Data Collection and Analysis, and Probability but these units were not part of the study. Following the implementation of each *Dynamic Pedagogy*-embedded lesson, each teacher participated in a debriefing session about the lesson with members of the research team. In addition, they received the traditional district professional development and supports that were provided to all teachers in the school system.

Table 1

Descriptive Statistics for Matched Pairs

Variable	***Dynamic Pedagogy***			**Non-*Dynamic Pedagogy***		
	f	**%**	***N***	***f***	**%**	***N***
Achievement Level						
1	42	30.9	136	42	30.9	136
2	42	30.9	136	42	30.9	136
3	49	36.0	136	49	36.0	136
4	3	2.2	136	3	2.2	136
Ethnicity						
Native American	0	0.0	136	0	0.0	136
Asian	12	8.8	136	12	8.8	136
Hispanic	16	11.8	136	16	11.8	136
African American	94	69.1	136	94	69.1	136
White	14	10.3	136	14	10.3	136

Table 2

Descriptive Statistics of Matched Pairs by School

Variable	Flatland			Grant			Homeland			Marvelle			Skyview		
	f	%	*N*	*f*	%	*N*	*f*	%	*N*	*f*	%	*N*	*f*	%	*N*
Achievement Level															
1	18	34.6	52	10	22.7	44	12	20.0	60	24	37.5	64	20	38.5	52
2	8	15.4	52	16	36.4	44	26	43.3	60	24	37.5	64	10	19.2	52
3	26	50.0	52	16	36.4	44	18	30.0	60	16	25.0	64	22	42.3	52
4	0	0.0	52	2	4.5	44	4	6.7	60	0	0.0	64	0	0.0	52
Ethnicity															
Native American	0	0.0	52	0	0.0	44	0	0.0	60	0	0.0	64	0	0.0	52
Asian	4	7.7	52	4	9.1	44	12	20.0	60	0	0.0	64	4	7.7	52
Hispanic	10	19.2	52	8	18.2	44	4	6.76	60	4	6.3	64	6	11.5	52
African American	32	61.5	52	26	59.1	44	38	3.3	60	50	78.1	64	42	80.8	52
White	6	11.5	52	6	13.6	44	6	10.0	60	10	15.6	64	0	0.0	52

Comparison Condition

All students in the comparison condition were enrolled in classes in each of the 5 schools and were taught by teachers with experience ranging from 1-30 years and with certification and license in K-6 General Education. These teachers received only the traditional district professional development and supports for teachers during the school year. They taught the same mathematics units as the *Dynamic Pedagogy*-trained teachers but received no feedback on their lesson plans nor were their lessons observed by the *Dynamic Pedagogy* research team.

Method

Professional Development

The first component of the *Dynamic Pedagogy* intervention was the professional development involving a mandatory 3-day summer session, 2 full-day and 2 after-school meetings. Using a social-constructive approach, project leaders engaged teachers in a discussion about: (a) the theoretical rationale for the interdependent components of *Dynamic Pedagogy*: curriculum-instructional-assessment strategies and its potential for improving the mathematics achievement of children from underrepresented groups; and (b) the use of these interdependent processes in promoting learning across three phases of a lesson: (i) Initiation; (ii) Development; and (iii) Closure.

The *Dynamic Pedagogy* professional development also provided participating teachers with experiences to deepen (i) their knowledge of elementary mathematics; (ii) their knowledge of how to teach that content before, during, and after classroom practice; and (iii) knowledge of how to make adjustments and accommodations in teaching that content to learners with different strengths and needs. Templates for planning lessons informed by *Dynamic Pedagogy* principles and concepts, prototype lesson plans in target mathematics units, samples of student work showing common conceptual and procedural errors, and teachers solving mathematics problems were among the activities used to engage teachers as active participants and co-constructors of the *Dynamic Pedagogy* professional development experience.

Preplanning Thoughts and Lesson Plans

The second component of the *Dynamic Pedagogy* intervention consisted of the documentation of teachers' knowledge on 3 forms before each lesson in the target mathematics unit of instruction. The first form is called a *preplanning template* on which the teachers recorded the curriculum tasks and the memory, analytical, creative, and practical processes teachers expected of students for the intended lesson on a given topic, e.g., Equivalent Fractions. On the second preplanning template the teacher recorded the "out-of-school" and "in-school" knowledge, misconceptions, and procedural errors of their students in relation to the learning goals and concepts for the intended lesson (see Appendix A and B: Lesson Preplanning Templates).

The third form is a *lesson plan template* on which teachers recorded the following: goals, objectives, materials, and phases of the lesson (Initiation, Development, and Closure). The goals are defined in terms of a general statement of the content knowledge and skills expected of the learners by the end of the lesson. The objectives are defined in terms of the specific learning behaviors that are indicative of the goals and for which learners are expected to demonstrate at the end of the lesson. Materials describe the manipulatives and tools teachers and learners use for enabling the goals and objectives of the lesson. The lesson phases are the temporal markers that serve to differentiate instructional episodes corresponding to the beginning, middle, and end of a lesson. The concept of phases is borrowed from previous work (Armour-Thomas & Szczesieul, 1989; Artzt & Armour-Thomas, 2002) that suggested that teachers make different decisions about enabling learning in the beginning (initiation), middle (development), and end (closure) of a lesson (see Appendix C: Lesson Planning Template).

Classroom Practice

The third component of the *Dynamic Pedagogy* intervention consisted of the actual implementation of *Dynamic Pedagogy* lesson plans for each of the target mathematics units of the project: Number Sense and Numeration; Equivalent Fractions; Geometry and Measurement. A typical *Dynamic Pedagogy* lesson consisted of the teacher's use of a combination of curriculum tasks, and instructional and assessment strategies across 3 phases of a lesson. In the *Initiation Phase* of the lesson, the teacher's efforts are on establishing readiness for learning related to the goals and objectives of the lesson by using *Dynamic Pedagogy* strategies to help children make connections with their prior knowledge and ascertain any misconceptions or procedural errors likely to pose obstacles to students' achievement of the lesson's goals and objectives. During the D*evelopment Phase*, the teacher's efforts are on using *Dynamic Pedagogy* strategies to monitor students' progress toward the goals and objectives of the lesson and helping them to construct new knowledge by (a) making connections of prior knowledge to new math concepts and procedures; (b) using multiple representations that call upon their practical, analytical, and creative thinking processes; and (c) correcting their misconceptions, if observed; and for *Closure Phase,* the teacher's efforts are on using *Dynamic Pedagogy* strategies to ascertain whether the goals and objectives are met and helping children to consolidate and extend newly acquired learning to other contexts.

Post-lesson Conference

The *Dynamic Pedagogy* intervention consisted of debriefing sessions that members of the research team held with participating teachers after observation of their lessons in each of the target mathematics units: Number Sense and Numeration, Equivalent Fractions, Geometry, and Measurement. This was an opportunity for the teachers to share with the researchers what they felt went well, what didn't go as planned, in addition to their thoughts and feelings about the experience. The researchers, in turn, would give their general impressions of the lesson calling attention to the teacher's use of

Dynamic Pedagogy strategies across the three phases of the lesson and the nature and quality of student engagement in the lesson.

Data Analysis

Before and After Classroom Practice

At the end of each *Dynamic Pedagogy* lesson taught for each of the target mathematics unit, participating teachers submitted a portfolio that included completed preplanning and lesson plan templates, samples of student work, and a completed self-assessment questionnaire about their classroom practice. These data sets were analyzed along with participating teachers' overall perceptions of the *Dynamic Pedagogy* intervention at the end of the academic year (2003-2004).

Classroom Practice

The grounded theory method of analysis was first used to identify indicators that emerged directly from a videotaped lesson on Equivalent Fractions. The lesson was transcribed verbatim then read, analyzed, and coded sentence by sentence. Once all the data were coded, the number of occurrences grouped into 5 main categories or themes: Teacher Talk, Student Talk, Student Engagement, Classroom Environment/Organization, and Lesson Sequence (see Table 3 for a breakdown of these categories into sub-themes). An analysis was then done to ascertain the degree to which these sub-themes were consistent with the theoretically-derived indicators of the *Dynamic Pedagogy* model.

Next, observations and videotaping of *Dynamic Pedagogy* teachers' lessons in action were conducted for each of the target mathematics unit, using a matrix sampling design, throughout the school year. Videotaped lessons were transcribed as running records of all events occurring during 50-60 minute class sessions, particularly focusing on the nature and quality of teacher-student interactions and level of student engagement.

Data gathered directly from 6 classrooms were analyzed using 3 procedures. The first one lists the components *of Dynamic Pedagogy* with coded indicators for each one. The list also includes indicators for the Initiation, Development, and Closure phases of the lesson. The second one is rating scale for making holistic judgments about the teacher's use of *Dynamic Pedagogy* indicators across each phase of the lesson as well as the quantity and quality of student engagement and teacher-student interaction in the classroom. The third procedure is a rubric for making overall judgment on the nature and quality of teacher-student interactions over the course of a lesson (see Appendices D, E, and F for each procedure).

The analysis was conducted to ascertain the extent to which teachers used strategies consistent with the *Dynamic Pedagogy* model and the quality of student engagement in *Dynamic Pedagogy* classrooms.

Table 3

Grounded Theory Analysis Results

Theme (Indicator)	Sub-Theme (Sub-Indicators)	# Occurrences (Frequency)	Rank
1.1 Teacher Talk	1.1.1 Teacher Talk-Lesson Related 1.1.2 Instructions/Call Attention 1.1.3 Instructions/Clear Desks 1.1.4 Instructions/Count Cookies 1.1.5 Instructions/Write Name on Worksheet 1.1.6 Instructions/Take out Manipulatives (e.g., fraction kits, tangrams) 1.1.7 Instructions/Communicating Lesson Objectives 1.1.8 Poses Questions 1.1.9 Probing 1.1.10 Probing/Clarification *Exe: T: What do you mean equal?* 1.1.11 Probing/Understanding *Ex: Is a whole a fraction?* 1.1.12 Provides Examples (real-world) *Exe: If someone has a name James but is called Jimmy are they the same person?* 1.1.13 Solicits Student Participation *Ex: Who can tell me what equals ½?* 1.1.14 Acknowledges Student Response *Ex: Let's see if she is right* 1.1.15 Provides Cues 1.1.16 Monitoring 1.1.17 Provides Positive Reinforcement 1.1.18 Asks for Students' Own Examples *Ex: If 3+3= 6, what else is equal to 6?* 1.1.19 Communicates Inaccuracy 1.1.20 Instructions/Calls on Students to Demonstrate 1.1.21 Demonstrates With Manipulatives (fraction kits) 1.1.22 Explains Fraction Game (objectives) 1.1.23 Reviews 1.1.24 Requests Explanations 1.1.25 Instructions/Sitting Location (rug area, desks) 1.1.26 Instructions/Directions 1.1.27 Instructions/Turn Taking 1.1.28 Instructions/Get Started 1.1.29 Instructions/Help Each Other 1.2 Teacher Talk-Unrelated	157	1

Table 3 (continued)

Grounded Theory Analysis Results

Theme (Indicator)	**Sub-Theme (Sub-Indicators)**	**# Occurrences (Frequency)**	**Rank**
2. Student Talk	2.1.1 Individual Student Response-Lesson Related *Example: Same Equal parts* 2.1.2 Group Student Talk-Lesson Related *Example: The class responds yes* 2.1.3 Individual Student Response-Unrelated 2.1.4 Group Student Response-Unrelated 2.2 Poses Question-Lesson Related 2.2.1 Poses Question-Lesson Unrelated	85	2
3. Student Engagement	3.1 Raising Hands 3.2 Blackboard Demonstration *Ex: S8: Comes to the blackboard to demonstrate that the fractions are equal* 3.3 Playing Fraction Game 3.4 Asks for Help 3.5 Disappointed When Time Is Up 3.6 Listening to Teacher 3.7 Working on Word Problem 3.8 Working on Worksheet 3.9 Student Distracted	23	3
4. Classroom Environment/ Organization	4.1 Desk Arrangement *Ex: The desks are set up in 4 groups* 4.2 Math Posters 4.3 Computer Area	3	5
5. Lesson Sequence	5.1 Beginning of Lesson 5.2 Transitioning to Fraction Game 5.3 Ending Fraction Game	4	4

Note. Total Frequency of Occurrences = 272

Outcomes

To examine early outcomes of the pilot year of the project (2003-2004), a comparison was made of achievement differences in paired students in *Dynamic Pedagogy* and non-*Dynamic Pedagogy* classrooms by school, matched on standardized test performance from the previous year (CTB-4, TerraNova Mathematics Subtest Levels 1-4) and race/ethnicity. Matched groups changed marginally due to student mobility and attrition by the end of the year. Thus, further controls were instituted by using a factorial Analyses of Covariance (ANCOVA), using prior achievement as the covariate, schools and the *Dynamic Pedagogy* condition as independent factors, and scores from the district's unit tests and the end-of-grade 3 CTB-4 as outcome measures. F tests were run to test for statistical significance of achievement differences in *Dynamic Pedagogy* and non-*Dynamic Pedagogy* students; effect size (as eta squared) values were also examined along with mean differences in groups, adjusted for the covariate. The analysis also included student performance on 4 mathematics unit tests each of which was administered to all children following instruction.

Measures

For teachers in the experimental condition only, the following independent measures were used:

- *Before classroom practice*: Lesson Planning and Lesson Plan Templates
- *During classroom practice*: Teacher-Student Interaction Protocol and Rubric
- *After classroom practice*: Teacher Self-Assessment Questionnaire.

The dependent measures for experimental and comparison groups were as follows:

- Third grade standardized mathematics tests
- Third grade district-developed assessments for target mathematics units.

Results

The section that follows first describes the results of the descriptive analysis of a sample (4) of teachers' completed preplanning and lesson plan templates for 2 mathematics units: *Equivalent Fractions* and *Geometry* that were the target areas for the study. Next, the results of analysis of samples of student work are given followed by results from the grounded theory analysis of one teacher's lesson and the results of analyses of a sample of 6 observed lessons.

Preplanning Thoughts

Results indicated that teachers did consider analytical, creative, practical, and memory task in planning the lesson. In addition, they stated the learning goals for the lesson, and described the "out-of school" and "in-school" knowledge and experiences of their students. And, finally, they identified the possible misconceptions and procedural errors that, in their judgment, were likely to pose problems for the students for the planned lesson.

Lesson Plans

Results showed that teachers specified the goals and objectives of the lesson, and listed the manipulatives and other materials they considered relevant for meeting the lesson objectives. For each phase of the lesson (*Initiation*, *Development*, and *Closure)*, they listed the activities, teaching-learning experiences, and grouping arrangements for organizing the lesson over a 50-60 minute period.

Samples of Student Work

Results of the analysis of student work showed wide variation. Some teachers collected math journals that showed students' reflections about their experiences after a completed math lesson; other collected individual student's work on a district-wide group assessment project; yet others compiled completed worksheets on assignments that were given during or after the lesson. For some of the work submitted, teachers distinguished what, in their judgment, were samples of "exemplary," "average," "struggling," and "surprising" work.

Classroom Practice

(a) Results of grounded theory analysis

The results of the grounded theory analysis of one lesson in Table 3 showed that the teacher used many of the theoretically-defined indicators of *Dynamic Pedagogy* in addition to some indicators that were not included in the *Dynamic Pedagogy* model. These other indicators: *student engagement*, *teacher feedback*, and *giving directions* were added to the *Dynamic Pedagogy* Indicators list, as indicated in Appendix D.

(b) *Dynamic Pedagogy* lessons in action across phases

We report the results of the analysis of 6 lessons on the topic of *Equivalent Fractions*. Results showed variations in the use of *Dynamic Pedagogy* strategies in the classrooms, as reflected in the unique patterns of teacher-student interactions that unfolded within and across the *Initiation*, *Development*, and *Closure* phases of the lessons. For all the observed lessons there was strong evidence that during the *Initiation* phase of the lesson teachers selected a variety of curricular tasks and used instructional and assessment strategies to help students make connections to their prior knowledge and skills in readiness for the lesson's objectives. However, there was some unevenness in how teachers used these strategies to support the efforts of students to build new knowledge and skills during the *Development* phase and to consolidate new learning during the *Closure* phase of the lesson.

Table 4 shows the ratings for teacher-student interactions within and across lesson phases of the 6 observed lessons (2 teachers team-taught all observed lessons). Ratings for the lessons observed indicated that student engagement was consistently high across all teachers who participated in the study.

Table 4

Ratings for Teacher-Student Interactions Across Lesson Phases in 6 *Dynamic Pedagogy* Classrooms

Lesson Phases				
Dynamic Pedagogy Classroom	**Initiation**	**Development**	**Closure**	**Level of Student Engagement**
Barbara	4	4	3	High
Ellen	4	4	3	High
Claire	3	2	1	High
Donna	4	4	3	High
Bonnie	3	3	1	High
Gene	4	3	3	High
Karen	4	3	3	High

5 = very high use of *Dynamic Pedagogy*
4 = high use of *Dynamic Pedagogy*
3 = moderate use of *Dynamic Pedagogy*
2 = low use of *Dynamic Pedagogy*
1 = very low use of *Dynamic Pedagogy*
0 = no use

We have chosen excerpts from Barbara's class (Ms. B), to illustrate patterns of teacher-student interactions during the *Initiation*, *Development*, and *Closure* phases of her observed lesson. For each phase of instruction, we looked for evidence of Ms. B's use of *Dynamic Pedagogy* indicators to support children's learning. We were interested in not merely noting the frequency of use of individual *Dynamic Pedagogy* indicators by the teachers, but rather their choice of clusters of indicators in each of the phases of instruction. In particular, we were interested in observing whether the teacher used *Dynamic Pedagogy* strategies to engage children in teaching-learning experiences likely to promote mathematics learning. Listed below are the goals and objectives of Ms. B's lesson followed by a discourse between the teacher and students across the 3 phases of the lesson:

***Goal**: To continue to develop the student understanding of equivalent fractions as equal parts of a whole.*

***Objectives**: (1) Students will understand the concept of a set as a whole that can be divided into fractions; and (2) Students will demonstrate their understanding of equivalent fractions as equal parts of a set through the use of concrete objects, drawings, and stories.*

Initiation: Supporting Activation of Prior Knowledge

As the following excerpt from the running record of Ms B's lesson illustrates, students were provided with opportunities to activate their prior knowledge related to the goal and objectives of the lesson. Through the use of Dynamic Pedagogy *probing and scaffolding strategies, she encouraged them to think about objects and numbers that have the same name.*

T: Can anyone think of anything in your neighborhood that has more than one name or even in our classroom that has more than one name?

Several students raise their hands and teacher calls on different students R, I, and S

R: A rug.

Teacher: And a?

Student RR: A carpet.

S: A sofa and a chair.

I: A cup and a mug.

T: Ok, very good.

T: All right, you all get the idea that some things have more than one name. In mathematics we have a name for that. It is called equivalent. *{writes word on the board}*
Can you give me a number that might be equivalent?

A number of students raise their hands and teacher calls on student SR

SR: 4 equals 4.

T: Well, both of those have the same name, but we want to think of a number that maybe has a similar name. *{Teacher calls on student BA}*

BA: 4 and quadruple.

T: Ok. Let's think in terms of a number sentence.

Several students raise their hands and teacher calls on Maria

M: 25 divided by 5 equals 5 and 5 times 5 equal 25.

T: That's a good way of doing it.

T: Today, boys and girls we are going to look at how equivalent fractions are another name for equal parts of the same whole.

Development: Supporting the Construction of New Knowledge

As illustrated in the following vignettes, Ms. B provided numerous opportunities for students to construct new knowledge about equivalent fractions by selecting tasks and using a variety of Dynamic Pedagogy *instructional strategies. The first vignette shows a discussion Ms. B had with students after they had spent a few minutes working on an assignment she had given. She had divided the class into pairs and gave each pair a graham cookie with instruction to share it equally.*

T: Ok let me have your attention. Tell me, what piece you have in your hand? Erica?

E: One half.

T: Ok, now I want you to break each of these pieces in half. Break it in half now. So how many pieces do you have that are equal?

ER: 2/4

T: Ok, I like the way you said that. Who can explain what ER means by that?

Teacher calls on student D

D: Out of 4 pieces you have 2.

T: But I thought I had a 1/2.

D: That's because when it was together that made it one. But when you break it in half that takes one part of each other and it makes 2.

T: Does that mean I have more now than before?

D: They are equal.

T: They are equal? I don't understand. Somebody has to explain it to me. Maybe it has to do with that word Ms. B used a while ago. *{Teacher calls on JA}*

JA: Equivalent. 2/4 is the same as 1/2.

T: Good. We actually proved that, didn't we?

Teacher demonstrates with the graham cookie as she explains. How many of you understand that?
Many students raise their hands.

T: Very good. Now you can eat them. We are going to do some more things on our own to help us understand this better.

Following this activity, Ms. B went over the rules of cooperative learning with the class and then she divided the students into groups of 4 and each group was given a set of materials to work with (crayons, markers). A worksheet was distributed to each group and students were asked to work together to answer questions about equivalent fractions. The teacher monitored this activity by moving from group to group, probing and scaffolding when necessary.

The teacher stops at the table of one group dividing 16 crayons into two equal groups

T: So how many in each group?

S. 8

T: So what is 1/2 of your set?

S: Oh, oh.

Student erases her answer on the worksheet and the teacher looks at student work and says

T: That's good. Now you have to explain why it is equivalent in words.

The teacher stops at another table and reviews the work of the group

T: So how many altogether did you start out?

S: 12

T: So what part of the fraction is that? *{student hesitated and the teacher added. . .}* the numerator or denominator?

S: The denominator.

T: Very good, ok.

Closure: Supporting the Reinforcement of New Knowledge

In this phase of the lesson Ms. B created a number of opportunities for children to demonstrate what they had learned. For example, in the instructional sequence that follows, Ms. B reassembled the class for a whole group discussion to review the assignment given earlier.

T: What ways of finding a half did you find?

Many students raised their hands to respond and teacher calls on student Samantha

S: Equals 8/16

The teacher rephrases the student response

T: She said she found 1/2 equals 8/16.

Teacher writes on the board 1/2 = 8/16

T: Good, can anybody explain why these are called equivalent fractions? Jonathan?

J: Because 8 is half of 16.

T: Well that's, one way of explaining it, but can you think of another way of explaining it.

J: 8 x 2 = 16

T: Ok, but does that tell us that is the same as 1/2? Who would like to explain it another way? Delroy?

D: Half of something is one number plus the same number that equals another.

T: Very good. Can you use any of the words in the definition to explain it?

D: They are equivalent because they are the same parts; they are equal parts of the same whole.

T: Very good

In another instructional sequence Ms. B showed the class an equivalent fraction chart and asked the children if they noticed a pattern in the numerators and denominators.

T: Can anybody tell me something that they see as a pattern? *{Teacher points to circles in the chart: 1/2 = 2/4 = 3/6 = 4/8 and calls on Cynthia?}*

C: When you look at the dominator they are counting by two's.

T: Very good. Look at the denominator. Each time you are adding 2. 2 + 2 = 4; 4 + 2 = 6; 6 + 2 = 8.

Another student volunteered an answer

S: There are 3 things you could tell about them.

T: Tell us.

S: This is one half, this is 2 out of 4; this is 3 out of 6, this is 4, . . . and you can keep going. . . .

T: Very good.

T: Vincent what would you like to say?

V: They are all gonna be halves.

T: They are all halves of the whole, exactly.

V: And they keep getting smaller and smaller.

T: That's right.

Following this instructional sequence the teacher provided an independent activity to assess children's individual understanding of equivalent fractions. She distributed 12 pictorial representations of fish on an 8.5x11 piece of paper with an accompanying worksheet that consisted of a number of equivalent fractions problems.

In summary, during the *Initiation* phase of the lesson, Ms. B used *Dynamic Pedagogy* probing and scaffolding strategies to help them activate their prior knowledge related to the concept of equivalence. During the *Development* phase of the lesson, she helped them to construct new knowledge by continuing to use *Dynamic Pedagogy* strategies of probing, scaffolding, modeling, and explaining. In addition, she used the *Dynamic Pedagogy* strategy of monitoring student work while they worked in small groups providing just enough scaffolding to let students figure out the problems on their own. Finally, during the C*losure* phase of the lesson, Ms. B again used *Dynamic*

Pedagogy probing strategies to help students consolidate their new learning. Through the use of these strategies, she encouraged them to review and reflect on themselves as learners and to explain and justify their solution strategies. In addition, she provided opportunity for them to engage in independent practice thereby helping them to further reinforce their understanding of equivalent fractions.

Post-lesson Reflections

In general, the majority of the teachers rated themselves highly in terms of their own performance in implementing the *Dynamic Pedagogy* lessons, yet there was variation among them. Whereas many teachers gave themselves the highest score for how well they prepared the students for the objectives of the lesson and checked their progress toward the lesson objectives, there was unevenness in their scoring on the item that asked about how well they checked whether students achieved the objectives of the lesson. They rated themselves highly in the use of creative, analytical, practical, and memory tasks, as well as their reported use of instructional strategies of modeling, monitoring, and shared practice. In the area of assessment they rated themselves more highly in the use of declarative and procedural probing than in their use of conceptual and metacognitive probing. And finally, in the area of lesson phases, they rated themselves highly in terms of the activities they provided for the *Initiation* and *Development* Phases; but teachers were uneven in their ratings for the activities they provided for the *Closure* phase of the lessons taught.

***Overall Perceptions of Teachers About* Dynamic Pedagogy**

At the end of the pilot year, teachers completed a self-assessment questionnaire to assess their perceptions of their experiences with *Dynamic Pedagogy* over the duration of the project (see Appendix G for the *Dynamic Pedagogy* Teacher Exit Questionnaire). Tables 5 and 6 present the means and standard deviation (SD) for their perceptions of various components of *Dynamic Pedagogy*.

Although there was some variation among the teachers, their overall ratings of their perceptions about various aspects of the *Dynamic Pedagogy* intervention fell within the middle range. On the average, they rated the components of the professional development (3A) as moderately helpful and the usefulness of completing the requirements for the *Dynamic Pedagogy* portfolio (4A) as moderately useful. Ratings were similarly moderate for the frequency with which they used the Curriculum, Instruction, and Assessment indicators (5A) and organized their classroom practice into the *Initiation*, *Development*, and *Closure* phases (6A). And finally, they rated the impact of *Dynamic Pedagogy* on their teaching (7A) and on students (8A) as moderate.

Table 5

Means From 2004 *Dynamic Pedagogy* Teacher Exit Questionnaire

Teacher Name	3A	4A	5A	6A	7A	8A
Barbara	4.86	3.86	4.75	4.67	4.00	5.00
Bonnie	5.29	4.14	4.44	4.33	4.44	3.00
Claire	4.86	3.71	3.94	5.67	4.44	5.00
Dona	4.00	4.57	4.31	4.33	4.89	5.57
Ellen	6.00	6.00	4.81	5.00	5.11	4.43
Fatima	4.29	4.43	5.50	5.67	5.33	4.00
Gene	5.57	2.57	4.44	4.00	4.00	5.00
Karen	4.57	4.5	4.63	5.00	4.56	4.00
Ingrid	4.33	2.86	4.19	4.00	4.11	3.00
Jenny	4.71	4.57	5.38	5.00	1.44	2.86

Table 6

Standard Deviations From 2004 *Dynamic Pedagogy* Teacher Exit Questionnaire

Teacher Name	3A	4A	5A	6A	7A	8A
Barbara	1.35	1.77	1.00	1.53	0.87	0.82
Bonnie	0.49	0.69	0.51	1.15	0.53	0.00
Claire	0.38	1.38	1.06	0.58	0.53	0.58
Dona	0.63	0.79	1.01	1.15	1.17	0.53
Ellen	0.00	0.00	1.17	0.00	1.05	0.79
Fatima	0.76	1.51	0.82	0.58	0.71	0.58
Gene	0.79	0.79	1.03	1.73	1.32	0.58
Karen	0.53	0.84	0.50	1.00	0.53	0.58
Ingrid	1.63	1.21	0.83	1.73	0.78	0.00
Jenny	0.95	1.81	0.72	1.00	0.73	0.69

Performance on Third Grade TerraNova Mathematics Subtest

A factorial analyses of covariance (ANCOVA) was done using prior achievement on the second grade TerraNova (covariate), schools, the *Dynamic Pedagogy* condition as independent factors, and scores from the end-of-grade 3 TerraNova Mathematics Subtest as the outcome measure. *F* tests were run to test for statistical significance of achievement differences in *Dynamic Pedagogy* and non-*Dynamic Pedagogy* children; effect size (as eta squared) values were also examined along with mean differences in groups, adjusted for the covariate (scores on the second grade TerraNova mathematics Subtest).

The results of the ANCOVA with TerraNova Mathematics Subtest scores as the end-of-year outcome in grade 3 showed significant differences favoring *Dynamic Pedagogy* over non-*Dynamic Pedagogy* (p = .018), with significant *Dynamic Pedagogy* by school interactions (p = .005). The adjusted means were 626 (*Dynamic Pedagogy*) and 618 (non-*Dynamic Pedagogy*). The effect size was .51, showing that 51% of the math achievement variance at the end of grade 3 was explained by the *Dynamic Pedagogy* variable and schools, and overall favored the *Dynamic Pedagogy* students. The assumption of homogeneity of regression lines was tested through treatment by covariate interaction tests and was found to be non-significant. The observed means and adjusted means for the third grade TerraNova Mathematics Subtest are found in Table 7 and Figure 2.

Table 7

Observed and Adjusted Means for the End-of-Year TerraNova Mathematics Subtest

Comparison			**Treatment**		
School	Observed Mean	Adjusted Mean	School	Observed Mean	Adjusted Mean
Flatland	629.091	**626.721**	Flatland	656.500	**655.749**
Grant	623.591	**620.692**	Grant	612.182	**608.620**
Homeland	626.100	**621.294**	Homeland	633.321	**630.970**
Marvelle	616.645	**622.099**	Marvelle	617.387	**622.089**
Skyview	595.192	**602.619**	Skyview	616.560	**615.715**
Average		**618.685**			**626.629**

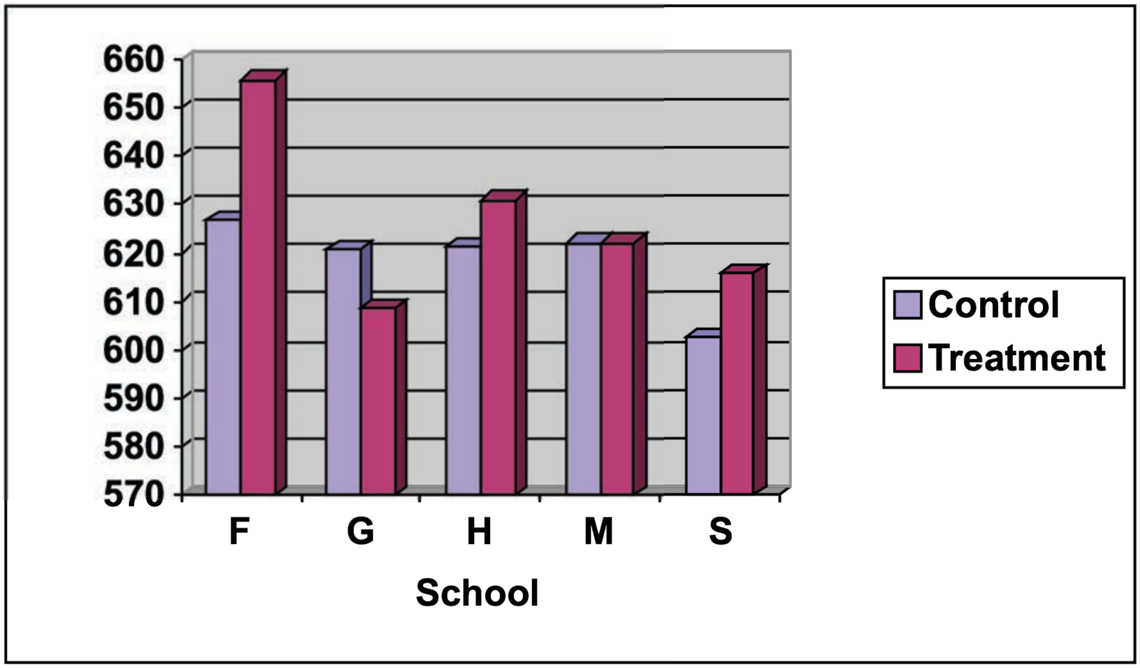


Figure 2. Effects of *Dynamic Pedagogy* using TerraNova Mathematics Subtest scores.

Performance on District Unit Assessment

A factorial analyses of covariance (ANCOVA) was also done using prior achievement on the second grade TerraNova Mathematics Subtest (covariate), schools, the *Dynamic Pedagogy* condition as independent factors, and scores from the end-of-unit district-developed assessments as outcome measures. *F* tests were also run to test for statistical significance of achievement differences in *Dynamic Pedagogy* and non-*Dynamic Pedagogy* children; effect size (as eta squared) values were also examined along with mean differences in groups, adjusted for the covariate. The analyses of process-outcome links by school focused on 4 mathematics units that were deliberately incorporated into the *Dynamic Pedagogy* professional development (Unit 2, Number Sense and Numeration; Unit 6, Equivalent Fractions; Unit 7, Measurement; and Unit 8, Geometry).

The results of the ANCOVA with the District unit assessments as scores at the end of each of the target mathematics unit of instruction showed significant differences favoring *Dynamic Pedagogy* over non-*Dynamic Pedagogy* children. The effect size for Unit 2 was .59; for Unit 6 was .54; for Unit 7 was .48; and for Unit 8 was .48. The assumption of homogeneity of regression lines was tested through treatment by covariate interaction tests and was found to be non-significant for Unit 2 only. The significance of the assumption of homogeneity of regression lines for Units 6, 7, and 8 suggest caution in interpreting the results. The observed means and adjusted means for the District unit assessments are found in Tables 8 through 11 and Figures 3 through 6.

Table 8

Observed and Adjusted Means for District Unit Test 2 (Number Sense and Numeration) Across Schools

UNIT 2					
Control			**Treatment**		
School	Observed Mean	Adjusted Mean	School	Observed Mean	Adjusted Mean
Flatland	19.000	**20.228**	Flatland	24.462	**24.190**
Grant	19.286	**18.735**	Grant	20.182	**19.347**
Homeland	20.133	**19.049**	Homeland	22.679	**21.815**
Marvelle	17.381	**17.859**	Marvelle	19.129	**19.951**
Skyview	14.500	**15.868**	Skyview	18.160	**17.870**

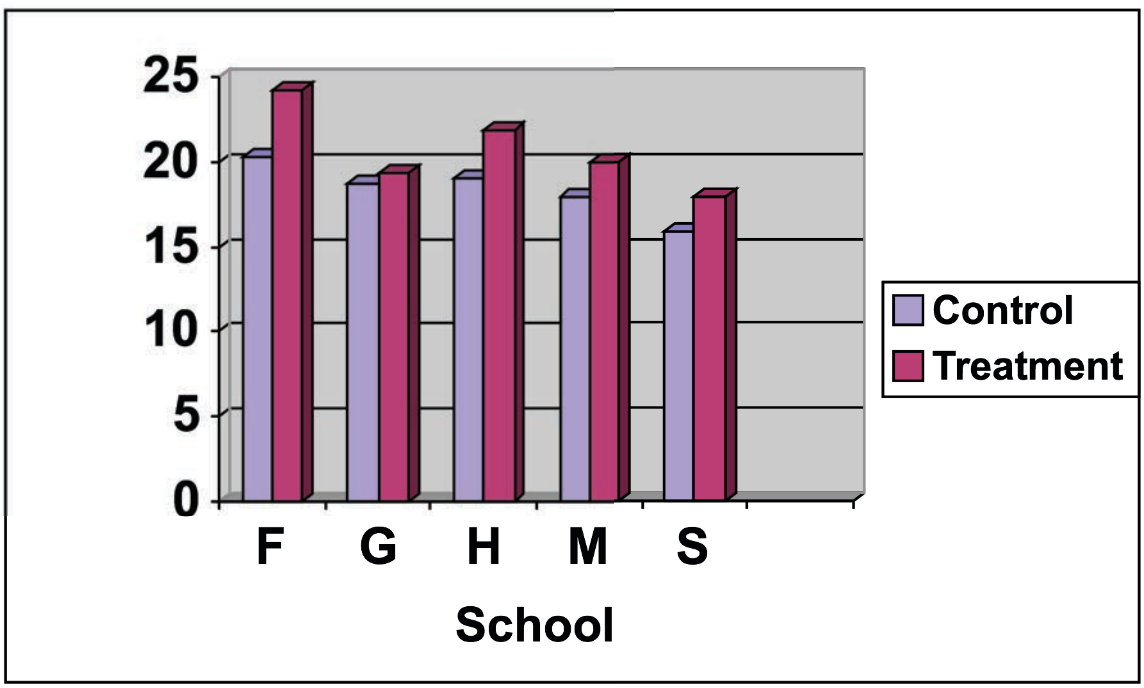


Figure 3. Effects of *Dynamic Pedagogy* using Unit 2 (Number Sense and Numeration).

Table 9

Observed and Adjusted Means for District Unit Test 6 (Equivalent Fractions) Across Schools

UNIT 6					
Control			**Treatment**		
School	Observed Mean	Adjusted Mean	School	Observed Mean	Adjusted Mean
Flatland	19.885	**21.040**	Flatland	24.038	**23.862**
Grant	20.421	**19.509**	Grant	18.905	**18.380**
Homeland	19.801	**18.989**	Homeland	23.074	**22.489**
Marvelle	19.300	**19.613**	Marvelle	17.767	**18.398**
Skyview	14.231	**15.533**	Skyview	18.00	**17.808**

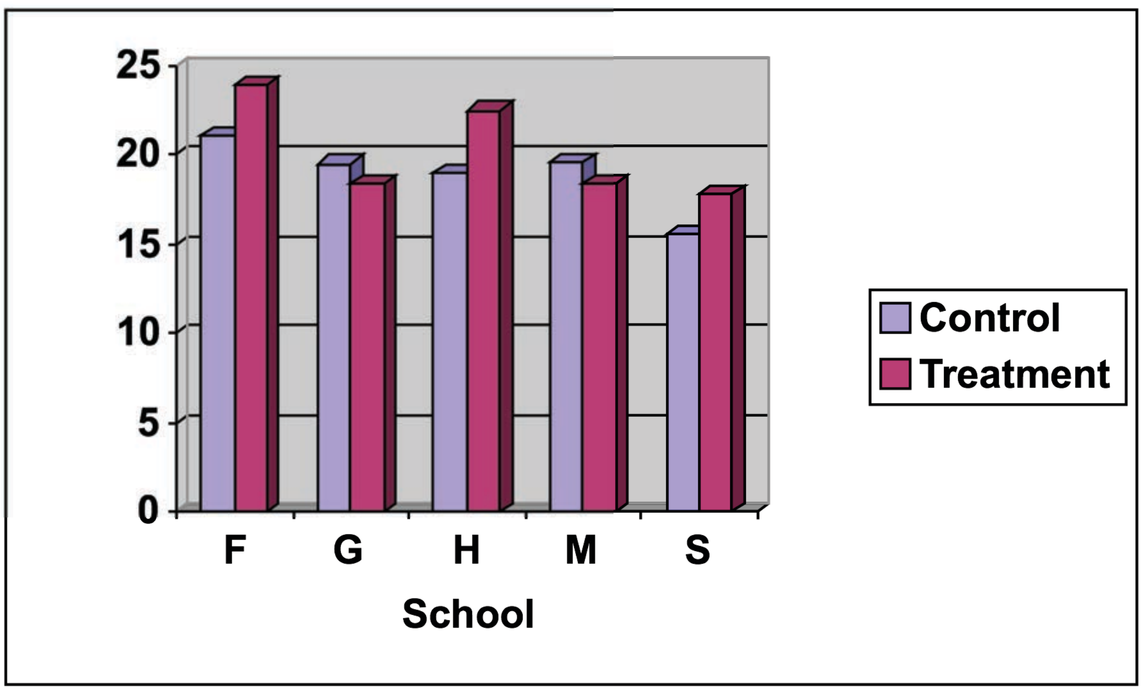


Figure 4. Effects of *Dynamic Pedagogy* using Unit 6 (Equivalent Fractions).

Table 10

Observed and Adjusted Means for District Unit Test 7 (Measurement) Across Schools

Unit 7					
Control			**Treatment**		
School	Observed Mean	Adjusted Mean	School	Observed Mean	Adjusted Mean
Flatland	18.8	**19.238**	Flatland	20.154	**20.077**
Grant	17.591	**17.358**	Grant	16.955	**16.674**
Homeland	18.5	**18.13**	Homeland	18.957	**18.583**
Marvelle	16.367	**16.516**	Marvelle	16.968	**17.285**
Skyview	14.423	**14.937**	Skyview	17.48	**17.396**

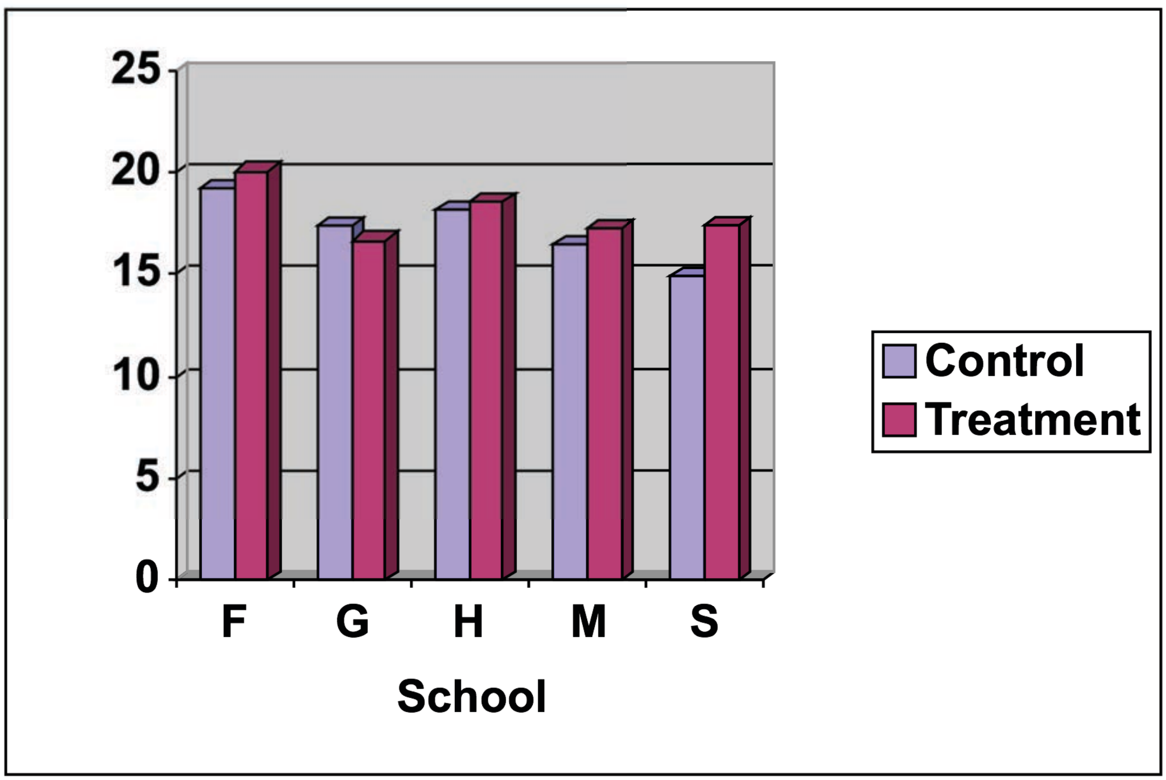


Figure 5. Effects of *Dynamic Pedagogy* using Unit 7 (Measurement).

Table 11

Observed and Adjusted Means for District Unit Test 8 (Geometry) Across Schools

UNIT 8					
Control			**Treatment**		
School	Observed Mean	Adjusted Mean	School	Observed Mean	Adjusted Mean
Flatland	16.042	**16.796**	Flatland	17.231	**17.11**
Grant	13.667	**13.436**	Grant	14.81	**14.294**
Homeland	15.733	**15.185**	Homeland	16.167	**15.552**
Marvelle	15.267	**15.476**	Marvelle	15.097	**15.551**
Skyview	10.5	**11.242**	Skyview	14.8	**14.67**

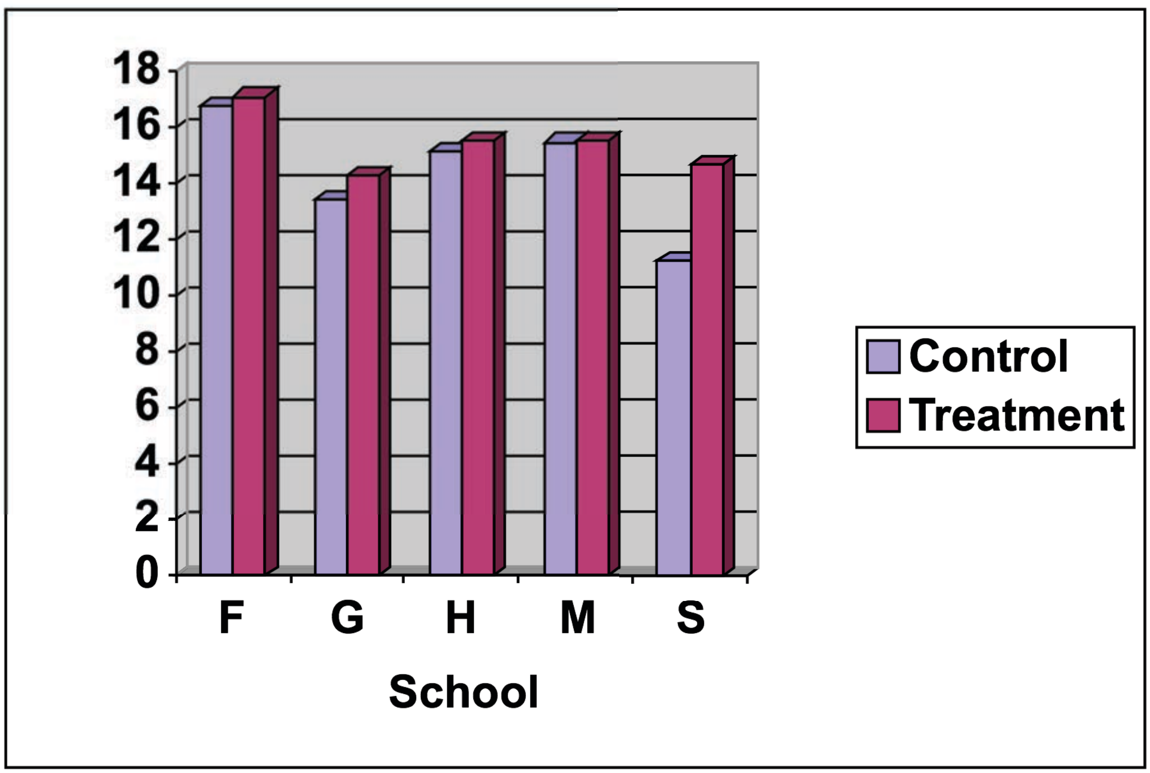


Figure 6. Effects of *Dynamic Pedagogy* using Unit 8 (Geometry).

Section 2: *Dynamic Pedagogy* Intervention—Year II

The second year of the study enabled us to examine longer-term differences between the treatment and comparison groups and assess whether student achievement changed after 2 years of exposure to the *Dynamic Pedagogy* intervention. Also, we wanted to ascertain whether similar positive outcomes would be obtained for a new cohort of students at the third grade level some of whom were taught by teachers who participated in the intervention study the previous year and others who were taught by teachers who participated in the study for the first time.

Study Design

Sample

At the end of the first year of the study, third grade subjects in the experimental and comparison groups were promoted to the fourth grade. Initially, 6 teachers at the fourth grade volunteered to participate in the study. Unfortunately, after receiving the 3-day professional development training, 4 of the teachers withdrew from the study leaving only 2 teachers in 1 school as participants. Subjects in the 2 experimental classrooms were matched with comparison students in other fourth grade classrooms in the school on ethnicity, gender, socioeconomic status (free or reduced-priced lunch eligibility), and end-of year math achievement level to create equivalent groups. Matching on these variables produced 36 cases, representing 18 subjects in the *Dynamic Pedagogy* condition and 18 in the control condition. (Table 12 shows a breakdown of the achievement level, demographics, gender, and eligibility for free/reduced-priced lunch.)

Table 12

Fourth Grade Descriptive Statistics for Matched Pairs for Academic Year 2004-2005

Variable	**Treatment (*Dynamic Pedagogy*)**			**Control**		
	f	**%**	***N***	***f***	**%**	***N***
Achievement Level (03-04 Third Grade TN)						
1	3	16.7	18	3	16.7	18
2	7	38.9	18	7	38.9	18
3	6	33.3	18	6	33.3	18
4	2	11.1	18	2	11.1	18
Ethnicity						
Native American	0	0.0	18	0	0.0	18
Asian	0	0.0	18	0	0.0	18
Hispanic	2	11.1	18	2	11.1	18
African American	15	83.3	18	15	83.3	18
White	1	5.6	18	1	5.6	18
Gender						
Female	11	61.1	18	11	61.1	18
Male	7	38.9	18	7	38.9	18
Free or Reduced-priced Lunch						
Eligible	10	55.6	18	10	55.6	18
Not Eligible	8	44.4	18	8	44.4	18

At the third grade level 4 teachers who participated in the pilot year of the study volunteered to continue their participation and were joined by 4 new participants. Altogether, at the third grade level there were 8 experimental classrooms and students in these classrooms were matched with control students in other third grade classrooms on ethnicity, gender, socioeconomic status (free or reduced-priced lunch eligibility), and third grade diagnostic test achievement level to create equivalent groups in each condition, *Dynamic Pedagogy* and non-*Dynamic Pedagogy*. Matching on these variables yielded 120 cases, representing 60 subjects from the 2 participating schools. Table 13 shows a breakdown of the achievement level, demographics, gender, and eligibility for free or reduced-priced lunch.

Table 13

Third Grade Descriptive Statistics for Matched Pairs for Academic Year 2004-2005

Variable	Treatment (*Dynamic Pedagogy*)			Control		
	f	%	*N*	*f*	%	*N*
Achievement Level (Diagnostic)						
1	19	31.7	60	19	31.7	60
2	24	40.0	60	24	40.0	60
3	17	28.3	60	17	28.3	60
Ethnicity						
Native American	0	0.0	60	0	0.0	60
Asian	2	3.3	60	2	3.3	60
Hispanic	15	25.0	60	15	25.0	60
African American	40	66.7	60	40	66.7	60
White	3	5.0	60	3	5.0	60
Gender						
Female	30	50.0	60	30	50.0	60
Male	30	50.0	60	30	50.0	60
Free or Reduced-priced Lunch						
Eligible	42	70.0	60	42	70.0	60
Not Eligible	18	30.0	60	18	30.0	60

Experimental Condition

At the third grade level there were 8 experimental classrooms, 4 in each of 2 schools, and at the fourth grade there were 2 experimental classrooms at 1 school. Altogether, 10 teachers from 3 schools participated in the second year of the study, 8 of whom taught third grade classes and 2 taught classes at the fourth grade level. Of the 8 teachers who taught at the third grade, 4 were from Flatland and 4 were from Homeland Elementary schools respectively. Two of the teachers at Flatland and 2 from Homeland participated in the study the previous year. The other 4 teachers were new to the project. At the fourth grade level, 2 teachers taught at Hearst and were first-time participants in the study. The teachers new to the project had at least 6 years of teaching experience and were certified and licensed in K-6 General Education. As in the pilot year of the study, these teachers participated in the *Dynamic Pedagogy* professional development workshops and on-site follow-up coaching sessions. The third grade teachers planned and implemented lessons consistent with *Dynamic Pedagogy* lessons on the same mathematics units as in the previous year. The 2 fourth grade teachers planned and implemented *Dynamic Pedagogy* lessons on Operations on Whole Numbers, Geometry, Measurement, Fractions, Decimals, Percent, and their Relationship to Money and the Metric System and Operations on Fractions and Decimals. Following the implementation of each *Dynamic Pedagogy*-embedded lesson, each teacher participated in a debriefing session about the lesson with members of the research team. In addition, they received the traditional district professional development and supports that were provided to all teachers in the school system.

Comparison Condition

At the third grade level all students in the comparison condition were enrolled in non-*Dynamic Pedagogy* third grade classes in each of the 2 schools and were taught by teachers with experience ranging from 1-30 years and with certification and license in K-6 General Education. At the fourth grade level, the comparison students were enrolled in non-*Dynamic Pedagogy* fourth grade classes at 1 school. The teachers of these comparison classes received only the traditional district professional development and supports for teachers during the school year. They taught the same mathematics units as the *Dynamic Pedagogy*-trained teachers, but they received no feedback on their lesson plans nor were their lessons observed by the *Dynamic Pedagogy* research team.

Method

Professional Development

As in the previous year, the *Dynamic Pedagogy* professional development consisted of a mandatory 3-day summer session, 2 full-day, and 2 after-school meetings. The structure and content of the professional development sessions were similar to those of the previous year, but incorporated feedback from the results of that year's implementation of the intervention. Specifically, greater attention was given to the use of *Dynamic Pedagogy* strategies during the *Closure* phase of the lesson. Also, additional opportunities were provided for teachers to review samples of student work and discuss word problems that were likely to pose difficulties for students in the target units of mathematics. These experiences were intended to deepen teachers' knowledge about (a) connections between mathematical topics, students "in- and out of school" knowledge; (b) multiple representations of mathematical concepts, problems, and solutions; and (c) misconceptions about mathematics concepts and procedures.

District-level support staff for teachers attended all professional development workshops: a third and a fourth grade mathematics coordinator and 3 instructional facilitators, 1 for each grade level in each of the 3 schools. These members of the district support staff served as liaisons with members of the research team, scheduling observation visits, helping participating teachers with their lesson planning, collecting portfolios of teachers' work, arranging for and sometime videotaping teachers' lessons, sitting-in on observations of participating teachers' lessons, and follow-up debriefing sessions with them and members of the research team.

Planning, Classroom Practice, and Post-lesson Reflections

As in the previous year, observations and videotaping of lessons were conducted in the experimental classrooms and members of the research team held debriefing sessions with participating teachers following implementation of their lessons. Also, for each of the target mathematics units, teachers prepared a portfolio that included the following: Completed preplanning templates and lesson plan templates, samples of student work, and completed teacher self-assessment questionnaire. Portfolios were collected and analyzed (see Appendix H for 2 sample portfolios, one for a first year teacher and the other for a second year teacher in the project).

There was some variation in the requirement for the 4 teachers who continued their participation in the study. Like their first year colleagues, teachers completed a portfolio for 2 lessons: equivalent fractions and geometry. In addition, they prepared a report in which they described their reflections about the goals, knowledge, and cognitions that informed the development and implementation of the lesson plans and evaluation of the lessons for each of the 2 mathematics units.

Measures

For teachers in the experimental condition only, the following independent measures were used:

- *Before classroom practice*: Lesson Planning and Lesson Plan Templates
- *During classroom practice*: Teacher-Student Interaction Protocol and Rubric
- *After classroom practice*: Teacher Self-Assessment Questionnaire.

The dependent measures for experimental and comparison groups were as follows:

- Third and fourth grade standardized mathematic tests
- Third and fourth grade district-developed assessments for target mathematics units.

Data Analysis and Results

As in the previous year, 5 areas were examined for evidence of the use of *Dynamic Pedagogy* principles and concepts: (a) participating teachers' preplanning and lesson plans; (b) Samples of student work; (c) Participating teachers' classroom practice; (d) Participating teachers' post-lesson reflections about their practice; and (e) Overall perceptions of participating teachers about *Dynamic Pedagogy*.

Following the implementation of each *Dynamic Pedagogy* lesson, the 6 third grade teachers and 2 fourth grade teachers who participated in the study for the first time submitted a portfolio that included the completed preplanning template and lesson plan templates, samples of student work, and a completed self-assessment questionnaire about their classroom practice. The section that follows describes the analysis and results of 4 of the third grade teachers' lessons for the mathematics unit of Fractions and Geometry and the 2 fourth grade teachers lessons for the units on Fractions, Decimals, Percent, and their Relationship to Money and the Metric System and Operations on Fractions and Decimals.

Preplanning Thoughts and Lesson Plans

A descriptive analysis of a sample of completed preplanning templates submitted for the 6 teachers showed that, like their colleagues of the previous year, teachers did consider analytical, creative, practical, and memory tasks in planning their respective lessons. Further, they listed "in and out-of school" knowledge of their students relevant for the learning goals they selected for the intended lesson. Also, they identified the misconceptions and procedural errors that students were likely to demonstrate during the actual implementation of the planned lesson. A descriptive analysis of their lesson plans indicated teachers specified the goals and objectives of the lesson, listed the manipulatives and other materials they considered relevant for meeting the lesson objectives. For each phase of the lesson (*Initiation, Development*, and *Closure*), they listed the activities, teaching-learning experiences, and grouping arrangements for organizing the lesson over a 50-60 minute period (see Appendix H for a sample of teacher preplanning).

Samples of Student Work

A descriptive analysis of samples of student work indicated that teachers collected a variety of student work as evidence of learning. Some third grade samples consisted of completed worksheets of problems that students were required to work on independently. Oftentimes, these assignments required students to describe their thoughts while solving math problems. The problems required students to think analytically and creatively for tasks that required them to explain their answers. Other samples required students to solve problems cooperatively. These problems also elicited practical and creative thinking. At the fourth grade level, samples consisted of completed answers to word problems requiring analytical thinking. Some teachers selected samples that, in their judgments, were categorized as "exemplary," "average," "struggling," and "surprising" (Samples of student work are included in Appendix H).

Classroom Practice

For the 4 first year teacher at the third grade level, 2 lessons were observed, videotaped (Equivalent Fractions and Geometry) and transcribed as running records of all events occurring during a 50-60 minute class session. Observations were not conducted for the 4 second year teachers, but 2 of their lessons (Equivalent Fractions and Geometry) were also videotaped and transcribed. For the 2 first year participating teachers at the fourth grade level, 2 lessons were observed, videotaped, and transcribed: Operations on Whole Numbers, Fractions, Decimals, Percent, and their relationship to Money and the

Metric System and Operations on Fractions and Decimals. As in the previous year, the transcriptions of the videotaped lessons were analyzed using *Dynamic Pedagogy Indicators in the Classroom,* the *Teacher-Student Interaction Protocol*, and *the Dynamic Pedagogy Rubric*. These analyses yielded qualitative judgments with which teachers used *Dynamic Pedagogy* strategies across three phases of an enacted lesson. Table 14a presents the combined ratings of Equivalent Fractions and Geometry Lessons in 8 third grade *Dynamic Pedagogy* classrooms. Table 14b presents the combined ratings of 2 lessons on Fractions in 2 fourth grade *Dynamic Pedagogy* classrooms.

Table 14a

Ratings of Teacher-Student Interactions Across Lesson Phases of 8 Third Grade *Dynamic Pedagogy* Lessons

Lesson Phases				
Classroom	**Initiation**	**Development**	**Closure**	**Level of Student Engagement**
Brown	5	5	3	High
Davidson	5	5	3	High
Foster	5	5	4	High
Johnson	5	4	3	High
Lawrence	5	5	3	High
Masters	5	5	3	High
Pearson	5	5	3	High
Williams	3	3	2	High

5 = very high use of *Dynamic Pedagogy*
4 = high use of *Dynamic Pedagogy*
3 = moderate use of *Dynamic Pedagogy*
2 = low use of *Dynamic Pedagogy*
1 = very low use of *Dynamic Pedagogy*
0 = no use

Table 14b

Ratings of Teacher-Student Interactions Across Lesson Phases of 2 Fourth Grade *Dynamic Pedagogy* Lessons

Lesson Phases				
	Initiation	**Development**	**Closure**	**Level of Student Engagement**
Saunders	5	5	4	High
Rogers	5	5	4	High

As the results in Table 14b indicate, participating teachers showed consistently highest use of *Dynamic Pedagogy* during the *Initiation* phase of the lesson and the lowest during the *Closure* phase of the lesson. These results were observed across all teachers at both third and fourth grade levels. The use of *Dynamic Pedagogy* was uneven during the *Development* phase of the lessons observed. In addition, analysis was done on the quality of student engagement and teacher-student interactions over the duration of the observed lessons. For all participating *Dynamic Pedagogy* teachers the level of student engagement was consistently high across lessons observed.

Post-lesson Reflections

In general, as in the previous year, the majority of the teachers rated themselves highly in terms of their own performance in implementing the *Dynamic Pedagogy* lessons. In terms of lesson objectives, they felt that they checked that students had the prerequisite knowledge and skills to learn the new content, monitored their progress toward the lesson objectives, and checked whether students attained the objectives of the lesson. For the curriculum strand of *Dynamic Pedagogy*, the majority of them claimed that they used tasks that required creative, analytical, and practical thinking as well as memory. Similarly, they claimed they used the instructional and assessment strands of *Dynamic Pedagogy* and provided activities for the *Initiation, Development,* and *Closure* phases of the lesson taught. The majority of them felt that most of the students understood the content of the lessons.

Overall Perceptions of Teachers About Dynamic Pedagogy

At the end of the study, an exit questionnaire was administered to participating teachers about their perceptions of their experiences with *Dynamic Pedagogy*. Tables 15 and 15a present the mean and standard deviations (SD) for their perceptions of various components of *Dynamic Pedagogy*.

In general, teachers' overall ratings of their perceptions of the *Dynamic Pedagogy* intervention were skewed to the right of the distribution. On the average, they rated the components of the professional development (3A) as very helpful and the usefulness of completing the requirements for the *Dynamic Pedagogy* portfolio (4A) as very useful. Ratings were similarly high for the frequency with which they used the Curriculum, Instruction, and Assessment indicators (5A) and organized their classroom practice into the Initiation, Development, and Closure phases (6A). And finally, they rated the impact of *Dynamic Pedagogy* on their teaching (7A) and on students (8A) as strong.

Third Grade District Unit Assessments and the TerraNova Mathematics Subtest

First, descriptive statistics were calculated for 2-8 District Unit assessments and the third grade TerraNova Mathematics Subtest for both *Dynamic Pedagogy* and Control groups in both schools combined and separate as shown in Tables 16 and 17.

Table 15

Means From 2005 *Dynamic Pedagogy* Teacher Exit Questionnaire

Teacher	3A	4A	5A	6A	7A	8A
Foster	5.14	5.00	5.11	5.00	5.11	5.43
Pearson	5.29	5.33	5.67	6.00	6.00	6.00
Brown	5.43	5.67	5.78	5.67	5.67	5.14
Davidson	6.00	4.83	5.28	6.00	6.00	5.71
Lawrence	5.00	3.67	5.06	6.00	4.33	5.14
Masters	5.86	5.67	5.78	6.00	5.56	5.71
Johnson	4.71	5.60	5.13	6.00	4.56	5.71
Williams	4.86	5.17	5.56	5.67	5.44	4.86
Saunders	4.86	5.17	5.56	5.67	5.44	4.86
Rogers	5.29	3.67	5.11	6.00	4.33	5.00

Table 15a

Standard Deviations From 2005 *Dynamic Pedagogy* Teacher Exit Questionnaire

Teacher	3A	4A	5A	6A	7A	8A
Foster	0.38	0.89	1.02	1.00	0.60	0.53
Pearson	0.49	0.52	0.69	0.00	0.00	0.00
Brown	0.79	0.52	0.43	0.58	0.50	0.38
Davidson	0.00	0.41	0.83	0.00	0.00	0.49
Lawrence	0.00	0.82	0.80	0.00	0.50	0.38
Masters	0.38	0.52	0.43	0.00	0.73	0.49
Johnson	0.95	0.55	1.20	0.00	0.73	0.49
Williams	0.38	0.75	0.70	0.58	0.53	0.38
Saunders	0.38	0.75	0.70	0.58	0.53	0.38
Rogers	0.76	1.03	0.68	0.00	0.50	0.00

Table 16.

Descriptive Statistics for *Dynamic Pedagogy* and Control Groups for District Units 2-8 Assessments and Third Grade TerraNova Mathematics Subtest

Condition		UNIT 2	UNIT 3	UNIT 4	UNIT 5	UNIT 6	UNIT 7	UNIT 8	THIRD TN
Control	Mean	17.79	19.32	14.48	21.72	26.37	20.83	15.28	611.17
	N	57	56	56	54	54	54	54	54
	SD	8.25	5.77	3.93	3.81	5.89	6.44	3.39	39.70
	Variance	68.06	33.29	15.44	14.52	34.69	41.47	11.49	1576.09
	Minimum	1.00	4.00	2.00	11.00	5.00	4.00	3.00	502.00
	Maximum	29.00	28.00	19.00	26.00	34.00	30.00	20.00	728.00
	Skewness	-.456	-.895	-1.005	-.859	-1.639	-.835	-1.118	.054
Treatment	Mean	18.06	21.27	15.06	22.06	27.35	21.94	16.80	624.04
	N	52	49	51	52	51	51	50	52
	SD	6.91	4.86	3.30	3.97	5.35	4.60	2.38	28.55
	Variance	47.75	23.62	10.89	15.76	28.62	21.16	5.66	815.10
	Minimum	4.00	7.00	6.00	11.00	9.00	12.00	11.00	561.00
	Maximum	30.00	27.00	19.00	27.00	34.00	29.00	20.00	671.00
	Skewness	-.384	-.959	-.811	-.946	-1.054	-.641	-.668	-.113
Total	Mean	18.06	20.23	14.76	21.89	26.85	21.37	16.01	617.48
	N	109	105	107	106	105	105	104	106
	SD	7.61	5.43	3.64	3.88	5.63	5.62	3.03	35.11
	Variance	57.91	29.48	13.25	15.05	31.70	31.58	9.18	1232.71
	Minimum	1.00	4.00	2.00	11.00	5.00	4.00	11.00	561.00
	Maximum	30.00	28.00	19.00	27.00	34.00	30.00	20.00	728.00
	Skewness	-.449	-.959	-.967	-.884	-1.392	-.889	-1.179	-.162

Table 17.

Descriptive Statistics by School for District Units 2-8 Assessments and Third Grade TerraNova Mathematics Subtest

SCHOOL		UNIT 2	UNIT 3	UNIT 4	UNIT 5	UNIT 6	UNIT 7	UNIT 8	THIRD TN
F	Mean	21.71	22.49	15.21	23.19	29.26	23.11	16.76	625.02
	N	49	47	48	47	46	47	45	46
	Std. Deviation	5.43	4.39	3.71	2.69	2.98	4.88	2.38	30.54
	Variance	29.48	19.27	13.76	7.24	8.88	23.81	5.66	932.69
	Minimum	8.00	6.00	6.00	18.00	23.00	4.00	11.00	555.00
	Maximum	29.00	28.00	19.00	27.00	34.00	30.00	20.00	683.00
	Skewness	-.970	-1.617	-1.049	-.429	-.376	-1.514	-.653	-.402
H	Mean	15.08	18.40	14.39	20.85	24.97	19.97	15.44	611.70
	N	60	58	59	59	59	58	59	60
	Std. Deviation	7.87	5.52	3.57	4.35	6.46	5.83	3.36	37.48
	Variance	61.94	30.47	12.74	18.92	41.73	33.99	11.29	1404.75
	Minimum	1.00	4.00	2.00	11.00	5.00	4.00	3.00	502.00
	Maximum	30.00	26.00	19.00	27.00	34.00	29.00	20.00	728.00
	Skewness	.093	-.673	-.980	-.614	-.952	-.550	-1.129	.084
Total	Mean	18.06	20.23	14.76	21.89	26.85	21.37	16.01	617.48
	N	109	105	107	106	105	105	104	106
	Std. Deviation	7.61	5.43	3.64	3.88	5.63	5.62	3.03	35.11
	Variance	57.91	29.48	13.25	15.05	31.70	31.58	9.18	1232.71
	Minimum	1.00	4.00	2.00	11.00	5.00	4.00	3.00	502.00
	Maximum	30.00	28.00	19.00	27.00	34.00	30.00	20.00	728.00
	Skewness	-.449	-.959	-.967	-.884	-1.392	-.889	-1.179	-.162

As the results in Table 16 show, the performance of students in the *Dynamic Pedagogy* treatment condition on both the third grade District Unit assessments as well as the standardized achievement test (TerraNova Mathematics Subtest) was higher than the control group. However, as Table 17 shows, the performance of students in the *Dynamic Pedagogy* condition at Flatland was higher than those in Homeland on all District Unit assessments and the standardized measure of mathematics achievement. These differences may not necessarily be due to differential impact of *Dynamic Pedagogy*, since differences were observed on the district diagnostic test that was administered as baseline prior to the start of the study as indicated in Tables 18 and 19.

Table 18

Descriptive Statistics for the Third Grade District Diagnostic Test by School

SCHOOL	**Mean**	***N***	**Std. Deviation**	**Minimum**	**Maximum**	**Skewness**
F	34.17	54	7.78	12.00	44.00	-1.453
H	32.03	66	7.67	8.00	44.00	-.890
Total	32.99	120	7.76	8.00	44.00	-1.096

Table 19

District Diagnostic Test Performance by Achievement Level and School

	Flatland			**Homeland**		
	f	**%**	***N***	***f***	**%**	***N***
Achievement Level						
1	12	22.2	54	26	39.4	66
2	20	37.0	54	28	42.4	66
3	22	40.7	54	12	18.2	66

As shown in Table 18, there was a bigger difference in mean scores on the diagnostic test, by school. Flatland averaged more than 2 points greater than Homeland on the test. The schools' standard deviations were roughly the same (indicating that their variances are similar), but Flatland's scores were much more negatively skewed than Homeland's scores. Therefore, before any analyses were conducted, Flatland had more scores lying to the right of the distribution than Homeland. The differences in initial differences between the two schools are also shown in Table 19.

Flatland has a lower percentage of students in Level 1 than Homeland (22.2% vs. 39.4%) and higher percentage of students in Level 3 than Homeland (40.7% vs. 18.2%).

Achievement Levels on the TerraNova Mathematics Subtest and District Unit Assessments

Additional descriptive analyses were done comparing the achievement levels of performance on the TerraNova Mathematics Subtests and the District's unit assessments of students in *Dynamic Pedagogy* classrooms vs. their peers in non-*Dynamic Pedagogy* classrooms at the same grades level within the school. A comparison was also done on the levels of both measures of *Dynamic Pedagogy* students vs. non-*Dynamic Pedagogy* students across the district.

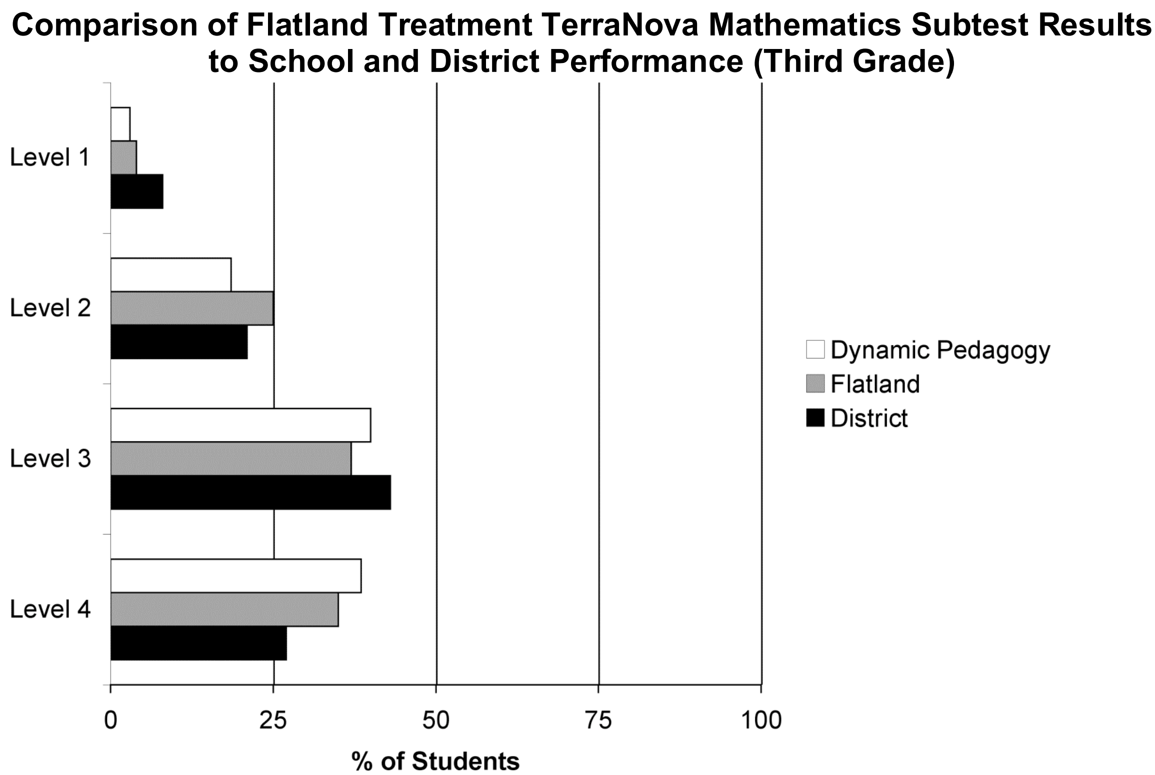
Flatland

These results are presented in Tables 20 through 25 and Figures 7 through 12. In comparison with their peers in the other third grade classes and the District, the *Dynamic Pedagogy* group had the lowest percentage of students who performed at the lowest level of achievement (level 1) on both the TerraNova Mathematics Subtest and District Unit assessments. Also, the *Dynamic Pedagogy* group had the highest percentage of students who performed at the highest level of achievement (level 4) on both measures of achievement.

Table 20

Flatland Level Analysis for Third Grade TerraNova Mathematics Subtest

	Dynamic Pedagogy Group			**Flatland**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	2	3	70	5	4	136	49	8	577
2	13	18.5	70	34	25	136	124	21	577
3	28	40	70	50	37	136	246	43	577
4	27	38.5	70	47	35	136	158	27	577



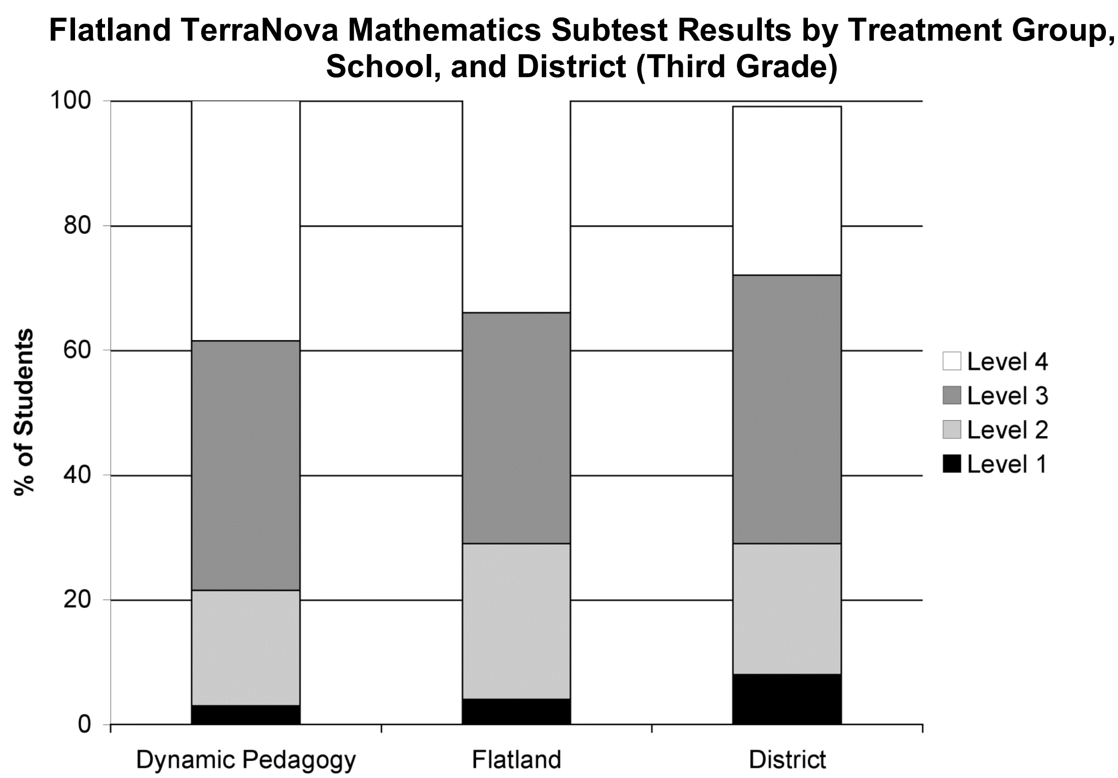
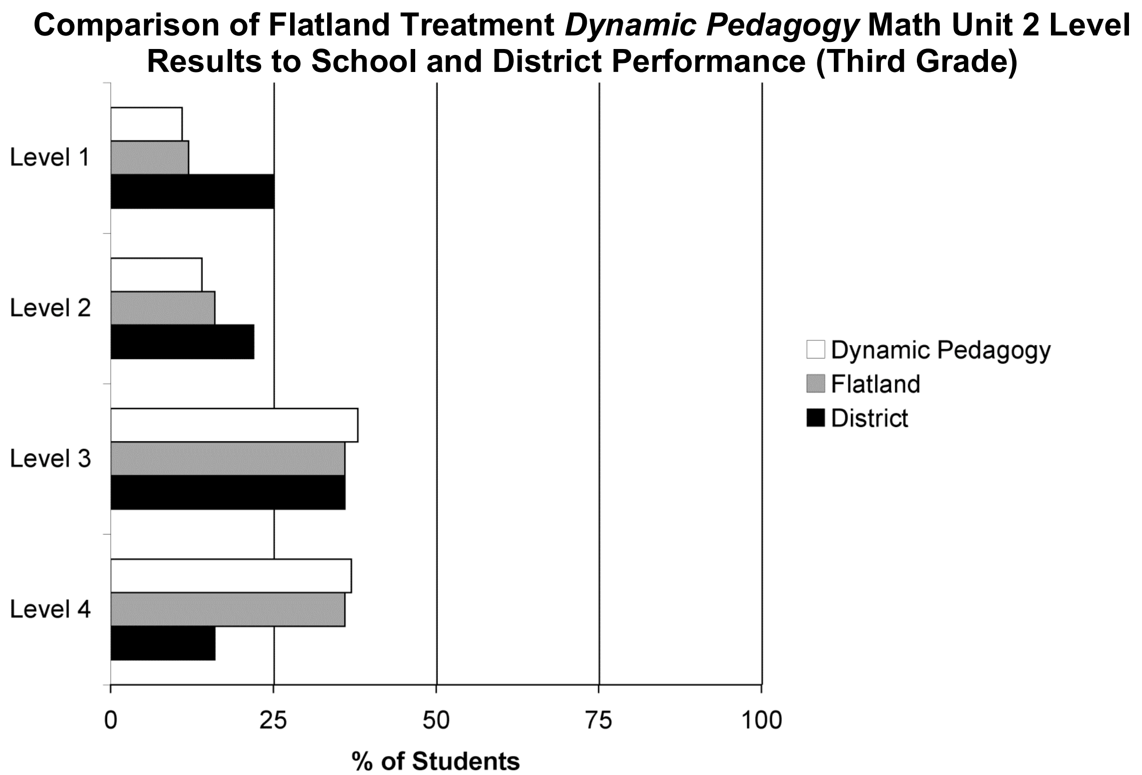


Figure 7. Comparison of Flatland TerraNova Mathematics Subtest to school and district performance (third grade).

Table 21

Flatland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 2

	***Dynamic Pedagogy* Group**			**Flatland**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	7	11	65	16	12	131	138	25	543
2	9	14	65	21	16	131	121	22	543
3	25	38	65	47	36	131	195	36	543
4	24	37	65	47	36	131	89	16	543



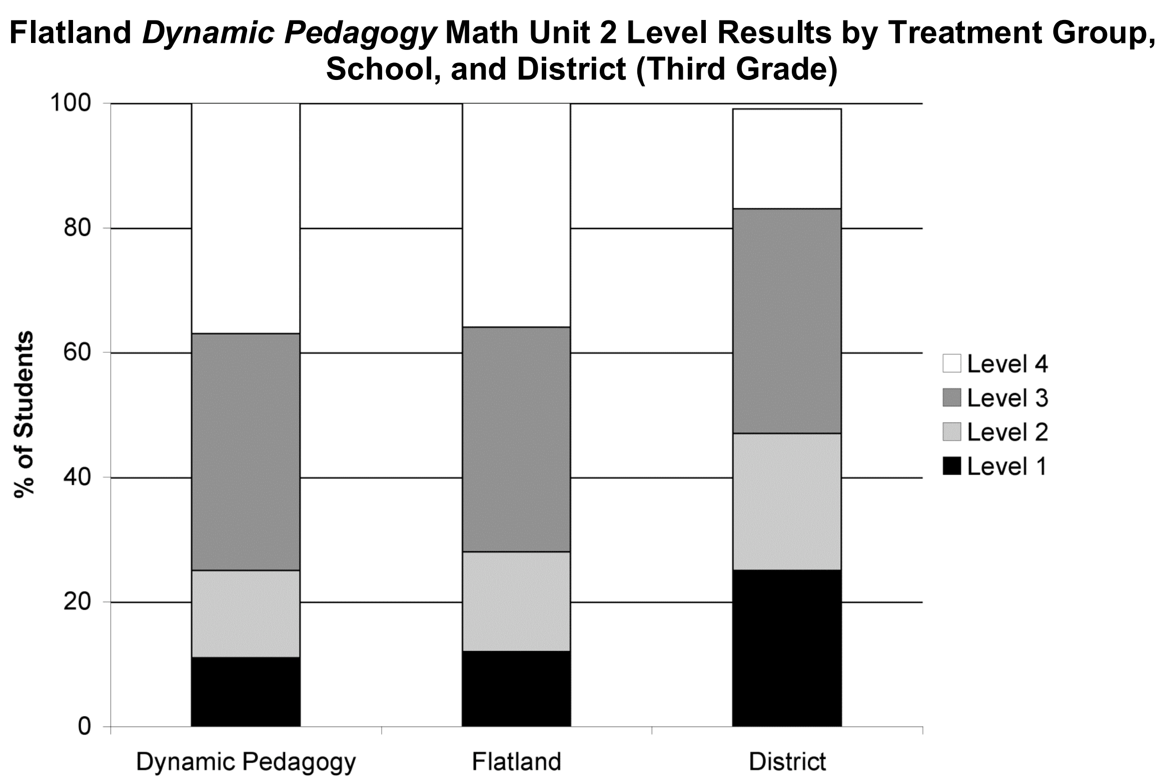
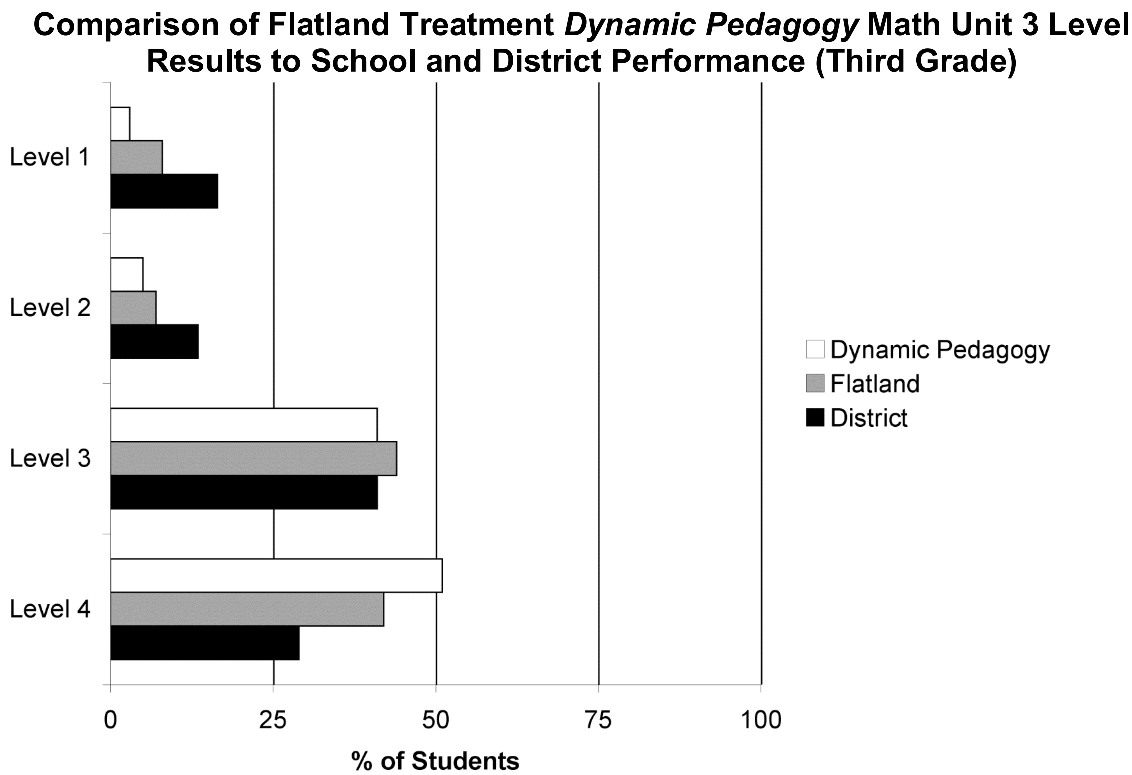


Figure 8. Comparison of Flatland Unit 2 to school and district performance (third grade).

Table 22

Flatland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 3

	***Dynamic Pedagogy* Group**			**Flatland**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	2	3	63	10	8	131	90	16.5	545
2	3	5	63	9	7	131	74	13.5	545
3	26	41	63	57	44	131	223	41	545
4	32	51	63	55	42	131	158	29	545



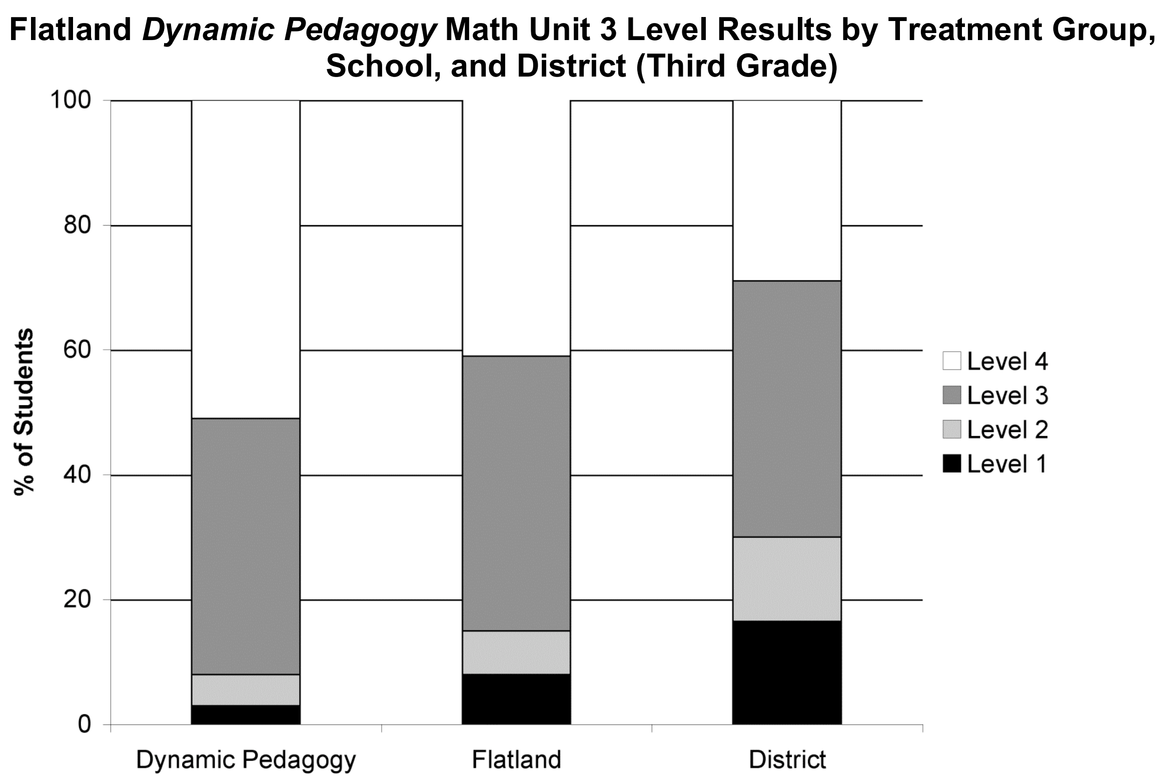
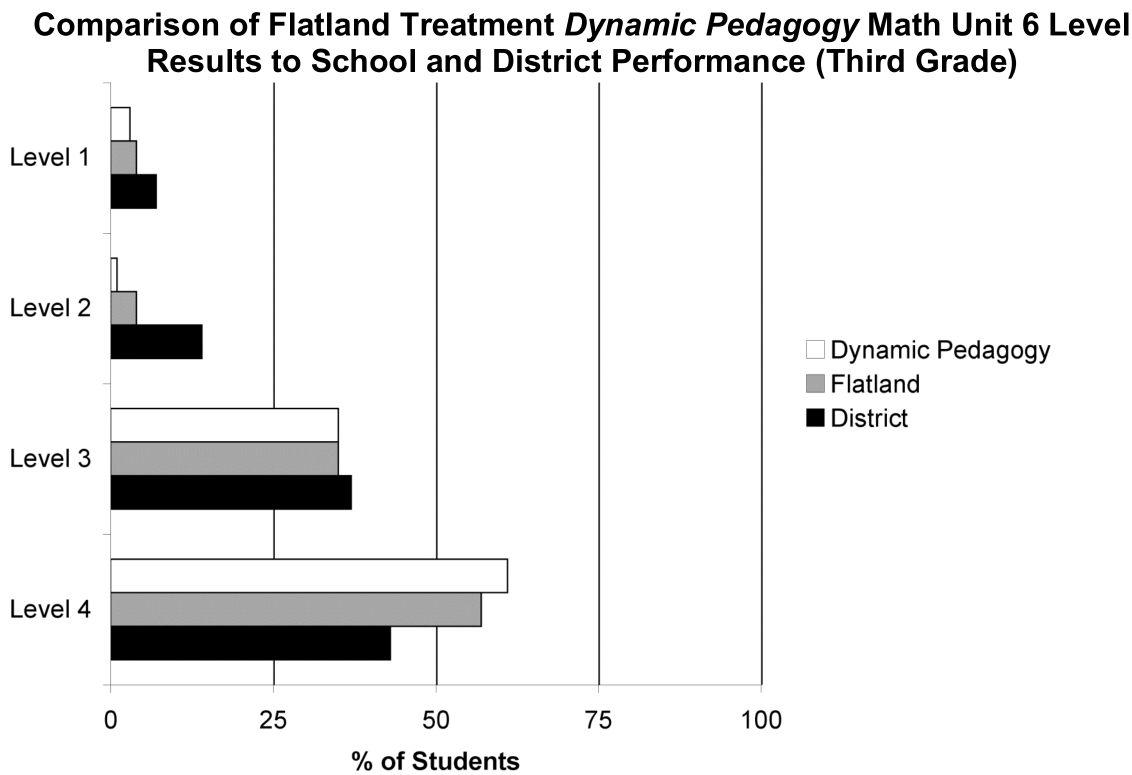


Figure 9. Comparison of Flatland Unit 3 to school and district performance (third grade).

Table 23

Flatland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 6

	***Dynamic Pedagogy* Group**			**Flatland**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	2	3	69	5	4	140	38	7	552
2	1	1	69	6	4	140	76	14	552
3	24	35	69	49	35	140	203	37	552
4	42	61	69	80	57	140	235	43	552



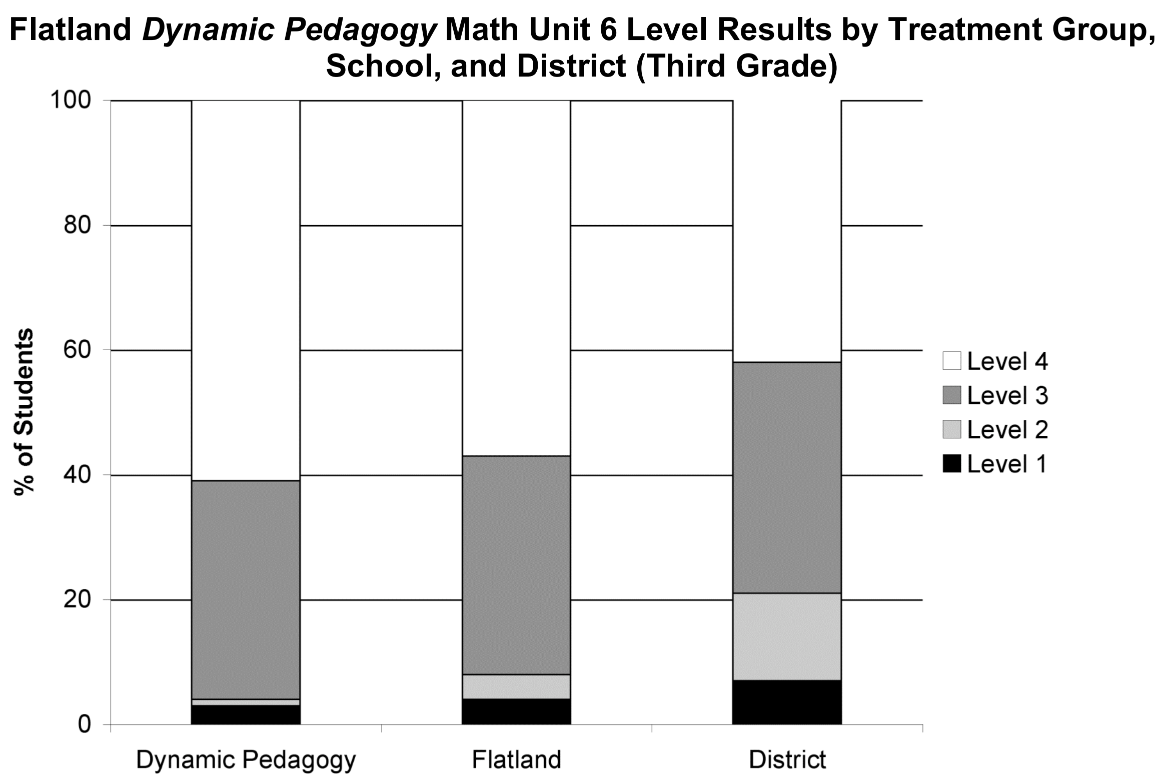
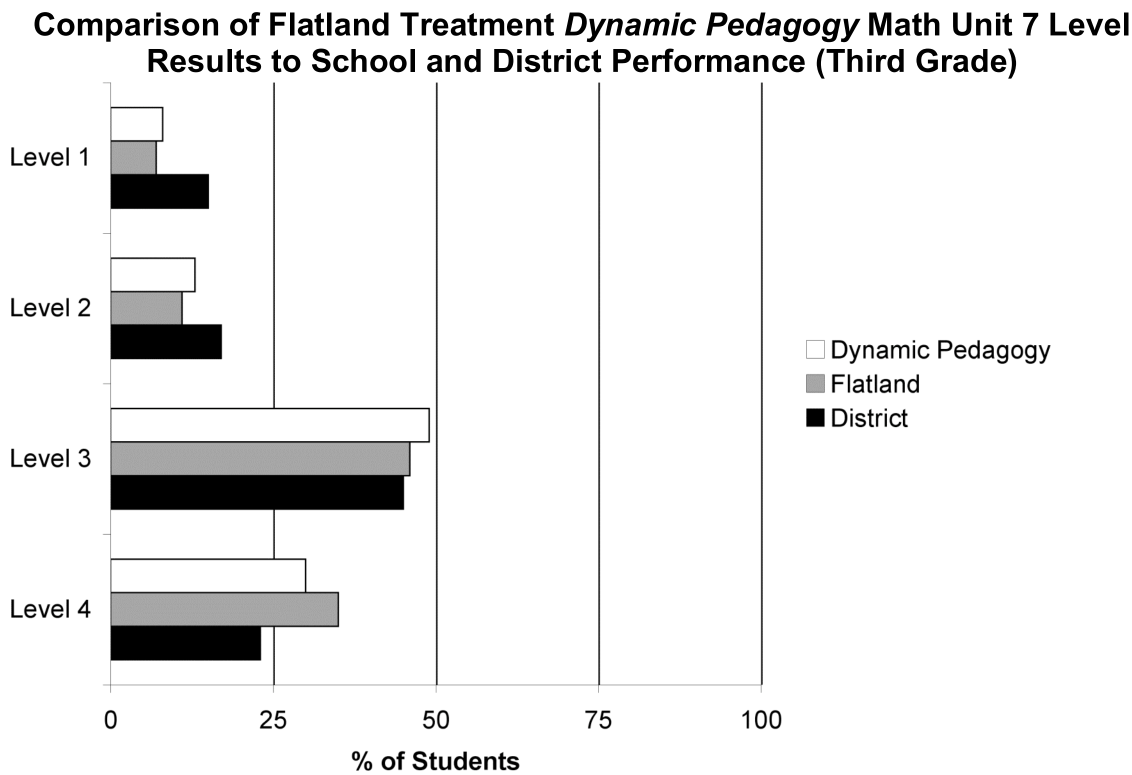


Figure 10. Comparison of Flatland Unit 6 to school and district performance (third grade).

Table 24

Flatland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 7

	***Dynamic Pedagogy* Group**			**Flatland**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	6	8	71	10	7	141	85	15	553
2	9	13	71	16	11	141	92	17	553
3	35	49	71	65	46	141	247	45	553
4	21	30	71	50	35	141	129	23	553



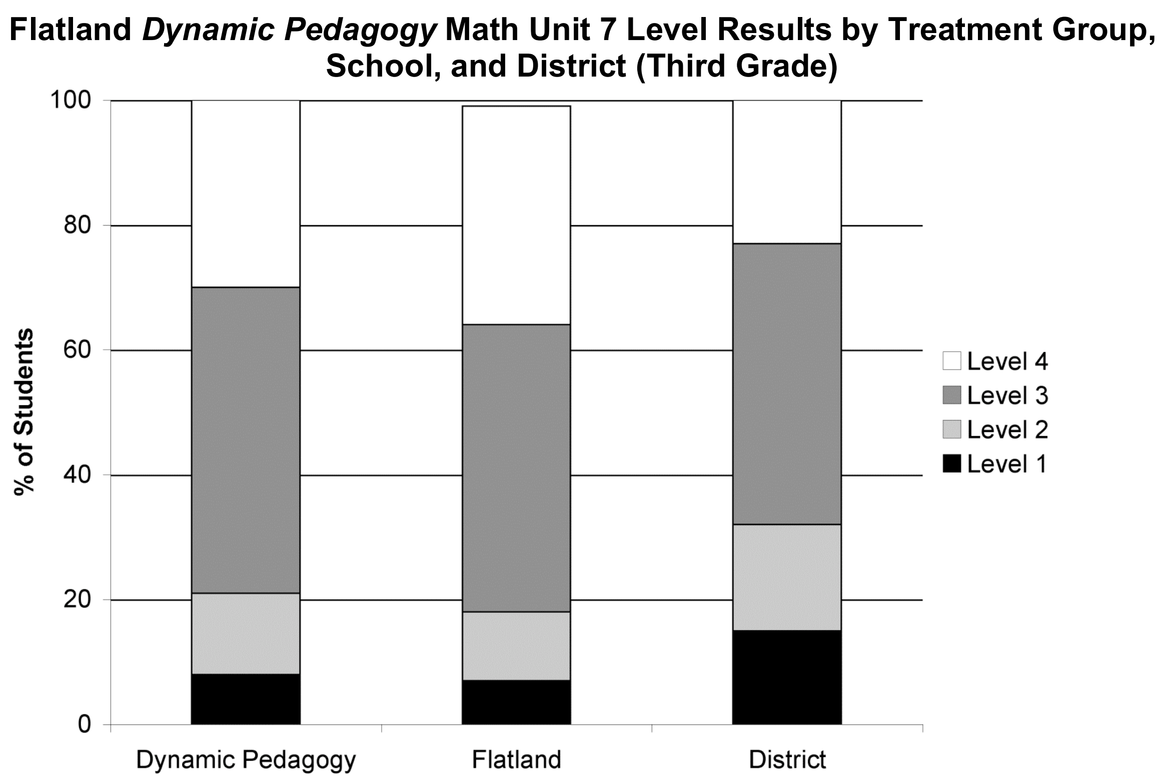
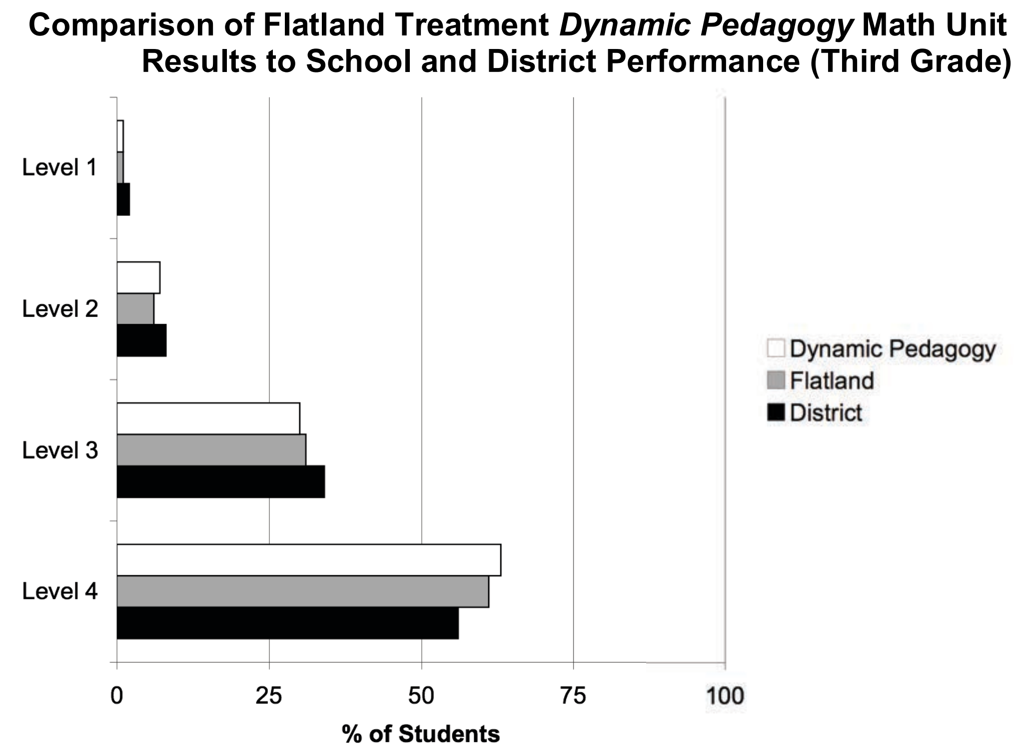


Figure 11. Comparison of Flatland Unit 7 to school and district performance (third grade).

Table 25

Flatland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 8

	***Dynamic Pedagogy* Group**			**Flatland**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	1	1	68	2	1	139	13	2	557
2	5	7	68	9	6	139	43	8	557
3	19	30	68	43	31	139	190	34	557
4	43	63	68	85	61	139	311	56	557



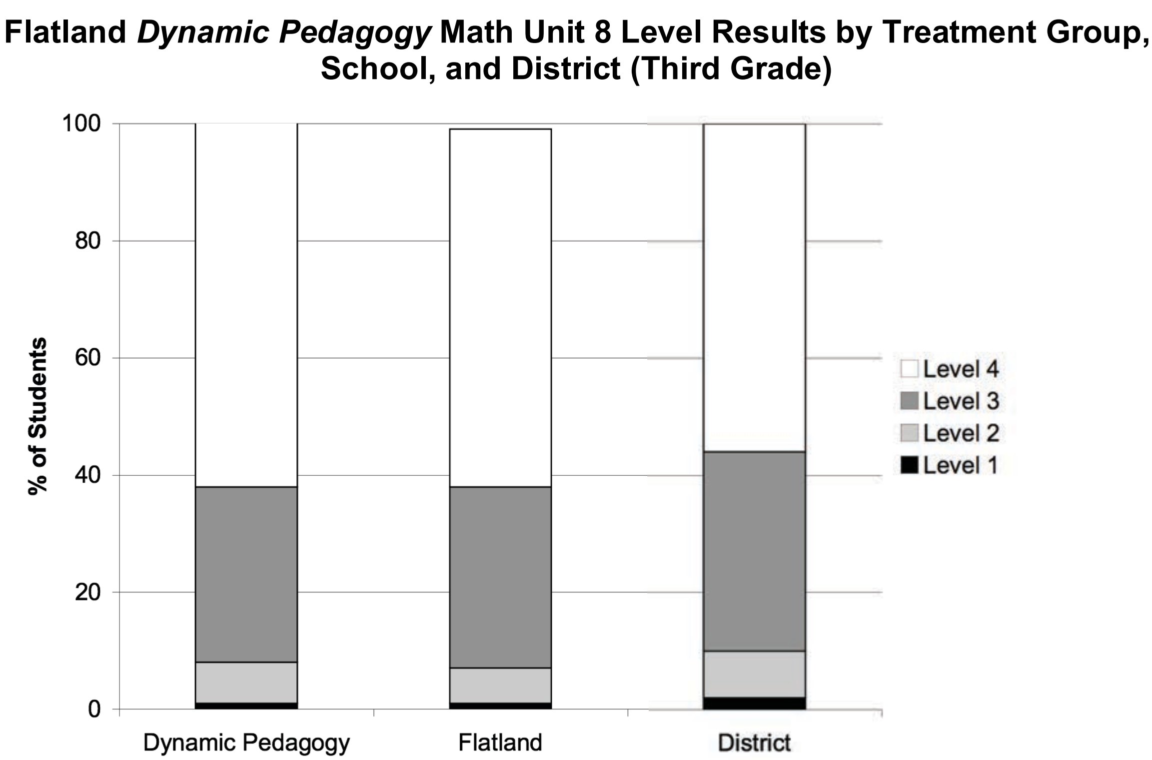


Figure 12. Comparison of Flatland Unit 8 to school and district performance (third grade).

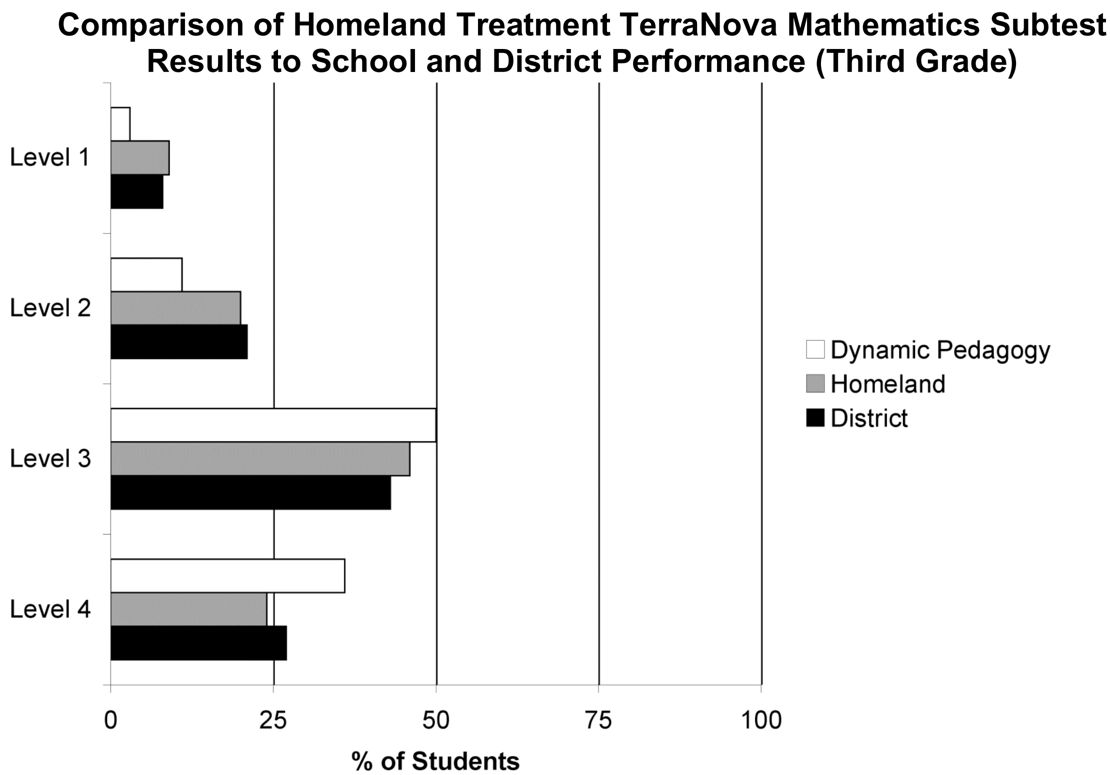
Homeland

The same pattern of achievement for *Dynamic Pedagogy* students compared with those of the school and district was found at Homeland. As Tables 26 through 31 and Figures 13 through 18 show, the *Dynamic Pedagogy* group had the lowest percentage of students who performed at the lowest level (level 1) on the TerraNova Mathematics Subtest and District Unit assessments. Like their peers at Flatland, the highest percentage of students who scored at the highest level (level 4) on both measures of achievement were from the *Dynamic Pedagogy* group.

Table 26

Homeland Level Analysis for Third Grade TerraNova Mathematics Subtest

	***Dynamic Pedagogy* Group**			**Homeland**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	2	3	70	11	9	119	49	8	577
2	8	11	70	24	20	119	124	21	577
3	35	50	70	55	46	119	246	43	577
4	25	36	70	29	24	119	158	27	577



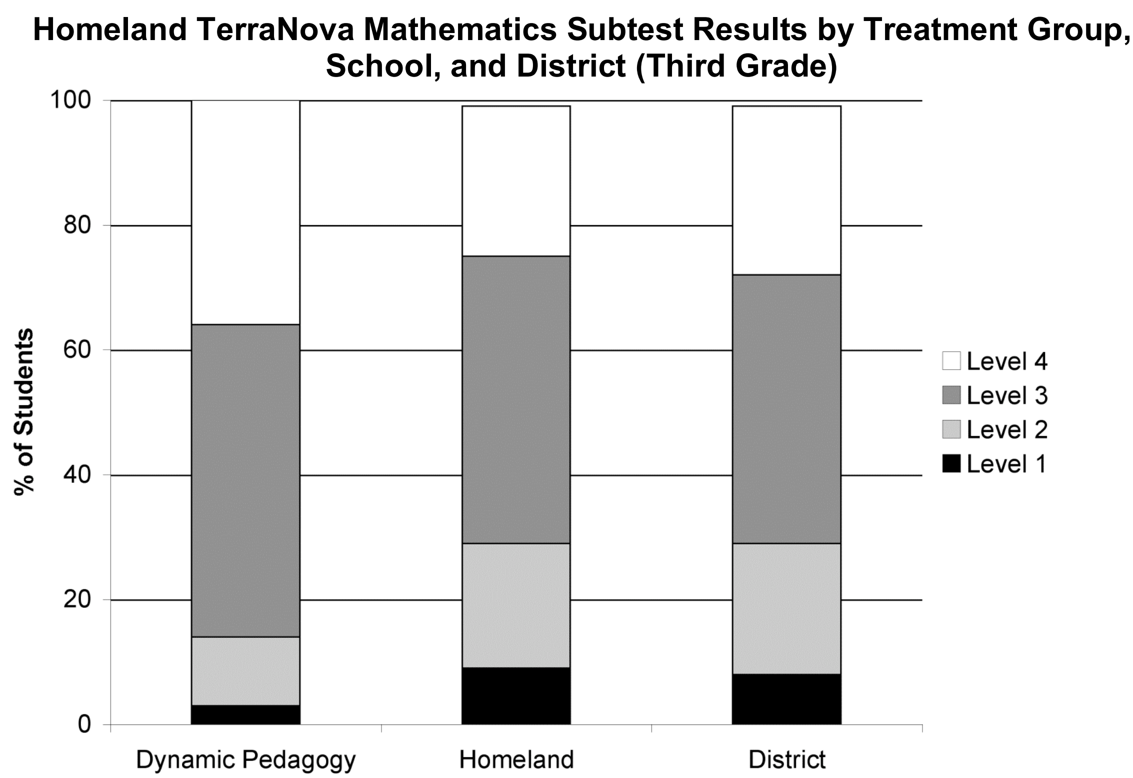
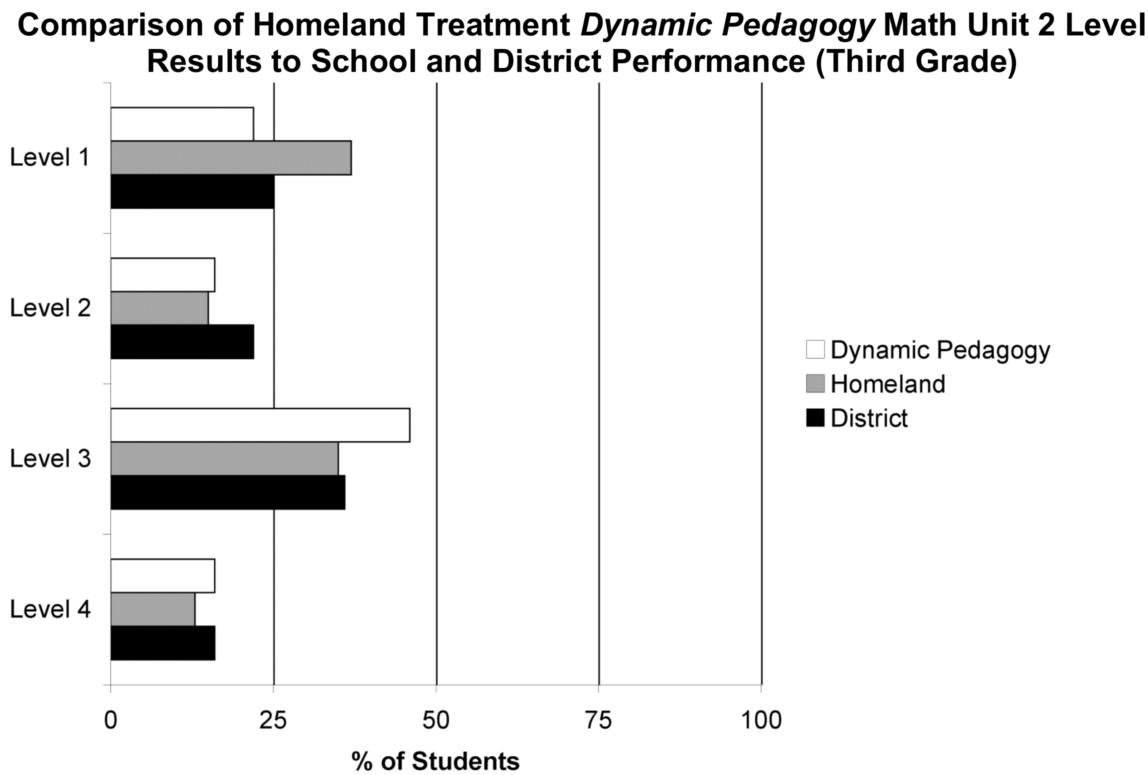


Figure 13. Comparison of Homeland TerraNova Mathematics Subtest to school and district performance (third grade).

Table 27

Homeland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 2

	***Dynamic Pedagogy* Group**			**Homeland**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	15	22	69	44	37	118	138	25	543
2	11	16	69	18	15	118	121	22	543
3	32	46	69	41	35	118	195	36	543
4	11	16	69	15	13	118	89	16	543



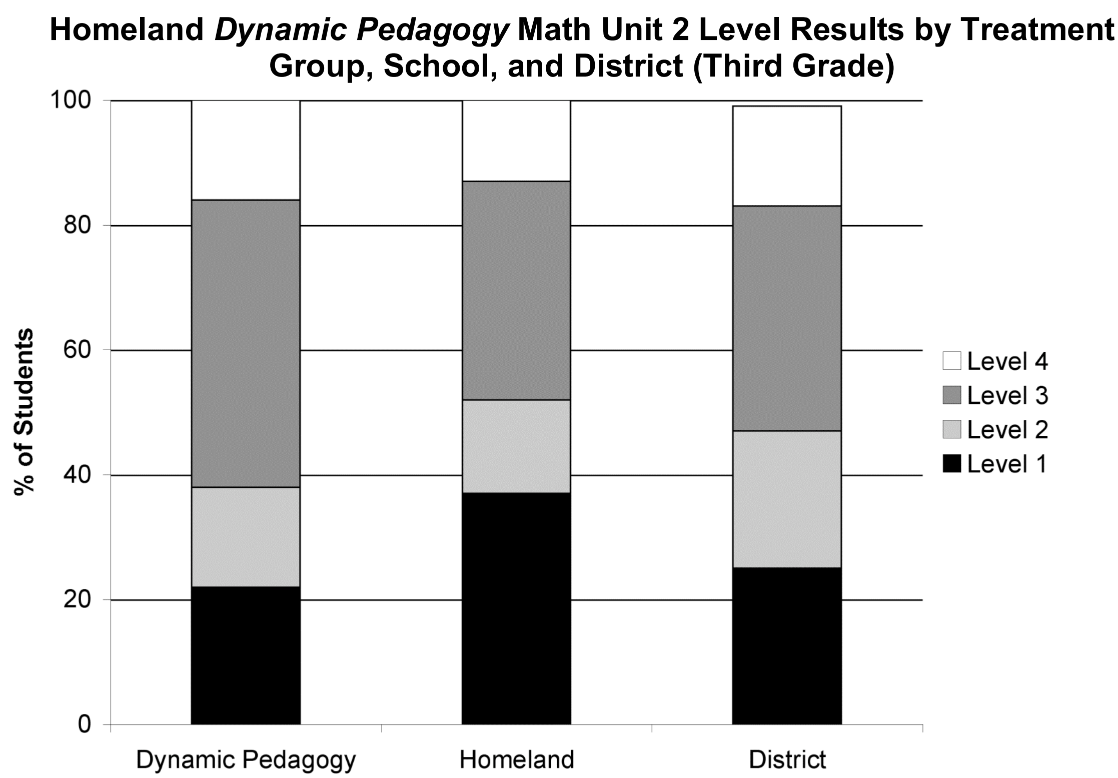
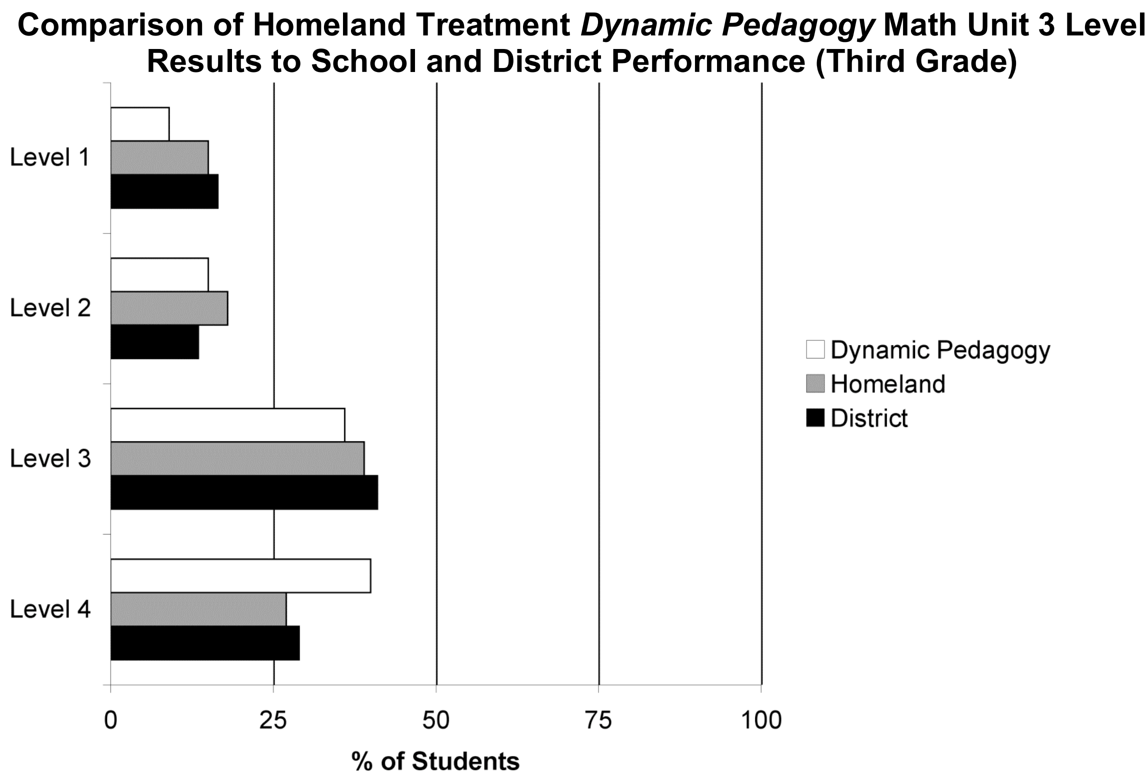


Figure 14. Comparison of Homeland Unit 2 to school and district performance (third grade).

Table 28

Homeland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 3

	***Dynamic Pedagogy* Group**			**Homeland**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	6	9	67	17	15	114	90	16.5	545
2	10	15	67	21	18	114	74	13.5	545
3	24	36	67	45	39	114	223	41	545
4	27	40	67	31	27	114	158	29	545



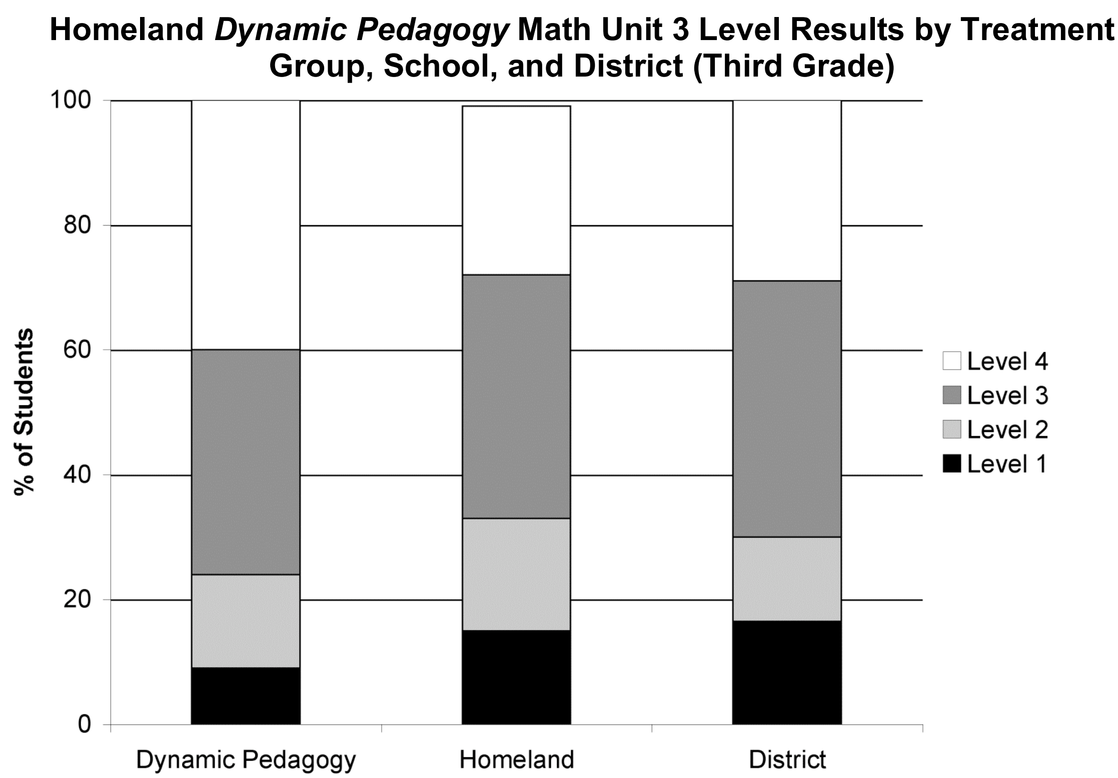
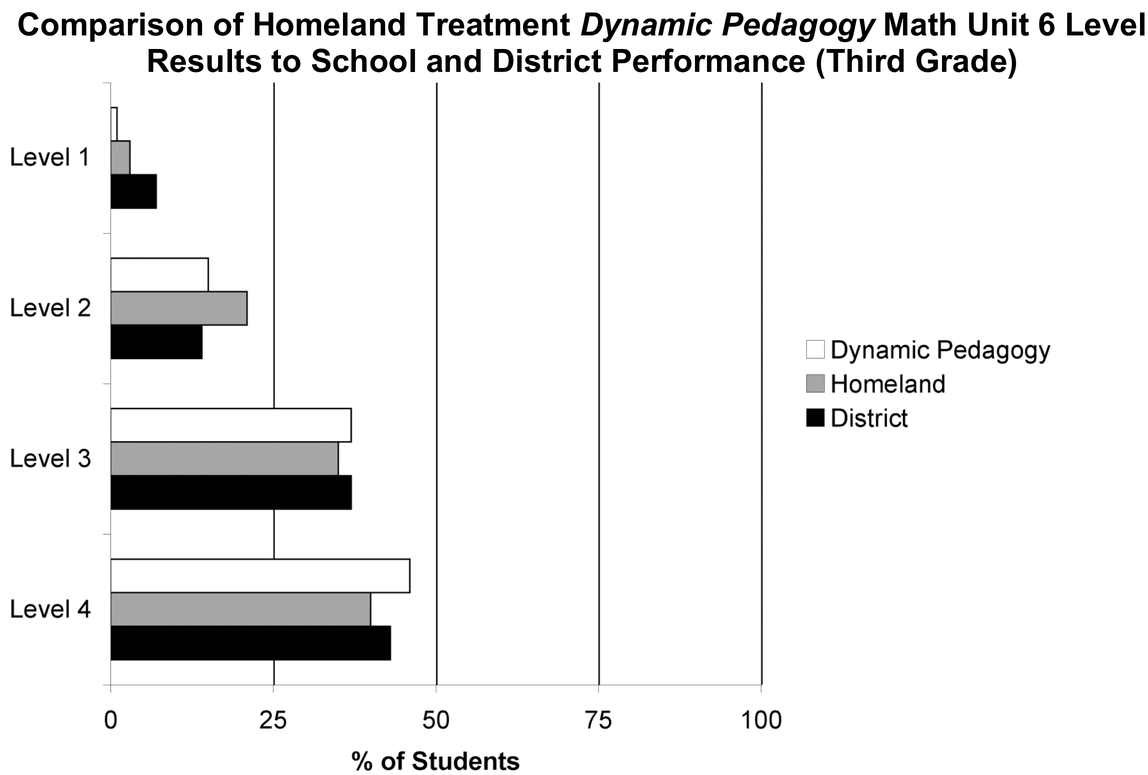


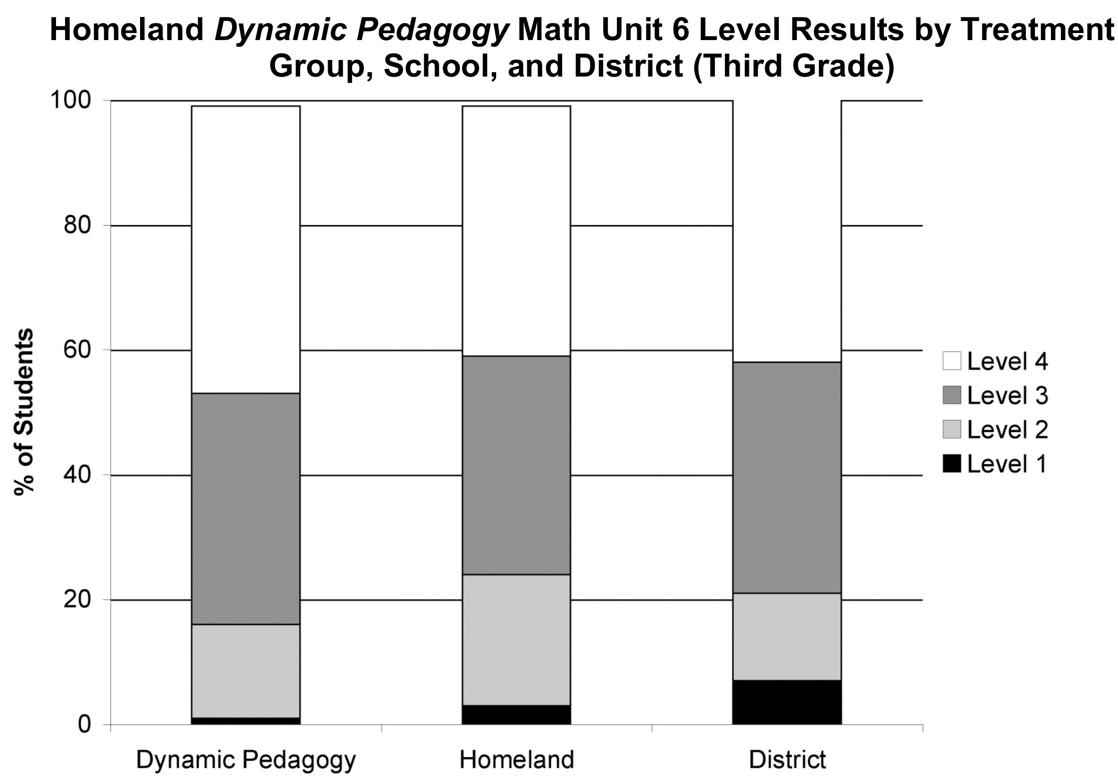
Figure 15. Comparison of Homeland Unit 3 to school and district performance (third grade).

Table 29

Homeland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 6

	***Dynamic Pedagogy* Group**			**Homeland**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	1	1	67	4	3	117	38	7	552
2	10	15	67	25	21	117	76	14	552
3	25	37	67	41	35	117	203	37	552
4	31	46	67	47	40	117	235	43	552



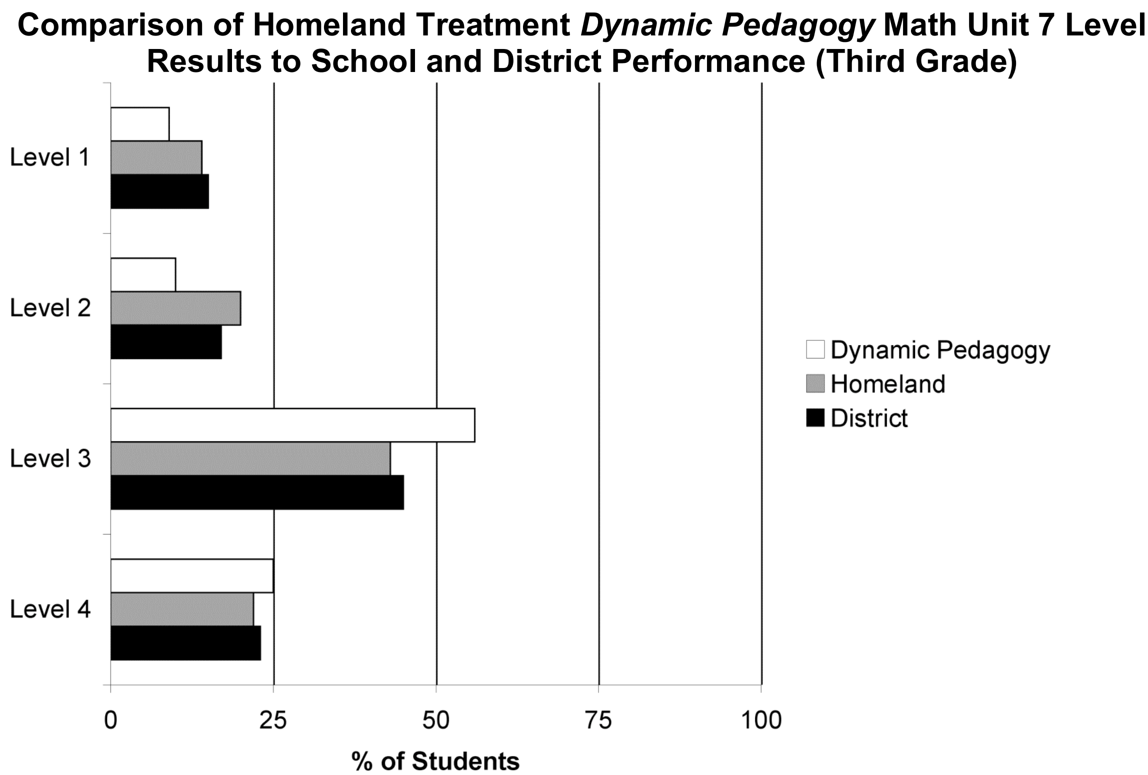


<u>Figure 16.</u> Comparison of Homeland Unit 6 to school and district performance (third grade).

Table 30

Homeland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 7

	***Dynamic Pedagogy* Group**			**Homeland**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	6	9	68	17	14	118	85	15	553
2	7	10	68	24	20	118	92	17	553
3	38	56	68	51	43	118	247	45	553
4	17	25	68	26	22	118	129	23	553



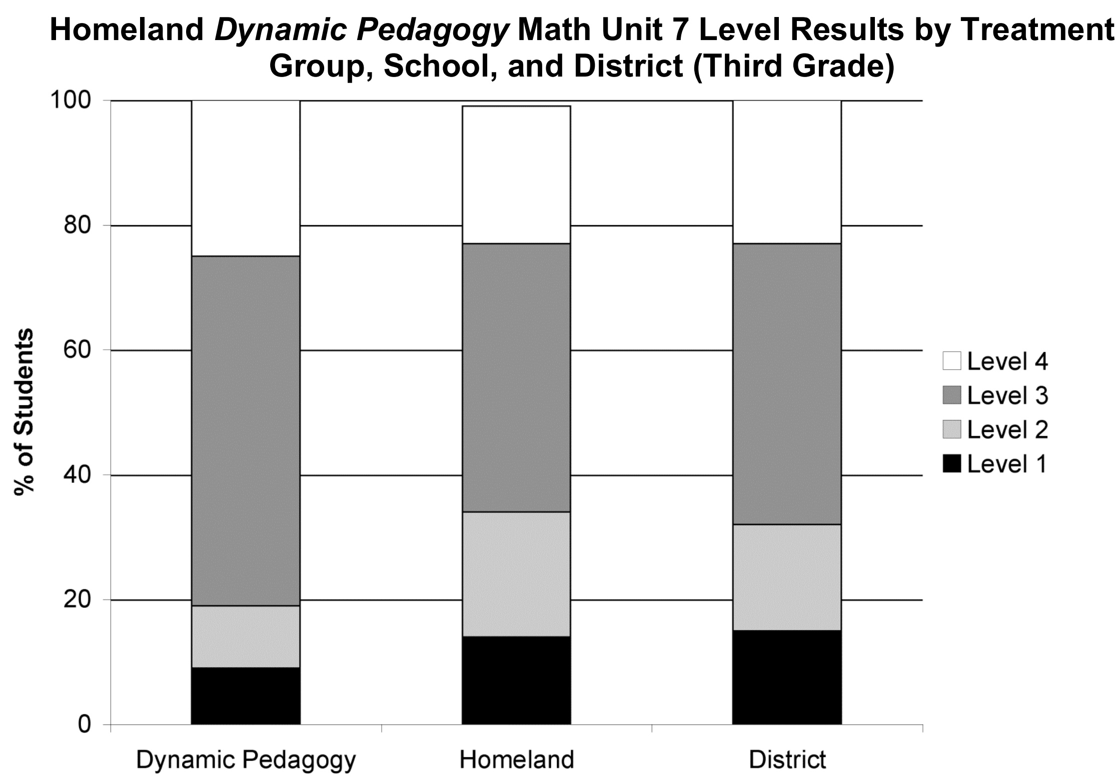
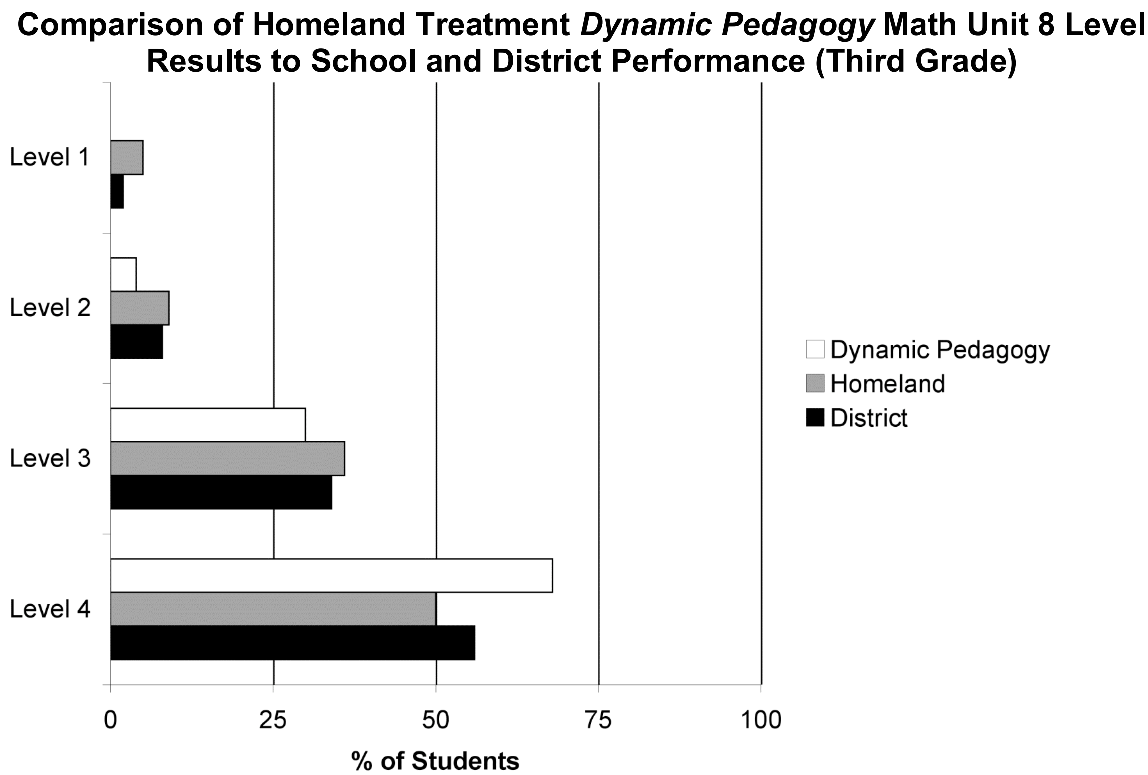


Figure 17. Comparison of Homeland Unit 7 to school and district performance (third grade).

Table 31

Homeland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 8

	***Dynamic Pedagogy* Group**			**Homeland**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	0	0	68	6	5	120	13	2	557
2	3	4	68	11	9	120	43	8	557
3	19	30	68	43	36	120	190	34	557
4	46	68	68	60	50	120	311	56	557



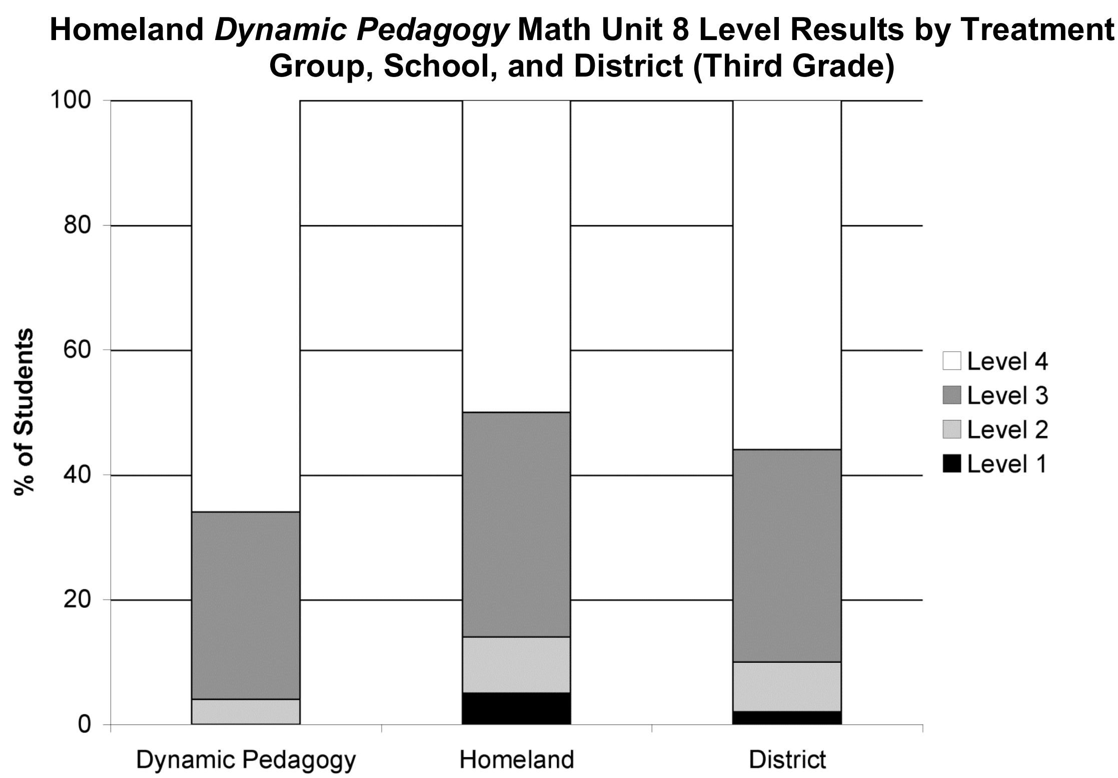


Figure 18. Comparison of Homeland Unit 8 to school and district performance (third grade).

Third Grade TerraNova Mathematics Subtest by School

To ascertain whether there were statistical differences in the performance of *Dynamic Pedagogy* and control groups, *t*-tests were used to analyze the scores of both groups on the TerraNova Mathematics Subtest. The results for each school follow.

Flatland

There were 136 valid cases for the third grade TerraNova Mathematics Subtest, comprising 70 cases in the *Dynamic Pedagogy* group and 66 cases in the non-*Dynamic Pedagogy* group. The mean score for the third grade TerraNova Mathematics Subtest in Flatland was 626.3 with a standard deviation of 40.0. The mean score of *Dynamic Pedagogy* students was higher than that of non-*Dynamic Pedagogy* ($\mu_{DP} = 633.1$, $\sigma_{DP} = 41.1$ vs. $\mu_{NDP} = 618.7$, $\sigma_{NDP} = 37.7$). *Dynamic Pedagogy* scores ranged from 518 to 740, while non-*Dynamic Pedagogy* students' scores ranged from 539 to 700. Scores from both conditions were positively skewed (.138 for *Dynamic Pedagogy* and .064 for non-*Dynamic Pedagogy*), indicating most scores were left of the distribution. Equal Variance for these 2 groups was assumed as the Levene's Test for Equality of Variance was non-significant, F = .009, p > .05. The *t*-test showed that the difference was significant, $t_{134} = 2.187$, $p < .05$.

Homeland

There were 119 valid cases for the third grade TerraNova Mathematics Subtest, comprising 70 cases in the *Dynamic Pedagogy* group and 49 cases in the non-*Dynamic Pedagogy* group. The mean score for the third grade TerraNova Mathematics Subtest in Homeland was 616.1 with a standard deviation of 40.0. The mean score of *Dynamic Pedagogy* students was higher than that of non-*Dynamic Pedagogy* ($\mu_{DP} = 630.1$, $\sigma_{DP} = 31.9$ vs. $\mu_{NDP} = 596.0$, $\sigma_{NDP} = 42.1$). *Dynamic Pedagogy* scores ranged from 547 to 718, while non-*Dynamic Pedagogy* students' scores ranged from 502 to 728. *Dynamic Pedagogy* scores were more negatively skewed compared to non-*Dynamic Pedagogy*'s positive skew (-.156 for *Dynamic Pedagogy* and .519 for non-*Dynamic Pedagogy*), indicating *Dynamic Pedagogy* had more scores to the right of the distribution and thus, had more subjects with higher scores. Equal Variance for these 2 groups was assumed as the Levene's Test for Equality of Variance was non-significant, F = 3.243, p > .05. The *t*-test showed that the difference was significant, $t_{117} = -5.031$, $p < .05$.

District Unit Assessments and TerraNova Mathematics Subtest by School and Teacher

Descriptive statistics were computed to ascertain whether differences obtained for students who were taught by teachers who participated in the study 1 year vs. 2 years. Table 32 shows the Mean and SD of students' performance on unit assessments and the standardized third grade (TerraNova Mathematics Subtest) test of the 2 groups of *Dynamic Pedagogy* teachers for each of the 2 schools, Flatland and Homeland.

Table 32

Descriptive Statistics Comparing First Year Teachers to Second Year Teachers by School for Units 2-8 and Third Grade TerraNova Achievement Subtest

Flatland		UNIT 2	UNIT 3	UNIT 4	UNIT 5	UNIT 6	UNIT 7	UNIT 8	THIRD TN
1st Year	Mean	21.97	23.10	14.44	23.66	28.37	21.11	16.65	626.67
	N	31	31	36	35	35	37	34	36
	SD	6.46	4.48	4.14	3.45	5.55	5.83	3.00	39.30
	Variance	41.73	20.07	17.14	11.90	30.80	33.99	9.00	1544.49
	Minimum	4.00	11.00	2.00	11.00	9.00	6.00	8.00	518.00
	Maximum	30.00	28.00	19.00	27.00	34.00	30.00	20.00	704.00
	Skewness	-1.275	-1.310	-.986	-1.671	-1.830	-.663	-1.056	-.586
2nd Year	Mean	22.68	22.84	16.41	22.88	29.44	23.50	17.06	640.76
	N	34	32	32	34	34	34	34	34
	SD	5.94	3.43	2.41	2.71	3.21	3.89	2.41	42.39
	Variance	35.28	11.76	5.81	7.34	10.30	15.13	5.81	1796.91
	Minimum	5.00	14.00	10.00	17.00	22.00	15.00	12.00	569.00
	Maximum	30.00	28.00	19.00	27.00	34.00	29.00	20.00	740.00
	Skewness	-.902	-.366	-.839	-.365	-.519	-.242	-.611	.693
Total	Mean	22.34	22.97	15.37	23.28	28.90	22.25	16.85	633.51
	N	65	63	68	69	69	71	68	70
	SD	6.15	3.95	3.55	3.11	4.55	5.11	2.71	41.15
	Variance	37.82	15.60	12.60	9.67	20.70	26.11	7.34	1693.32
	Minimum	4.00	11.00	2.00	11.00	9.00	6.00	8.00	518.00
	Maximum	30.00	28.00	19.00	27.00	34.00	30.00	20.00	740.00
	Skewness	-1.088	-.983	-1.287	-1.133	-1.877	-.799	-.942	.138

Table 32 (continued)

Descriptive Statistics Comparing First Year Teachers to Second Year Teachers by School for Units 2-8 and Third Grade TerraNova Achievement Subtest

Homeland		UNIT 2	UNIT 3	UNIT 4	UNIT 5	UNIT 6	UNIT 7	UNIT 8	THIRD TN
1st Year	Mean	16.86	20.06	15.57	21.83	26.34	22.94	16.94	624.39
	N	36	35	37	36	35	34	36	36
	SD	6.52	5.04	3.45	3.69	5.47	4.80	2.32	30.56
	Variance	42.51	25.40	11.90	13.62	29.92	23.04	5.38	933.91
	Minimum	4.00	7.00	6.00	14.00	17.00	13.00	11.00	547.00
	Maximum	29.00	28.00	19.00	26.00	34.00	30.00	20.00	684.00
	Skewness	-.279	-.655	-.991	-.870	-.258	-.393	-.615	-.167
2nd Year	Mean	22.55	22.59	16.13	21.67	27.38	21.44	17.59	636.24
	N	33	32	32	33	32	34	32	34
	SD	5.09	4.30	2.65	4.72	5.29	4.78	2.18	32.53
	Variance	25.91	18.49	7.02	22.28	27.98	22.85	32.04	1058.20
	Minimum	8.00	13.00	10.00	8.00	9.00	10.00	12.00	561.00
	Maximum	30.00	28.00	19.00	27.00	34.00	28.00	20.00	718.00
	Skewness	-1.455	-1.126	-.955	-1.344	-1.523	-.893	-1.048	-.238
Total	Mean	19.58	21.27	15.83	21.75	26.84	22.19	17.25	630.14
	N	69	67	69	69	67	68	68	70
	SD	6.50	4.84	3.10	4.18	5.37	4.82	2.26	31.86
	Variance	42.25	23.43	9.61	17.47	28.84	23.23	5.11	1015.06
	Minimum	4.00	7.00	6.00	8.00	9.00	10.00	11.00	547.00
	Maximum	30.00	28.00	19.00	27.00	34.00	30.00	20.00	718.00
	Skewness	-.714	-.847	-1.042	-1.193	-.808	-.601	-.783	-.156

What follows is a comparison of the two groups by school using *t*-tests to ascertain whether there were statistical differences in the performance of their students on both the District Unit assessments and the TerraNova Mathematics Subtest.

Third Grade TerraNova Mathematics Subtest by School and Teacher

Flatland

There were 70 valid cases for the third grade TerraNova Mathematics Subtest, comprising 34 cases in classrooms with second year teachers and 36 cases were in classrooms with first year teachers. The mean score for the third grade TerraNova Mathematics Subtest in Flatland was 633.5 with a standard deviation of 41.1. The mean score of students in second year classrooms was higher than that of the students in the first year classrooms ($\mu_{2nd} = 640.8$, $\sigma_{2nd} = 42.4$ vs. $\mu_{1st} = 626.7$, $\sigma_{1st} = 39.3$). Scores in the second year classrooms ranged from 569 to 740, while students' scores in the first year classrooms ranged from 518 to 704. Scores from the first year classrooms were negatively skewed compared to the second year's positive skew (-.586 for first year and .693 for second year), indicating that first year has more scores that were to the right of the distribution. An independent *t*-test showed the difference was not statistically significant, $t_{68} = -1.444$, p > .05. The Levene's Test for Equality of Variance showed equal variance assumed, F = .026, $p > .05$.

Homeland

There were 70 valid cases for the third grade TerraNova Mathematics Subtest, comprising 34 cases in classrooms with second year teachers and 36 cases were in classrooms with first year teachers. The mean score for the third grade TerraNova Mathematics Subtest in Homeland was 630.1 with a standard deviation of 41.9. The mean score of students in second year classrooms was higher than that of the students in the first year classrooms ($\mu_{2nd} = 636.2$, $\sigma_{2nd} = 32.5$ vs. $\mu_{1st} = 624.4$, $\sigma_{1st} = 30.6$). Scores in the second year classrooms ranged from 561 to 718, while students' scores in the first year classrooms ranged from 547 to 784. Scores from both conditions were negatively skewed (-.167 for first year and -.238 for second year), indicating that most scores were slightly to the right of the distribution. An independent *t*-test showed the difference was not statistically significant, $t_{68} = -1.571$, $p > .05$. The Levene's Test for Equality of Variance showed equal variance assumed, F = .082, $p > .05$.

Achievement Levels on the TerraNova Mathematics Subtest and District Unit Assessments by School and Teacher

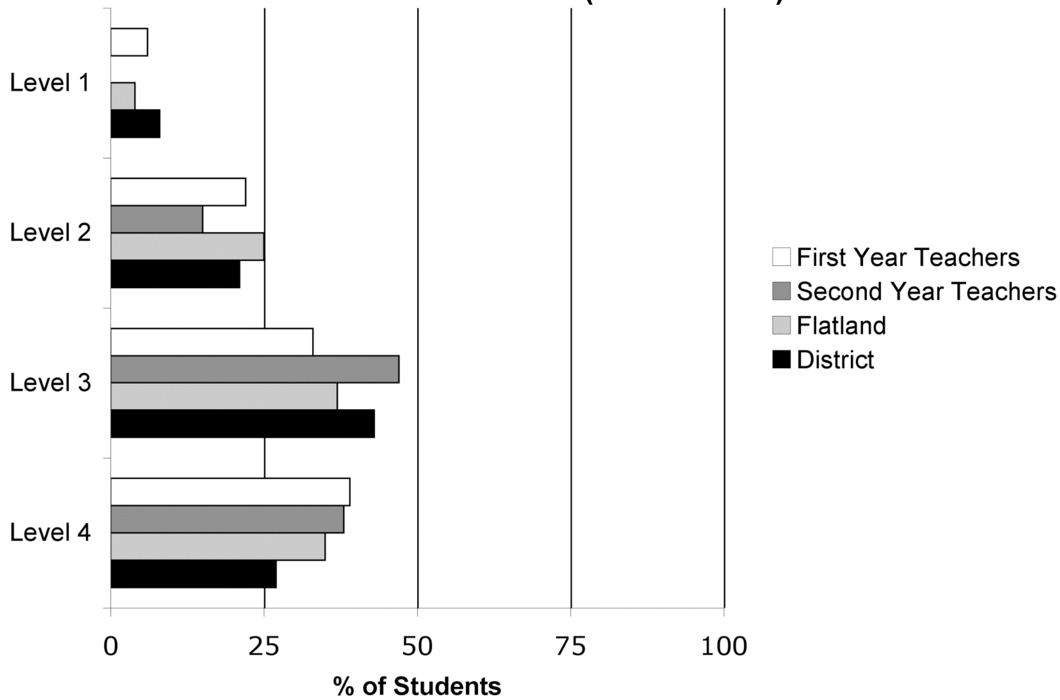
Descriptive analyses were also done comparing the level of achievement on the TerraNova Mathematics Subtest and the District's unit assessments of students taught by teachers with 1 and 2 years of *Dynamic Pedagogy* experience vs. their peers in non-*Dynamic Pedagogy* classrooms at the same grades level within the school and across the district. These results are presented in Tables 33 through 44 and Figures 19 through 30.

Table 33

Flatland Level Analysis for Third Grade TerraNova Mathematics Subtest by First and Second Year Teachers

	Flatland First Year Teachers			Flatland Second Year Teachers			Flatland School Level			District		
	f	*%*	*N*	*f*	*%*	*N*	*f*	*%*	*N*	*f*	*%*	*N*
Achievement Level												
1	2	6	36	0	0	34	5	4	136	49	8	577
2	8	22	36	5	15	34	34	25	136	124	21	577
3	12	33	36	16	47	34	50	37	136	246	43	577
4	14	39	36	13	38	34	47	35	136	158	27	577

Comparison of Flatland First and Second Year Treatment Teachers' TerraNova Mathematics Subtest Results to School and District Performance (Third Grade)



Flatland TerraNova Mathematics Subtest Results by First Year Treatment Teachers, Second Year Treatment Teachers, School, and District (Third Grade)

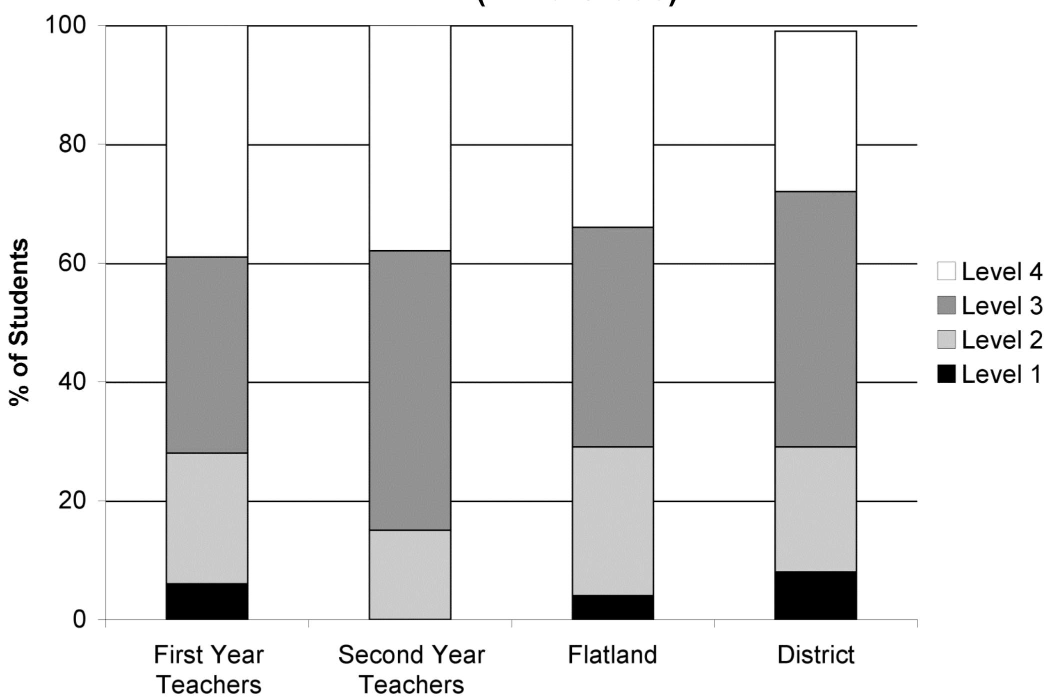
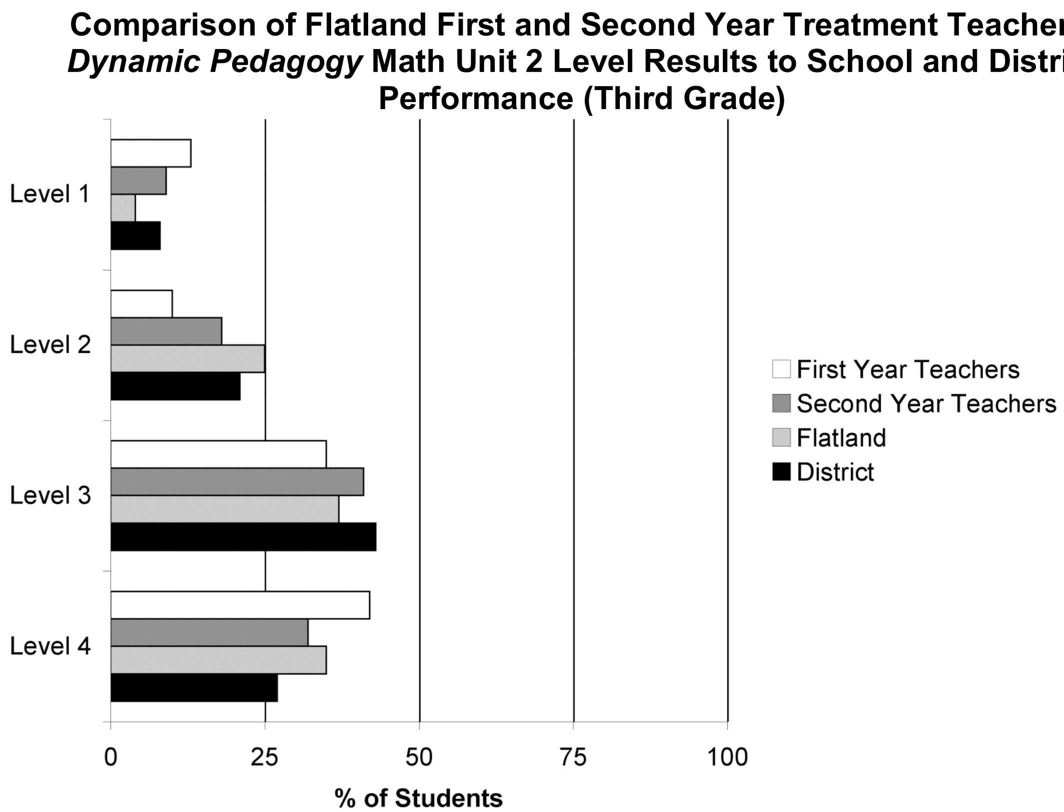


Figure 19. Comparison of Flatland first and second year treatment teachers' TerraNova Mathematics Subtest results to school and district performance (third grade).

Table 34

Flatland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 2 by First and Second Year *Dynamic Pedagogy* Teachers

	Flatland First Year Teachers			**Flatland Second Year Teachers**			**Flatland School Level**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level												
1	4	13	31	3	9	34	5	4	136	49	8	577
2	3	10	31	6	18	34	34	25	136	124	21	577
3	11	35	31	14	41	34	50	37	136	246	43	577
4	13	42	31	11	32	34	47	35	136	158	27	577



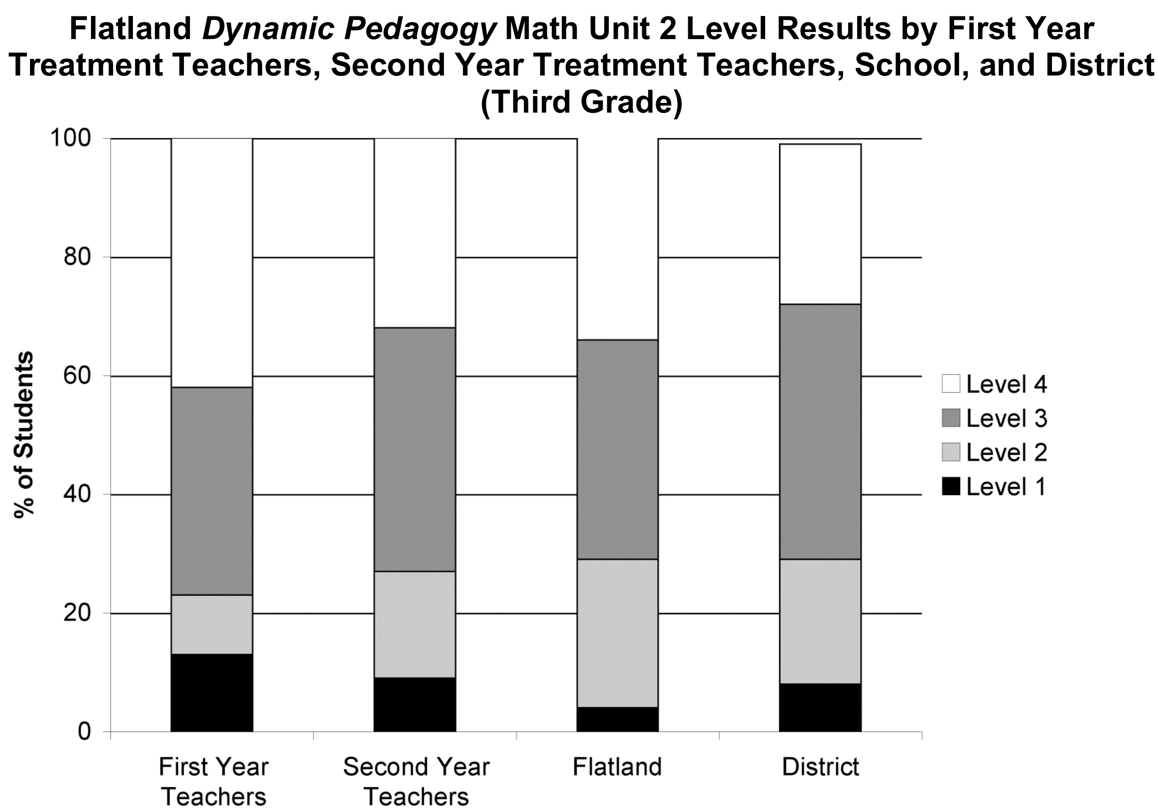
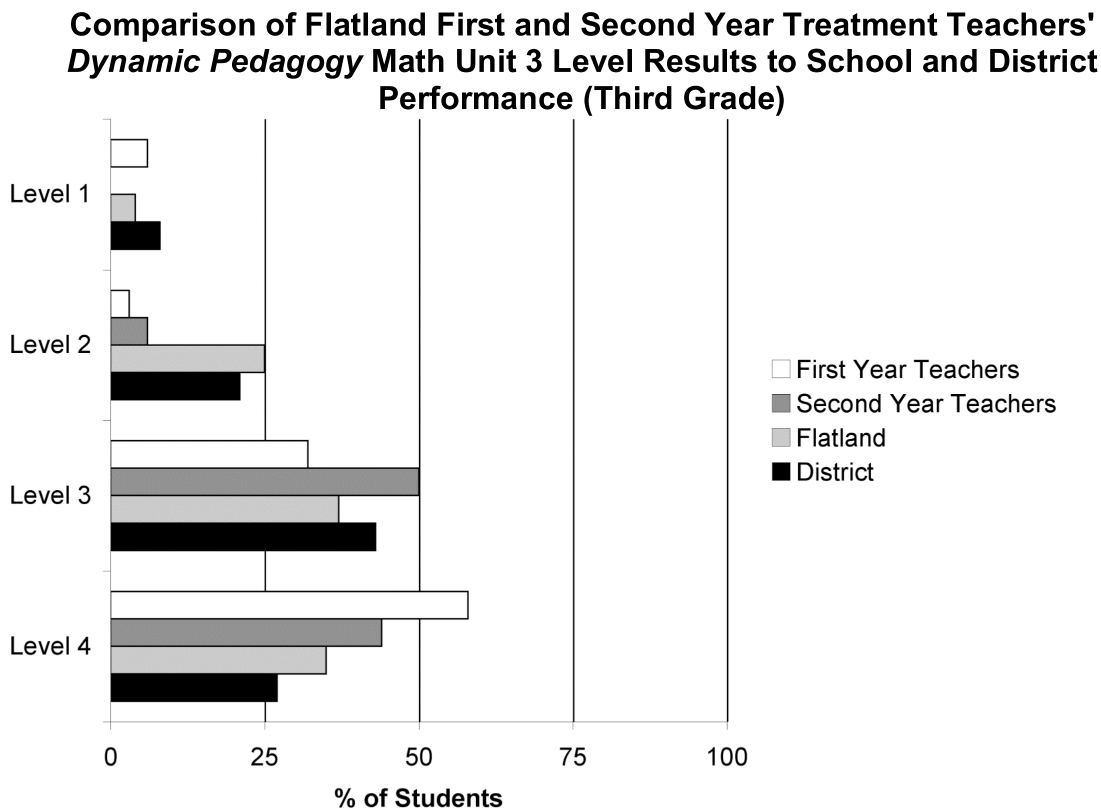


Figure 20. Comparison of Flatland first and second year treatment teachers' *Dynamic Pedagogy* Unit 2 results to school and district performance (third grade).

Table 35

Flatland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 3 by First and Second Year *Dynamic Pedagogy* Teachers

	Flatland First Year Teachers			**Flatland Second Year Teachers**			**Flatland School Level**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level												
1	2	6	31	0	0	32	5	4	136	49	8	577
2	1	3	31	2	6	32	34	25	136	124	21	577
3	10	32	31	16	50	32	50	37	136	246	43	577
4	18	58	31	14	44	32	47	35	136	158	27	577



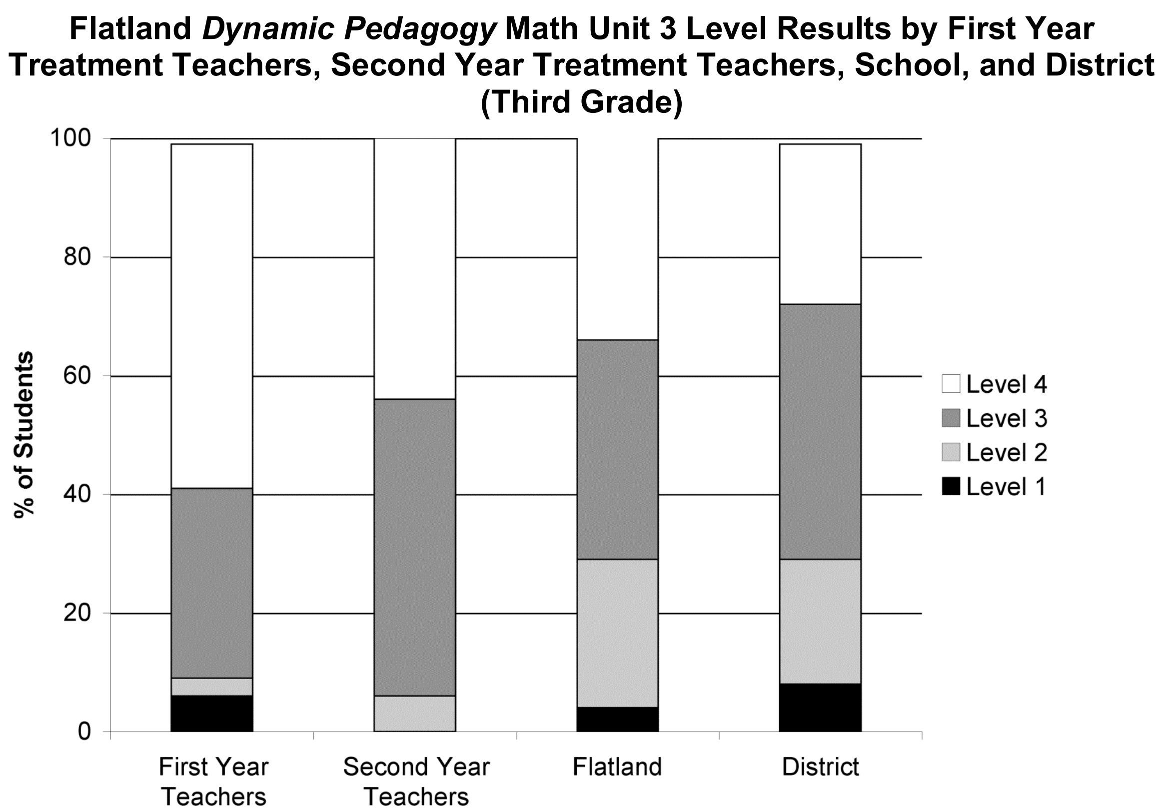
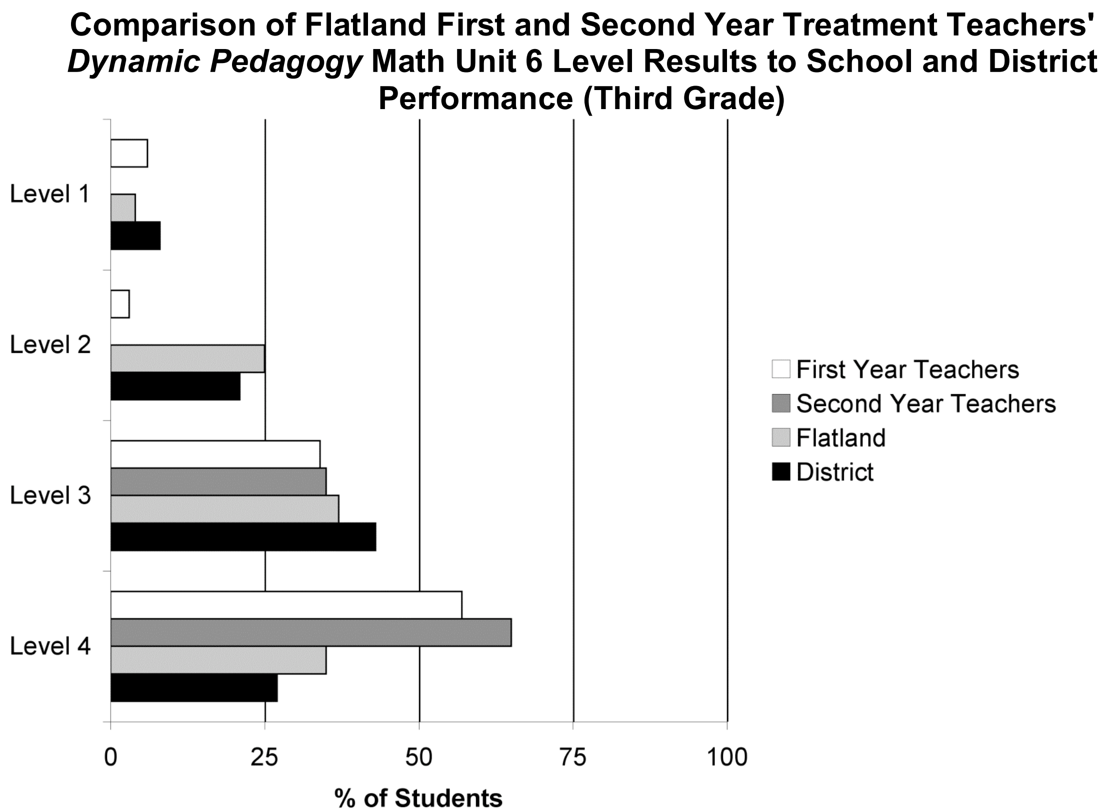


Figure 21. Comparison of Flatland first and second year treatment teachers' *Dynamic Pedagogy* Unit 3 results to school and district performance (third grade).

Table 36

Flatland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 6 by First and Second Year *Dynamic Pedagogy* Teachers

	Flatland First Year Teachers			**Flatland Second Year Teachers**			**Flatland School Level**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level												
1	2	6	35	0	0	34	5	4	136	49	8	577
2	1	3	35	0	0	34	34	25	136	124	21	577
3	12	34	35	12	35	34	50	37	136	246	43	577
4	20	57	35	22	65	34	47	35	136	158	27	577



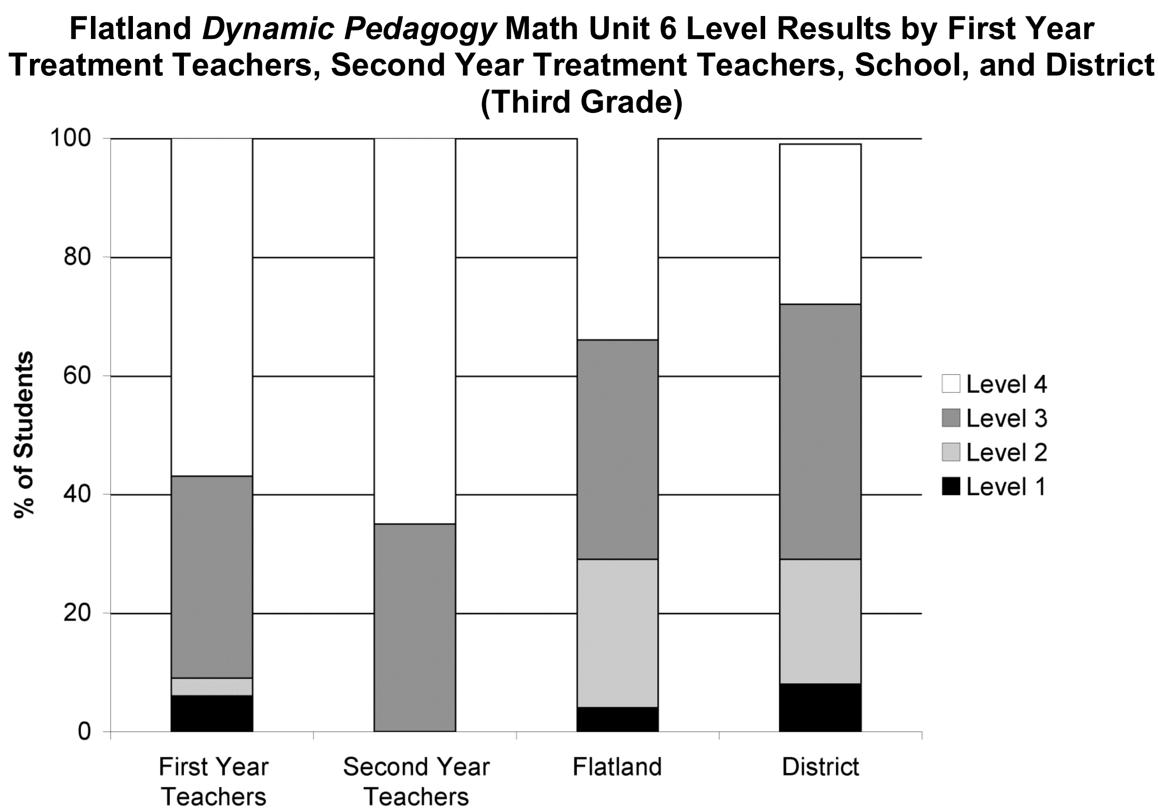
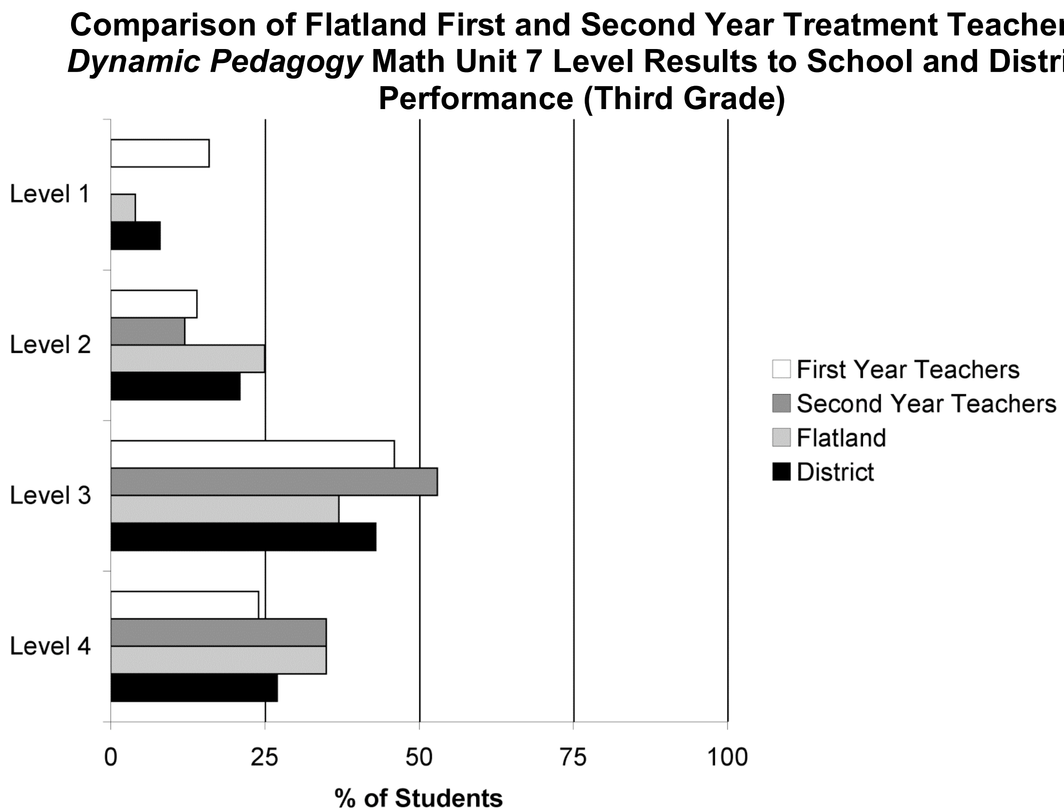


Figure 22. Comparison of Flatland first and second year treatment teachers' *Dynamic Pedagogy* Unit 6 results to school and district performance (third grade).

Table 37

Flatland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 7 by First and Second Year *Dynamic Pedagogy* Teachers

	Flatland First Year Teachers			**Flatland Second Year Teachers**			**Flatland School Level**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level												
1	6	16	37	0	0	34	5	4	136	49	8	577
2	5	14	37	4	12	34	34	25	136	124	21	577
3	17	46	37	18	53	34	50	37	136	246	43	577
4	9	24	37	12	35	34	47	35	136	158	27	577



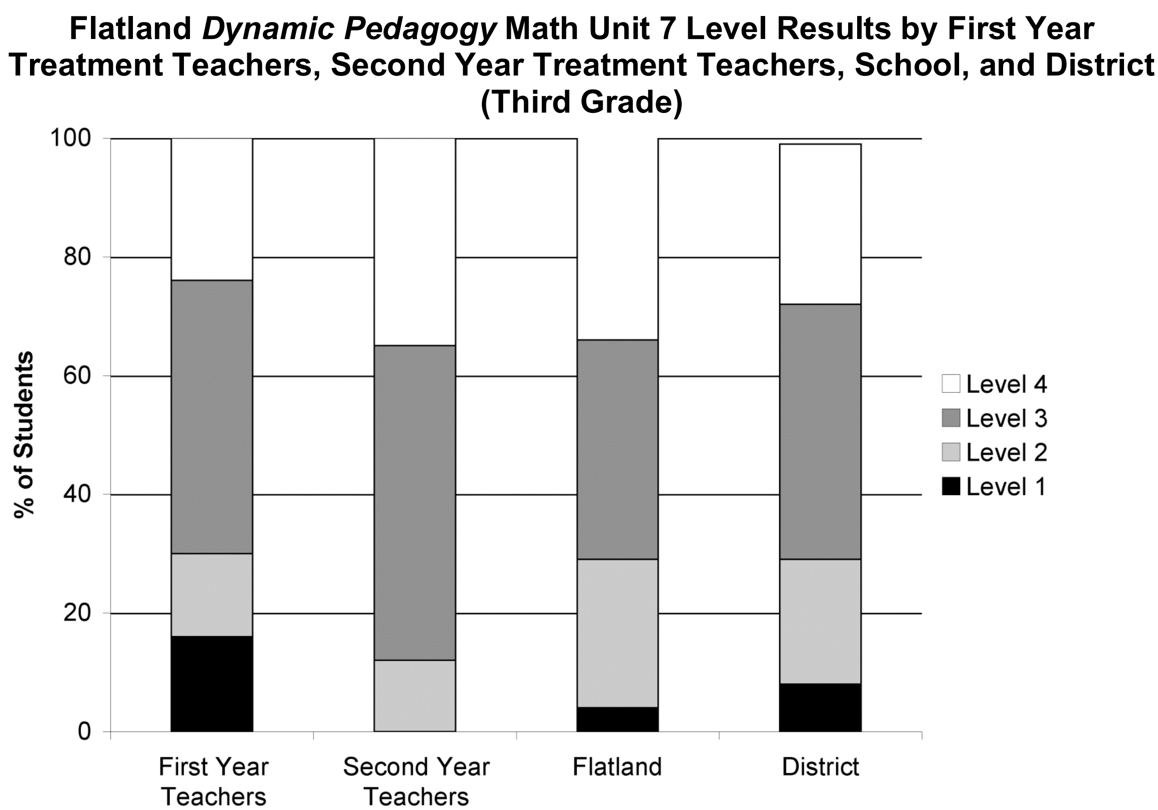
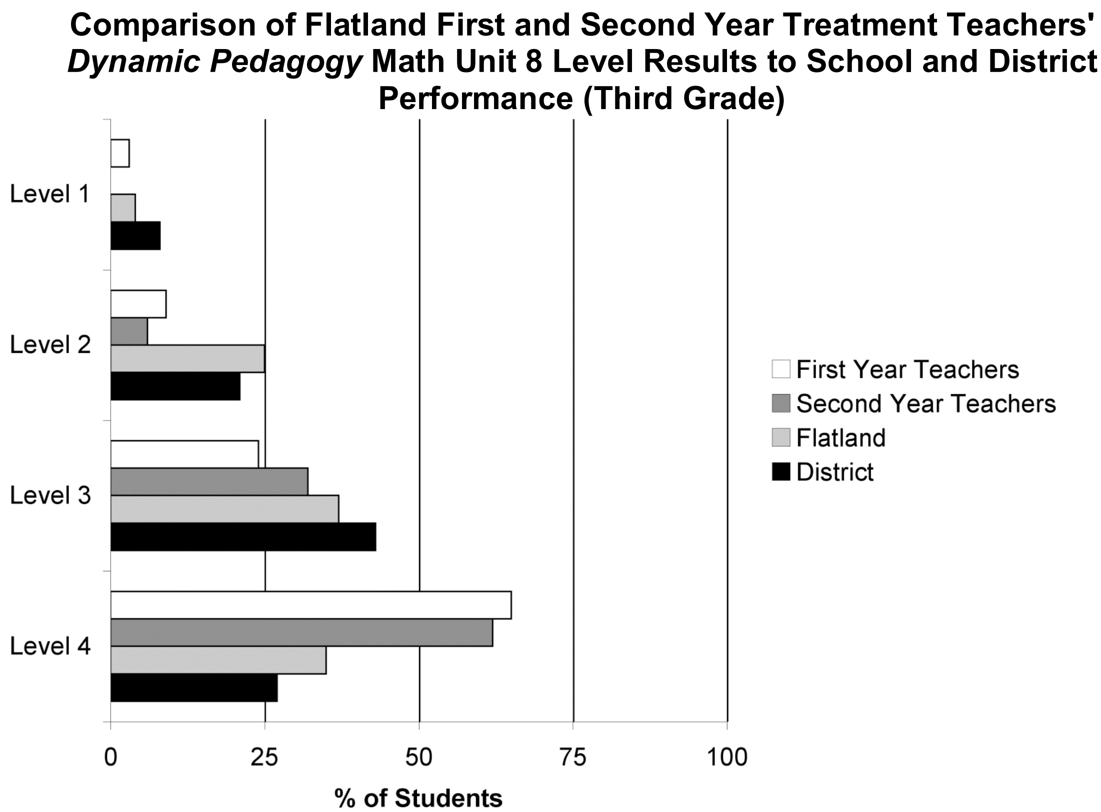


Figure 23. Comparison of Flatland first and second year treatment teachers' *Dynamic Pedagogy* Unit 7 results to school and district performance (third grade).

Table 38

<u>Flatland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 8 by First and Second Year *Dynamic Pedagogy* Teachers</u>

	Flatland First Year Teachers			**Flatland Second Year Teachers**			**Flatland School Level**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level												
1	1	3	34	0	0	34	5	4	136	49	8	577
2	3	9	34	2	6	34	34	25	136	124	21	577
3	8	24	34	11	32	34	50	37	136	246	43	577
4	22	65	34	21	62	34	47	35	136	158	27	577



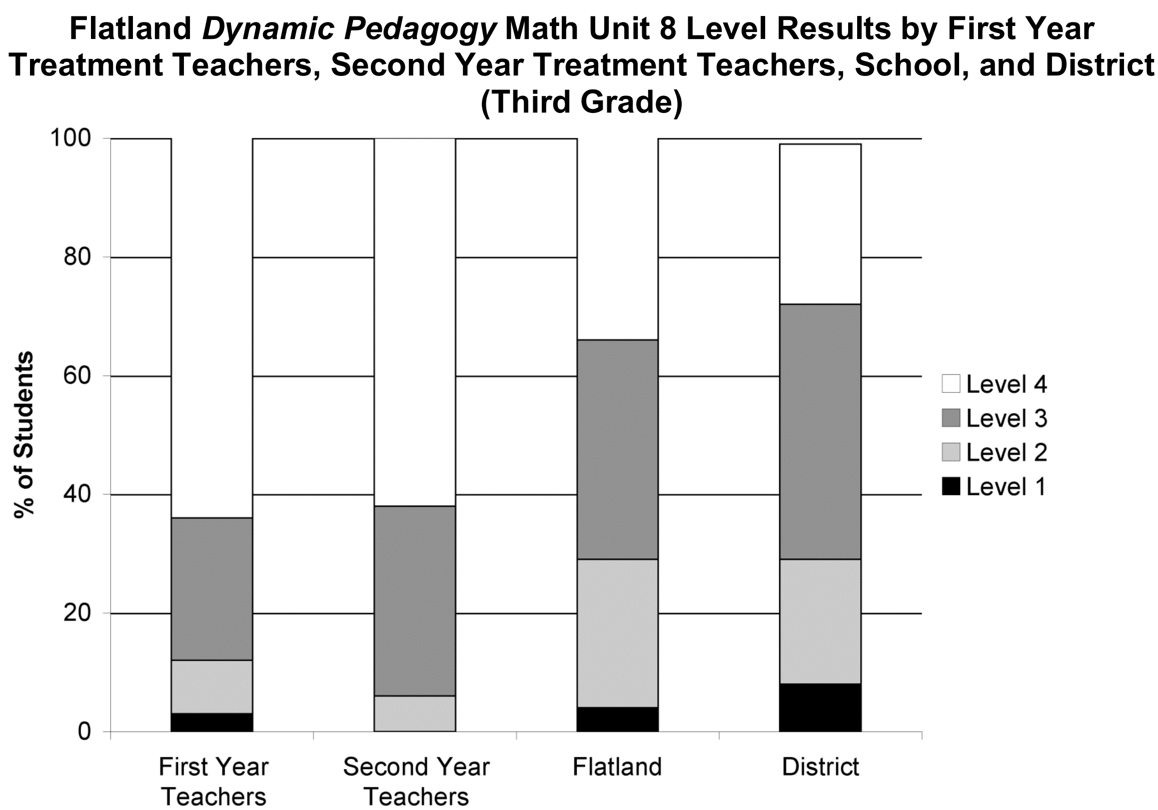
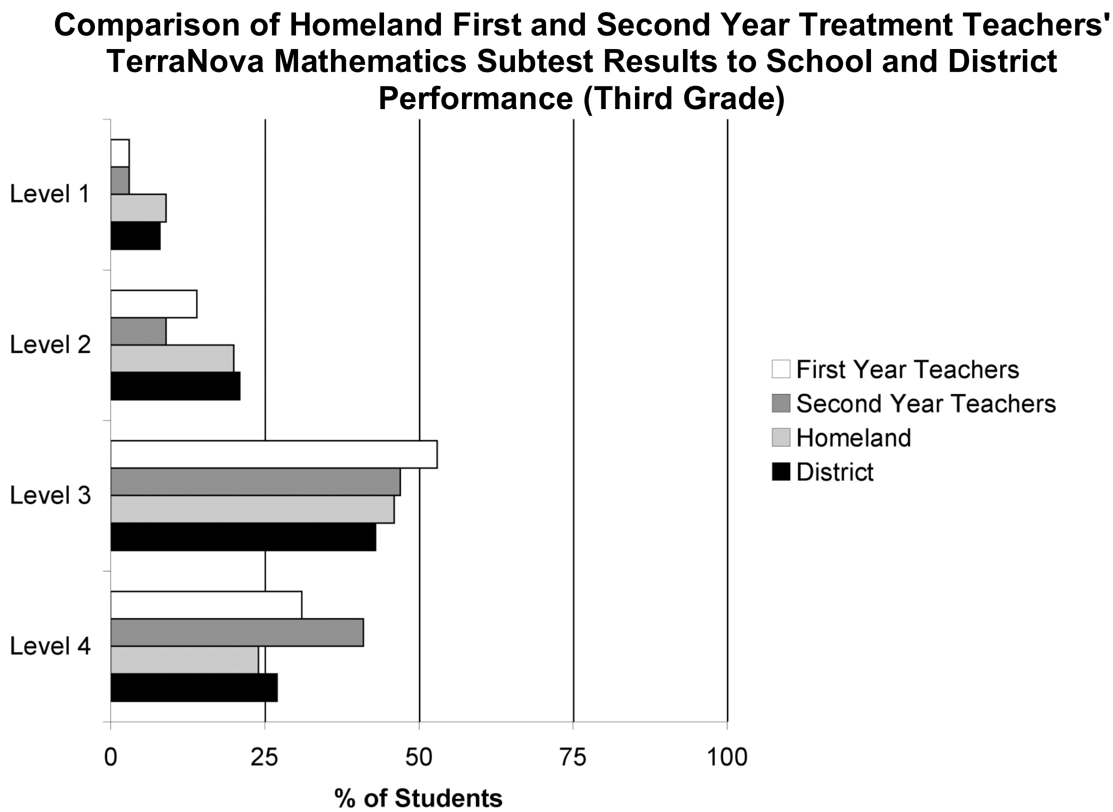


Figure 24. Comparison of Flatland first and second year treatment teachers' *Dynamic Pedagogy* Unit 8 results to school and district performance (third grade).

Table 39

Homeland Level Analysis for Third Grade TerraNova Mathematics Subtest by First and Second Year *Dynamic Pedagogy* Teachers

	Homeland First Year Teachers			**Homeland Second Year Teachers**			**Homeland School Level**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level												
1	1	3	36	1	3	34	11	9	119	49	8	577
2	5	14	36	3	9	34	24	20	119	124	21	577
3	19	53	36	16	47	34	55	46	119	246	43	577
4	11	31	36	14	65	34	29	24	119	158	27	577



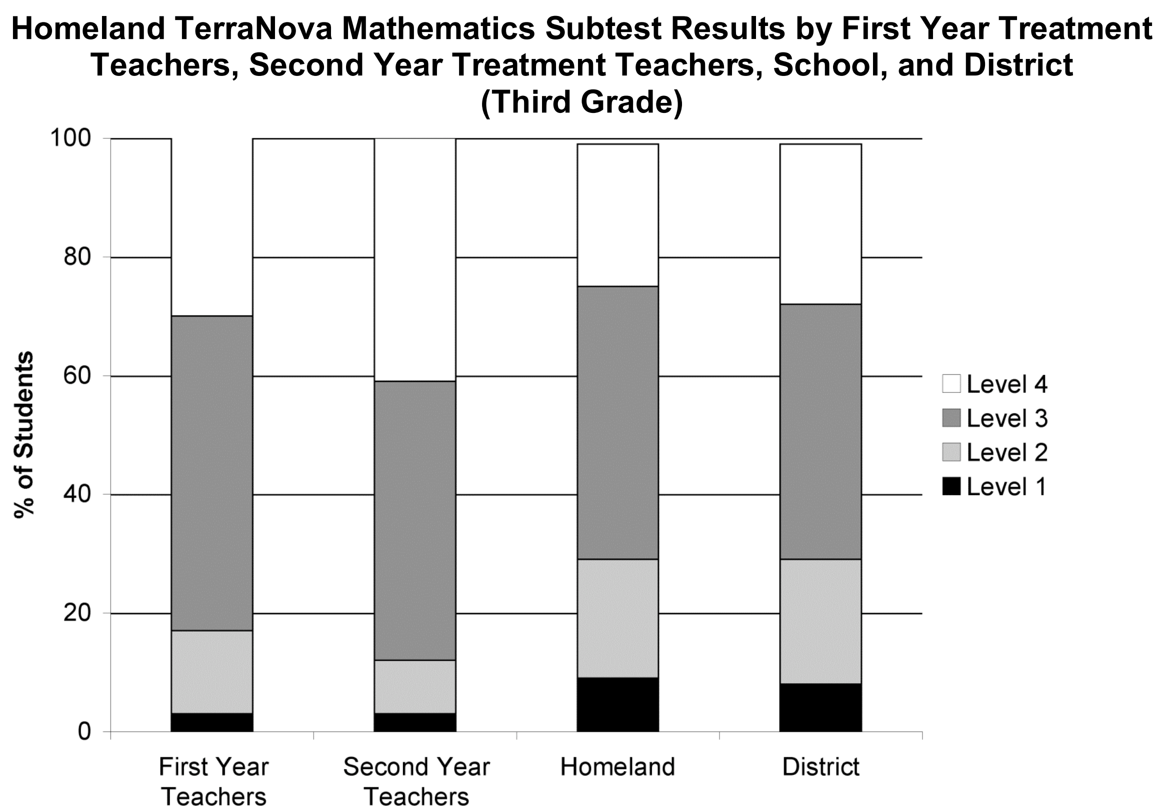
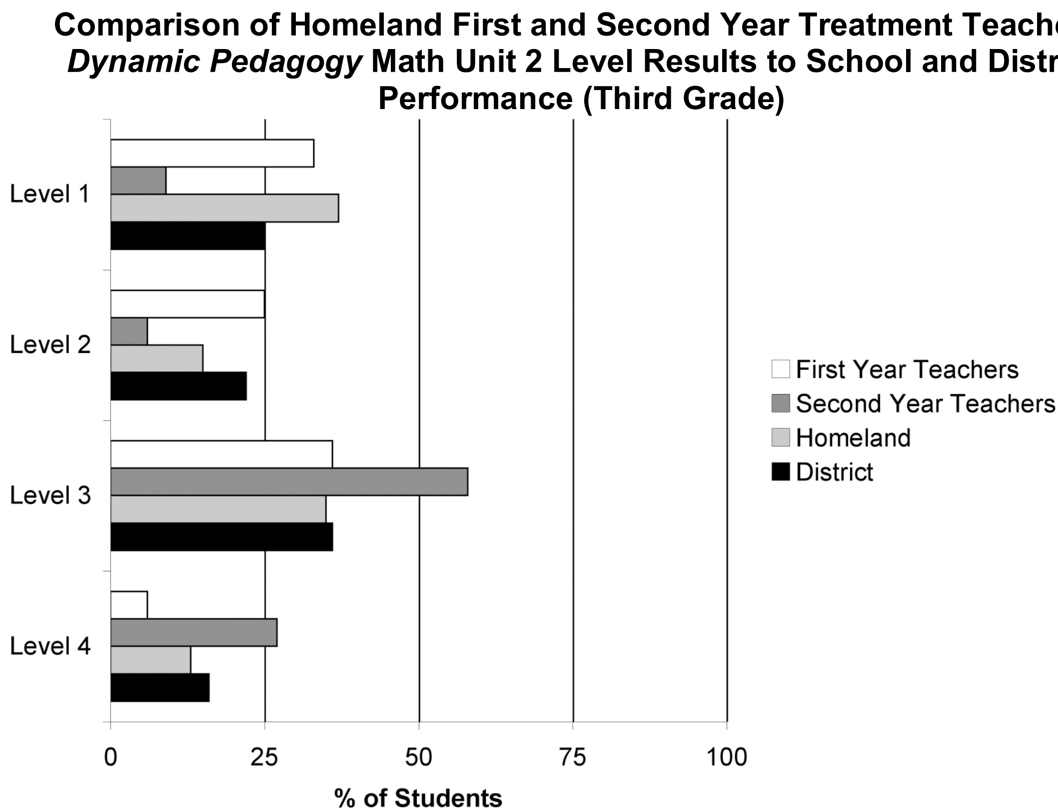


Figure 25. Comparison of Homeland first and second year treatment teachers' TerraNova Mathematics Subtest results to school and district performance (third grade).

Table 40

Homeland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 2 by First and Second Year *Dynamic Pedagogy* Teachers

	Homeland First Year Teachers			**Homeland Second Year Teachers**			**Homeland School Level**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level												
1	12	33	36	3	9	33	44	37	118	138	25	543
2	9	25	36	2	6	33	18	15	118	121	22	543
3	13	36	36	19	58	33	41	35	118	195	36	543
4	2	6	36	9	27	33	15	13	118	89	16	543



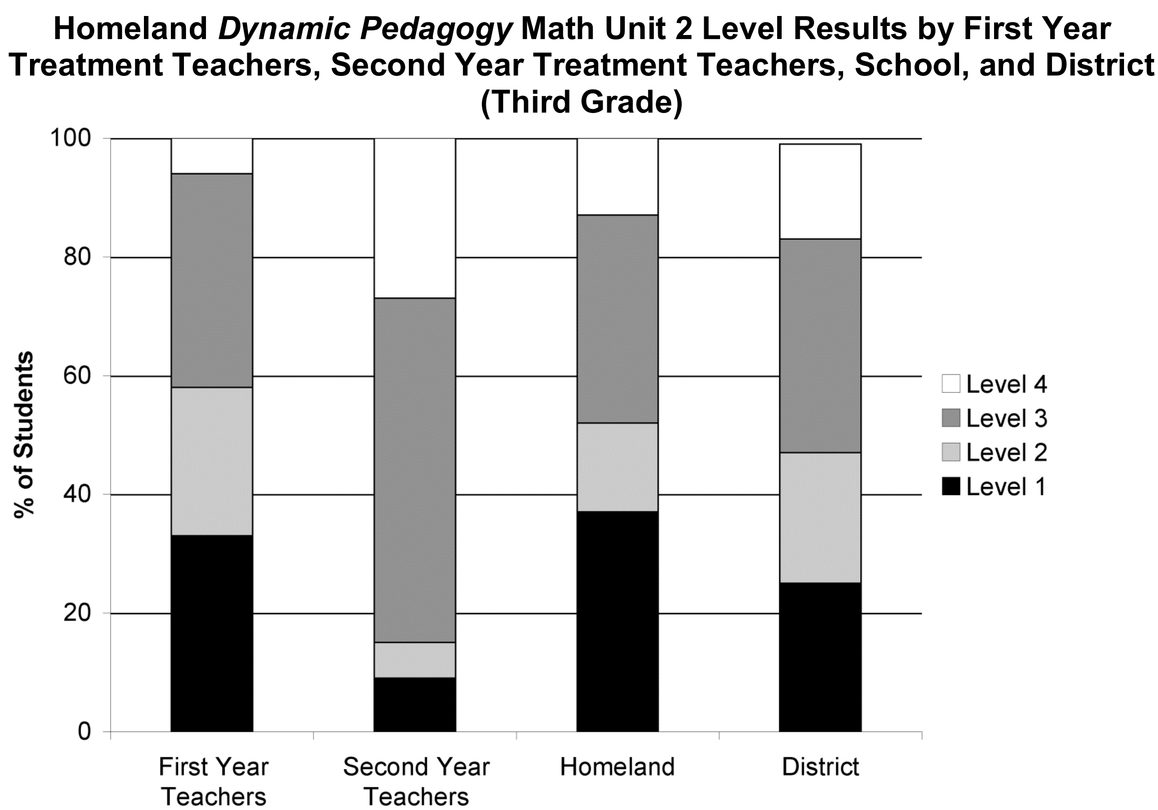
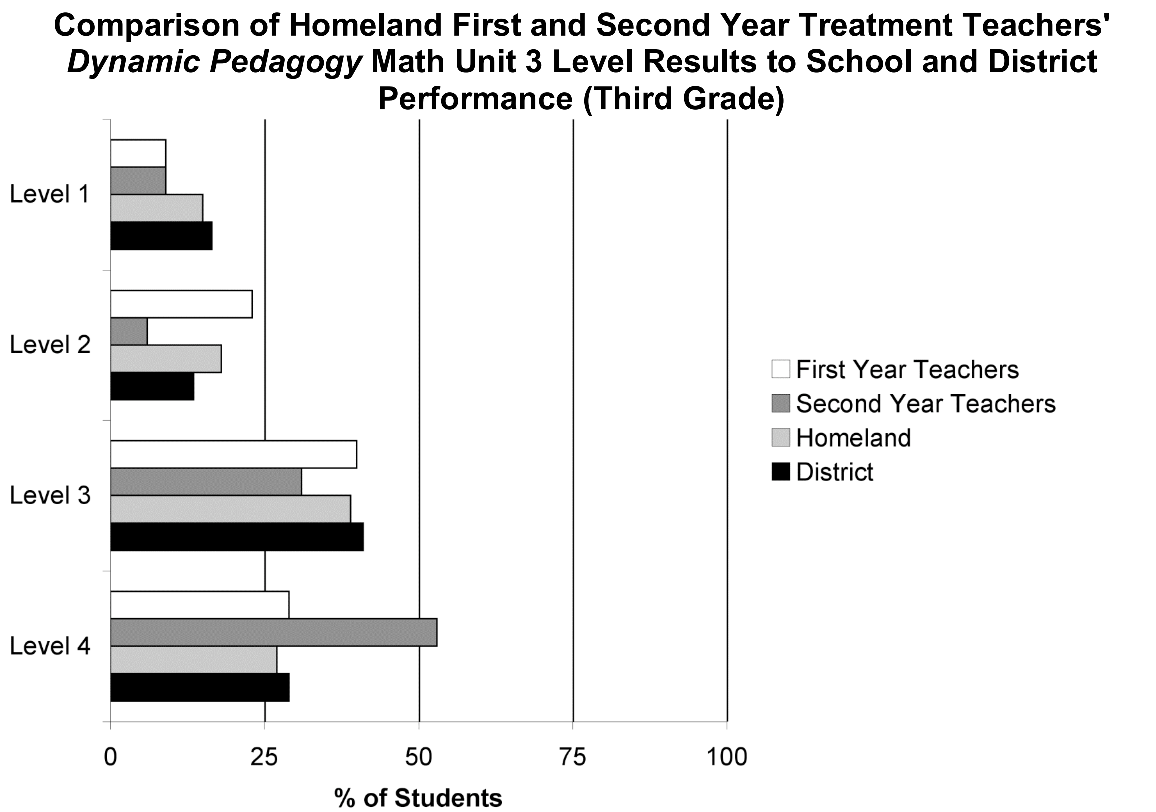


Figure 26. Comparison of Homeland first and second year treatment teachers' *Dynamic Pedagogy* Unit 2 results to school and district performance (third grade).

Table 41

Homeland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 3 by First and Second Year *Dynamic Pedagogy* Teachers

	Homeland First Year Teachers			**Homeland Second Year Teachers**			**Homeland School Level**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level												
1	3	9	35	3	9	32	17	15	114	90	17	545
2	8	23	35	2	6	32	21	18	114	74	14	545
3	14	40	35	10	31	32	45	39	114	223	41	545
4	10	29	35	17	53	32	31	27	114	158	29	545



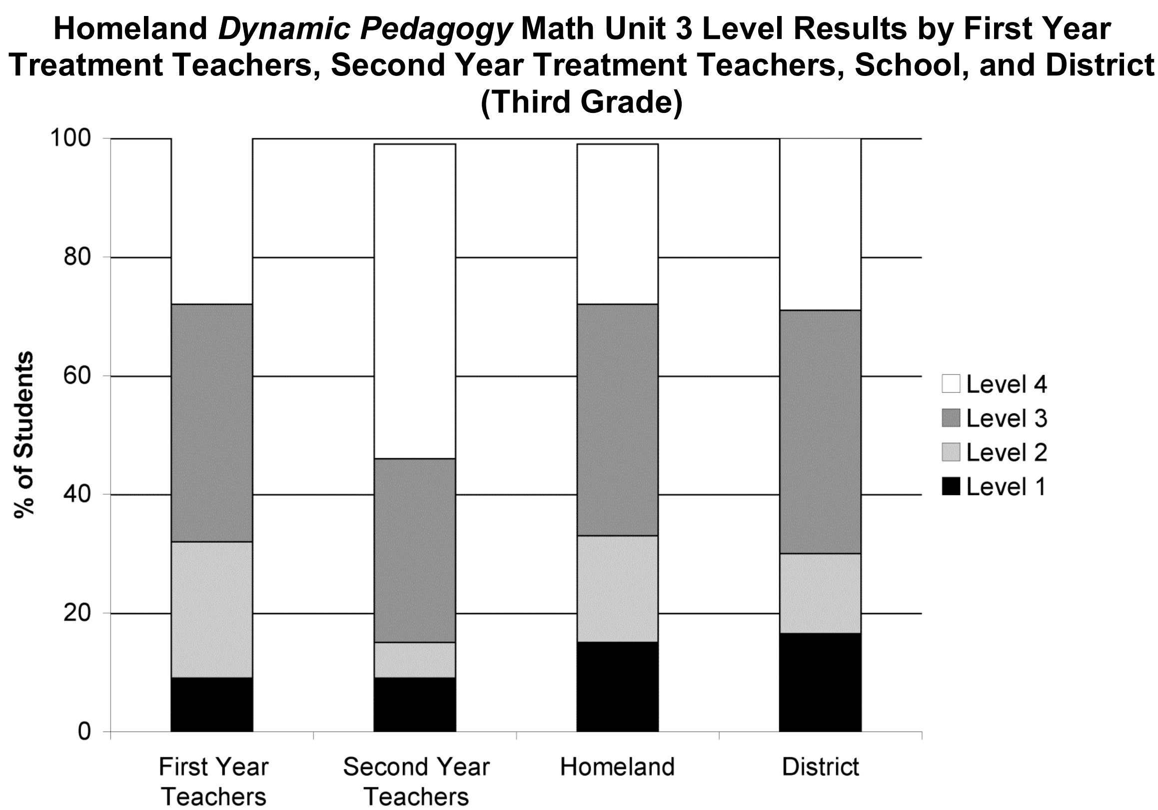
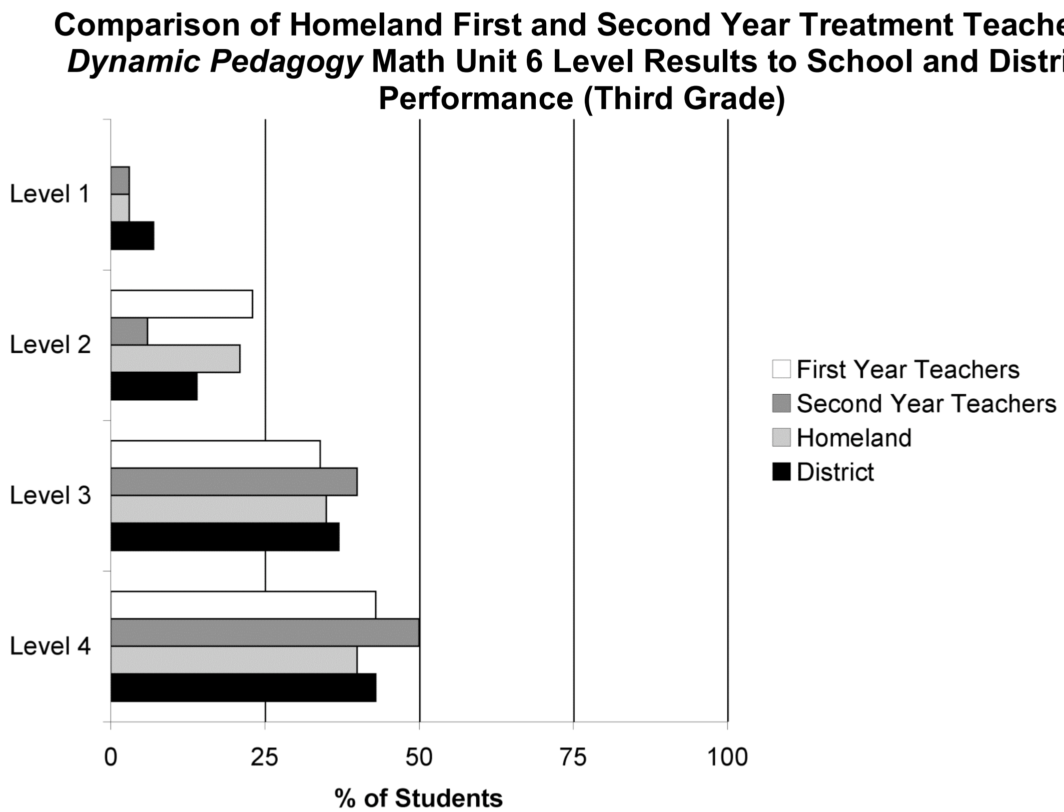


Figure 27. Comparison of Homeland first and second year treatment teachers' *Dynamic Pedagogy* Unit 3 results to school and district performance (third grade).

Table 42

Homeland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 6 by First and Second Year *Dynamic Pedagogy* Teachers

	Homeland First Year Teachers			**Homeland Second Year Teachers**			**Homeland School Level**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level												
1	0	0	35	1	3	32	4	3	117	38	7	552
2	8	23	35	2	6	32	25	21	117	76	14	552
3	12	34	35	13	40	32	41	35	117	203	37	552
4	15	43	35	16	50	32	47	40	117	235	43	552



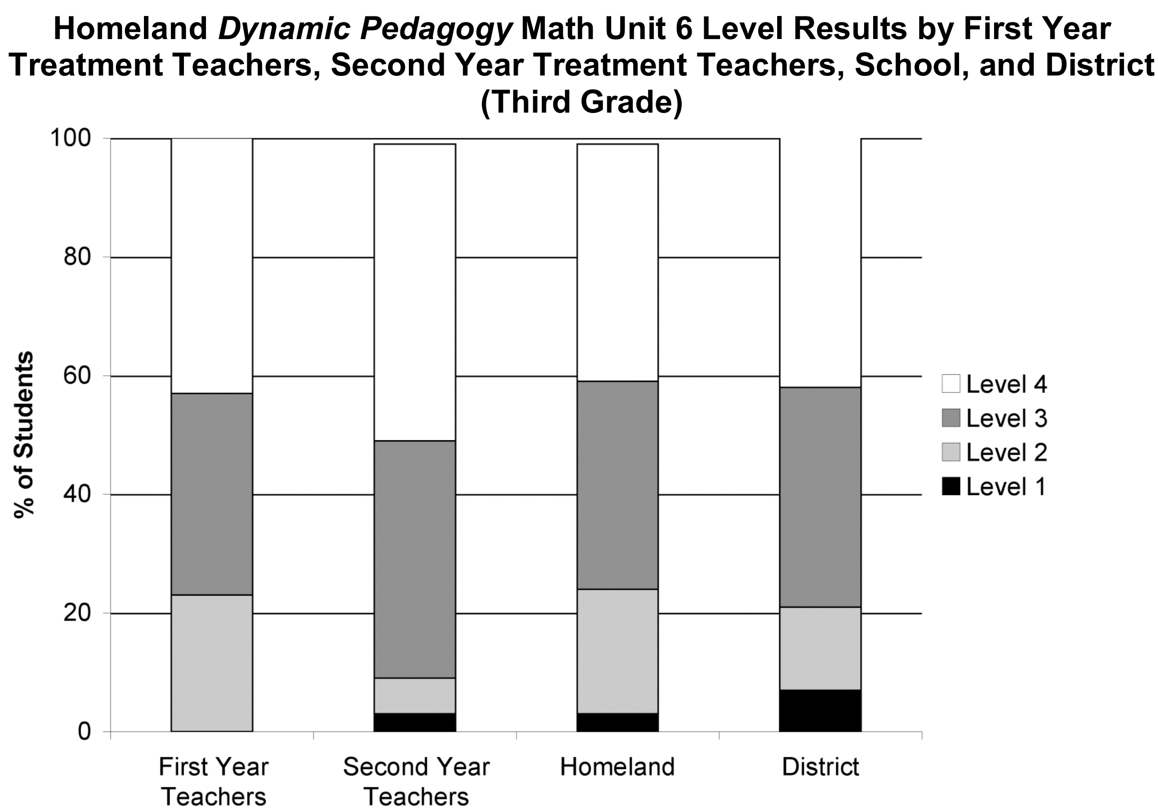
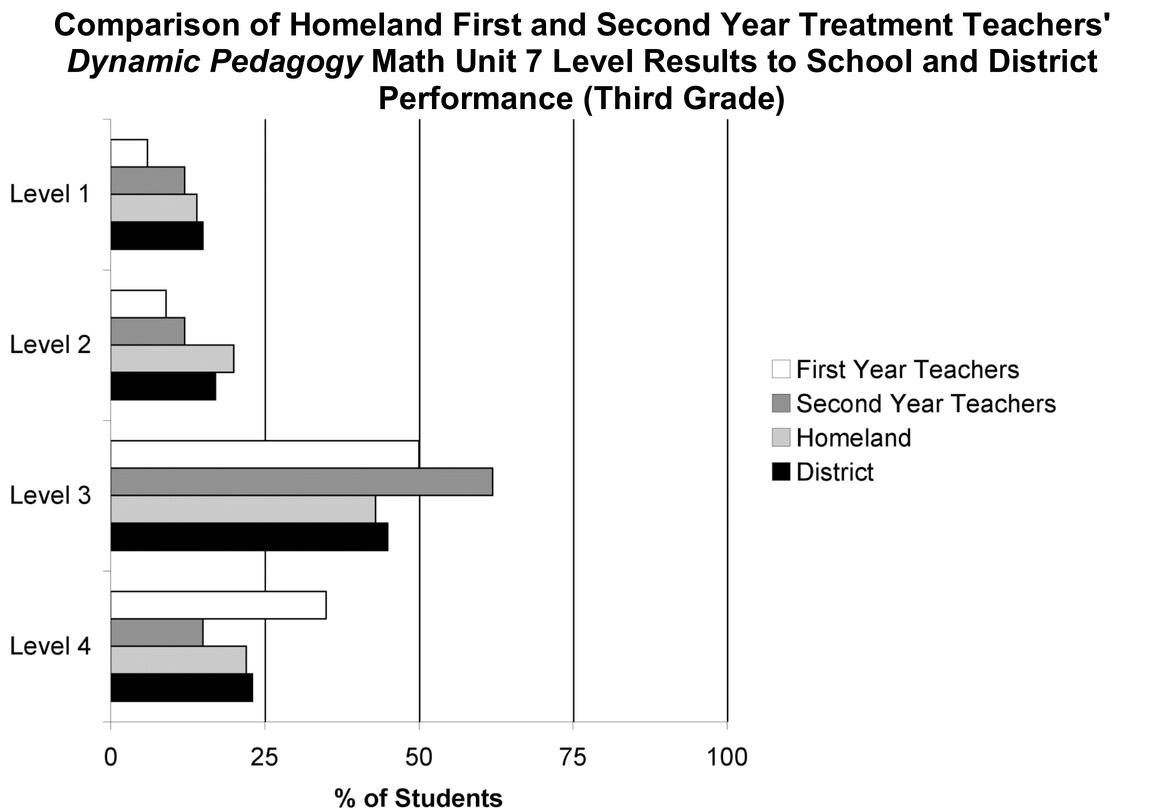


Figure 28. Comparison of Homeland first and second year treatment teachers' *Dynamic Pedagogy* Unit 6 results to school and district performance (third grade).

Table 43

Homeland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 7 by First and Second Year *Dynamic Pedagogy* Teachers

	Homeland First Year Teachers			**Homeland Second Year Teachers**			**Homeland School Level**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level												
1	2	6	34	4	12	34	17	14	118	85	15	553
2	3	9	34	4	12	34	24	20	118	92	17	553
3	17	50	34	21	62	34	51	43	118	247	45	553
4	12	35	34	5	15	34	26	22	118	129	23	553



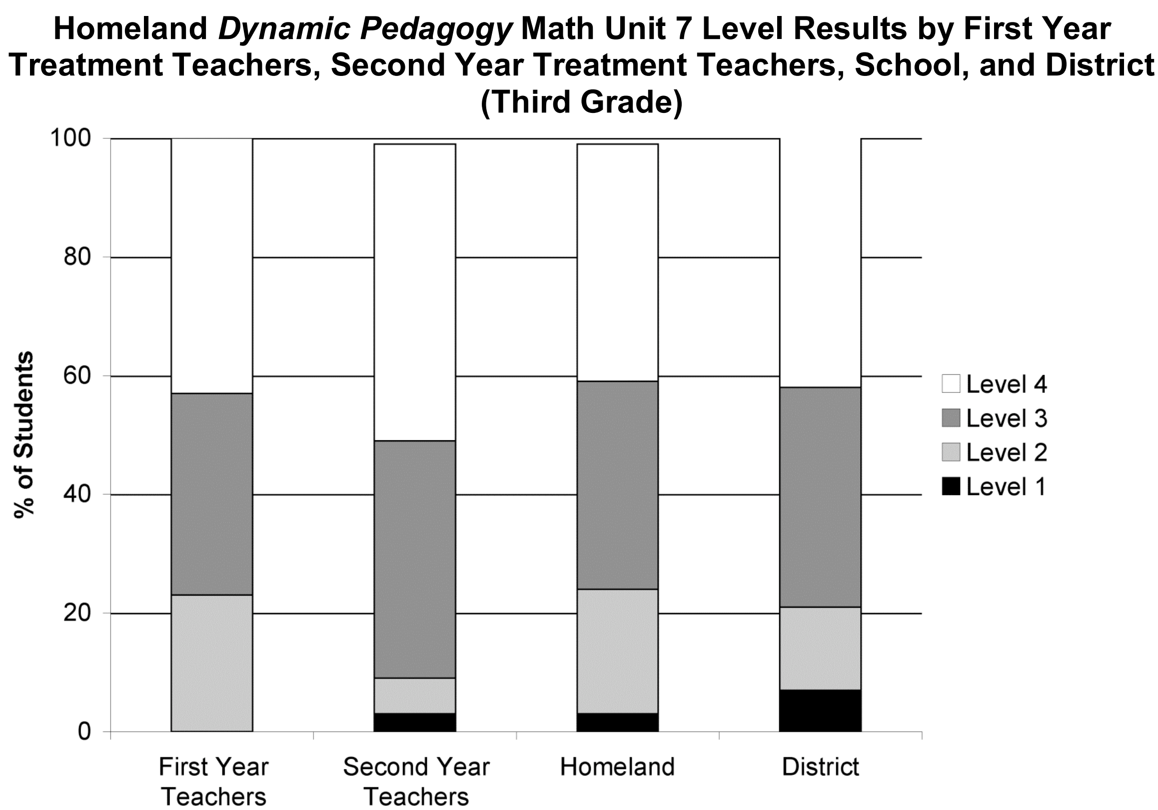
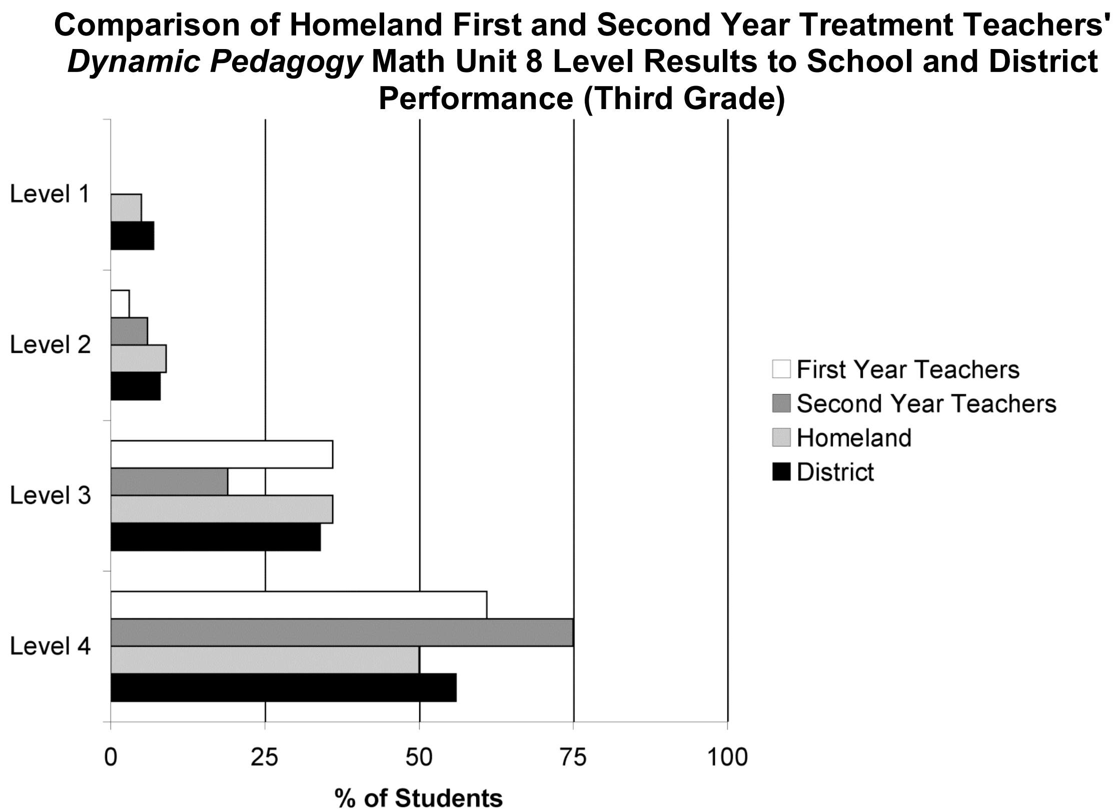


Figure 29. Comparison of Homeland first and second year treatment teachers' *Dynamic Pedagogy* Unit 7 results to school and district performance (third grade).

Table 44

Homeland Third Grade Level Analysis for *Dynamic Pedagogy* Math Unit 8 by First and Second Year *Dynamic Pedagogy* Teachers

	Homeland First Year Teachers			**Homeland Second Year Teachers**			**Homeland School Level**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level												
1	0	0	36	0	0	32	6	5	120	13	2	557
2	1	3	36	2	6	32	11	9	120	43	8	557
3	13	36	36	6	19	32	43	36	120	190	34	557
4	22	61	36	24	75	32	60	50	120	311	56	557



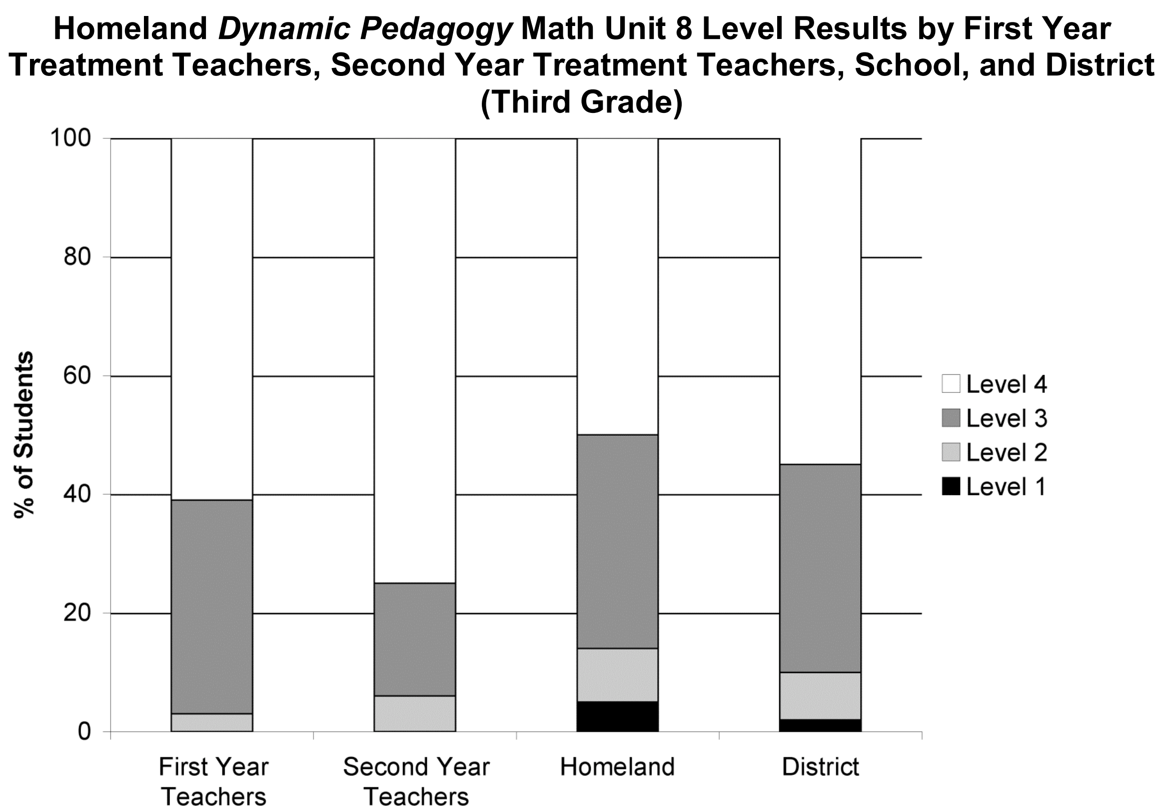


Figure 30. Comparison of Homeland first and second year treatment teachers' *Dynamic Pedagogy* Unit 8 results to school and district performance (third grade).

Race/Ethnic Comparisons on the Third Grade TerraNova Mathematics Subtest by School

Dynamic Pedagogy student scores were compared to other third graders in the school by race/ethnicity. The students were grouped as either (White and Asian students) or non-Asian (Native American, African American, and Hispanic students).

Flatland

Dynamic Pedagogy students (Asian and White) had a mean score of 642.92, SD = 34.83 (n = 13), the Asian and White students in the other non-*Dynamic Pedagogy* third grade classes in the school had an overall mean score of 633.81, *SD* = 41.15 (n = 21). Variance for these 2 groups was assumed as the Levene's Test for Equality of Variance was non-significant, F = .588, p = .449. A t-test showed the difference between these two groups was not statistically significant, t_{32} = - .664, p = .512.

Analysis of *Dynamic Pedagogy* non-Asian students (African American and Hispanic) showed a mean score of 631.37, *SD* = 42.44 (n = 57), whereas the non-Asian students in the other non-*Dynamic Pedagogy* third grade classes in the third grade had an overall mean of 611.64, *SD* = 34.15 (n = 45). Variance for these 2 groups was assumed as the Levene's Test for Equality of Variance was non-significant, F = .514, p = .475. A t-test showed the difference between these 2 groups to be statistically significant, t_{100} = -2.536, p = .013. The difference favored the *Dynamic Pedagogy* students by approximately 20 points.

Homeland

Dynamic Pedagogy Asian and White students had a mean score of 655.15, SD = 30.42 (n = 13), the Asian and White students in the other non-*Dynamic Pedagogy* third grade classes in the school had an overall mean score of 586.67, *SD* = 55.90 (n = 3). Variance for these 2 groups was assumed as the Levene's Test for Equality of Variance was non-significant, F = 2.084, p = .171. A t-test showed the difference between these two groups to be statistically significant, t_{14} = -3.037, p = .009. The difference favored the *Dynamic Pedagogy* students by approximately 70 points, but caution should be taken with this comparison since the number of subjects in the non-*Dynamic Pedagogy* group was so small.

Analysis of *Dynamic Pedagogy* non-Asian students showed a mean score of 624.44, SD = 29.57 (n = 57), whereas the school non-Asian students in the other non-*Dynamic Pedagogy* third grade classes in the school had an overall mean of 596.65, *SD* = 41.74 (n = 46). Variance for these 2 groups was not assumed as the Levene's Test for Equality of Variance was significant, F = 4.192, p = .043. A t-test showed the difference between these 2 groups to be statistically significant, t_{78} = -3.809, p = .000. The difference favored the *Dynamic Pedagogy* students by approximately 30 points.

Fourth Grade District Unit Assessments and New York State Mathematics Test

As indicated in Table 45 students in the *Dynamic Pedagogy* condition did better than their non-*Dynamic Pedagogy* peers on all measures of achievement: the District's Unit assessments and the end-of year New York State mathematics Test.

Table 45

Descriptive Statistics of Fourth Grade District Unit Assessments and the New York State Mathematics Test

	Dynamic Pedagogy		**Control**	
	Mean	SD_σ	Mean	SD_σ
Unit 4	24.65	6.43	19.89	10.17
Unit 5	22.88	6.41	21.28	8.82
Unit 6	24.75	5.91	20.00	9.09
Unit 8	24.75	5.11	12.83	4.74
Unit 9	16.12	5.11	15.82	6.16
Fourth Grade State Test *	679.9	36.31	653.1	34.61

*Represents a significant difference ($p < .05$) between *Dynamic Pedagogy* and Control group.

To ascertain whether these differences were statistically significant, an ANCOVA procedure was used:

Fourth Grade Model:

$$Assessment = \beta_0 + \beta_1 DynamicPedagogy + \beta_2 ThirdGradeTerraNova + \varepsilon$$

For the fourth grade sample, analyses of covariance (ANCOVA) were computed to examine the effect of *Dynamic Pedagogy* on the Fourth Grade State Test (FGST). After adjustment by the students Third Grade TerraNova Mathematics Subtest scores, the overall model was found to be statistically significant ($F = 9.41$, $df = 2$, $p = .001$), indicating that the overall model is significantly predicting on the FGST. The coefficient of determination ($r^2 = .37$) indicates that 37% of the variation in Third Grade TerraNova is being explained by the overall model. The covariate was also found to be statistically significant ($\beta = .331$, $t = 3.48$, $p = .001$) indicating a positive effect on the FGST. *Dynamic Pedagogy* was found to be statistically significant ($F = 6.77$, $df = 1$, $p = .014$, $\eta^2 = .175$), indicating that *Dynamic Pedagogy* accounts for 17.5% of the variance in the adjusted FGST scores. The participants in *Dynamic Pedagogy* ($mean_{FGST} = 679.96$, CI: (664.81, 695.11)) performed significantly better than the control group participants (mean$_{FGST}$ = 652.98, CI: (638.26, 667.70) on the Fourth Grade State Test after adjustment.

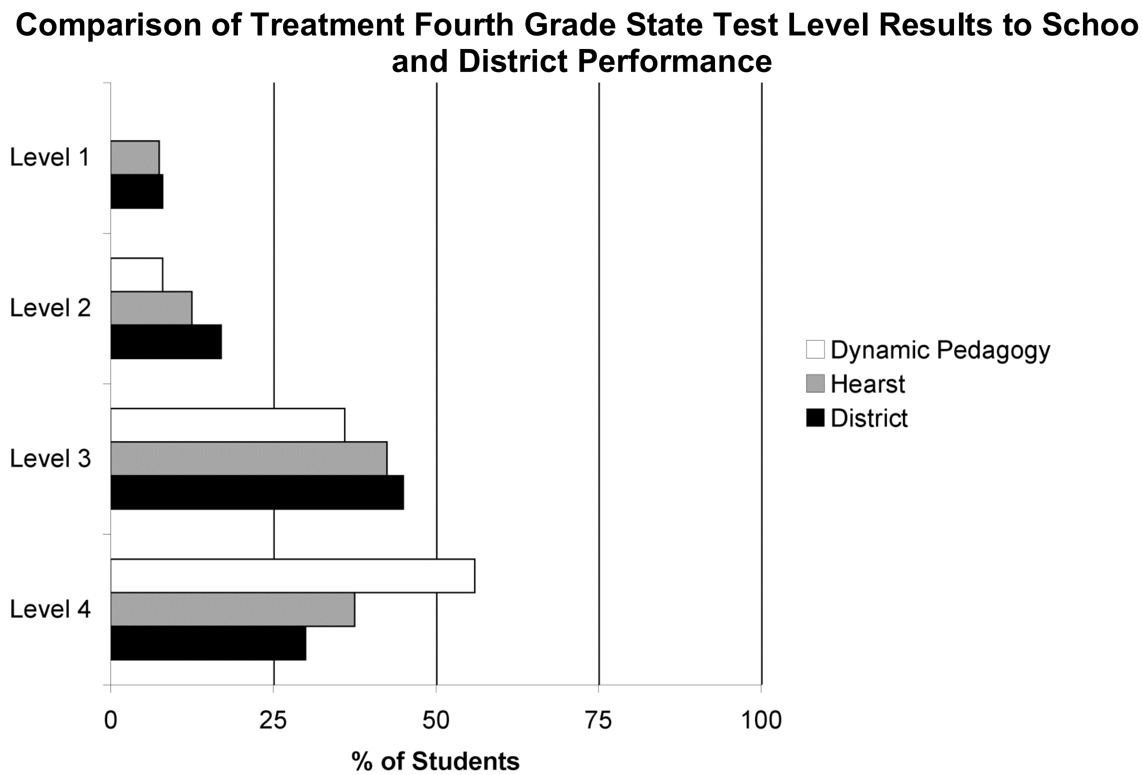
Achievement Levels on the New York State Mathematics Test and District Unit Assessments

Results showing differences in the level of achievement are presented in Tables 46 through 51 and Figures 31 through 36. In comparison with their peers in the other fourth grade classes and the District, the *Dynamic Pedagogy* group had the lowest percentage of students who performed at the lowest level of achievement (level 1) on both the New York State Mathematics test and District Unit assessments. Conversely, the *Dynamic Pedagogy* group had the highest percentage of students who performed at the highest level of achievement (level 4) on both measures of achievement.

Table 46

Fourth Grade Level Analysis for State Test

	***Dynamic Pedagogy* Group**			**Hearst**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	0	0	36	9	7.5	120	45	8	575
2	3	8	36	15	12.5	120	96	17	575
3	13	36	36	51	42.5	120	261	45	575
4	20	56	36	45	37.5	120	173	30	575



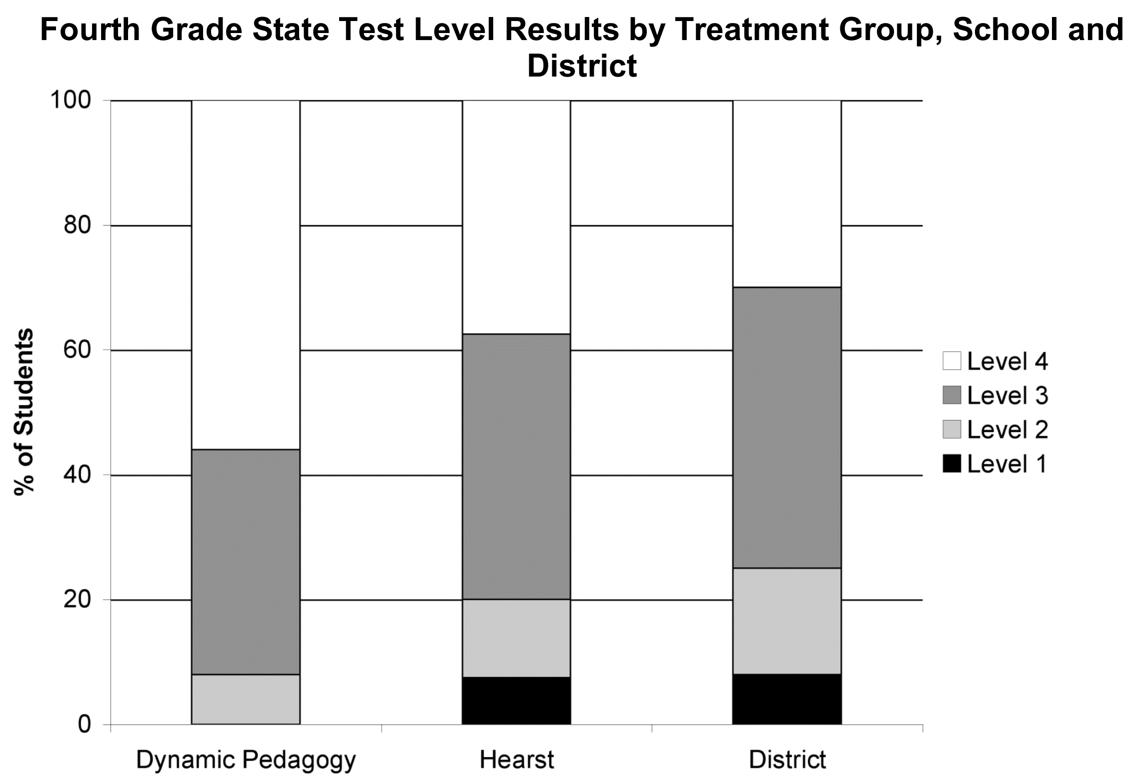
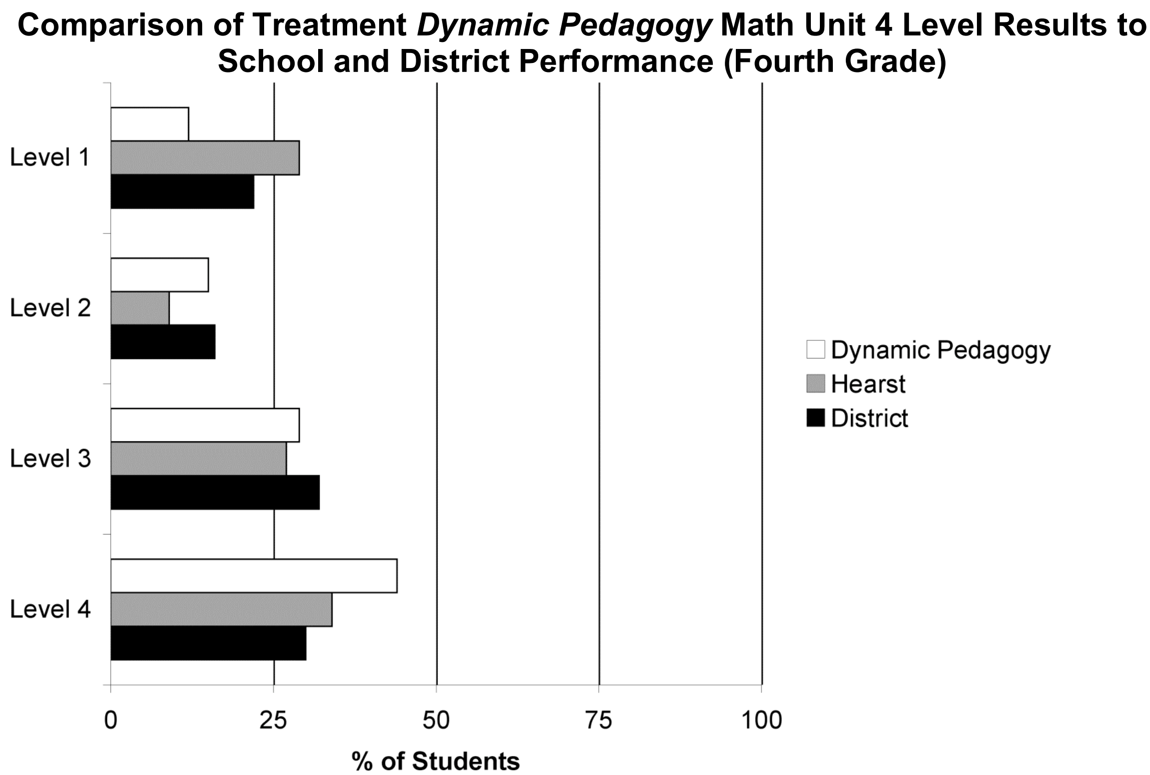


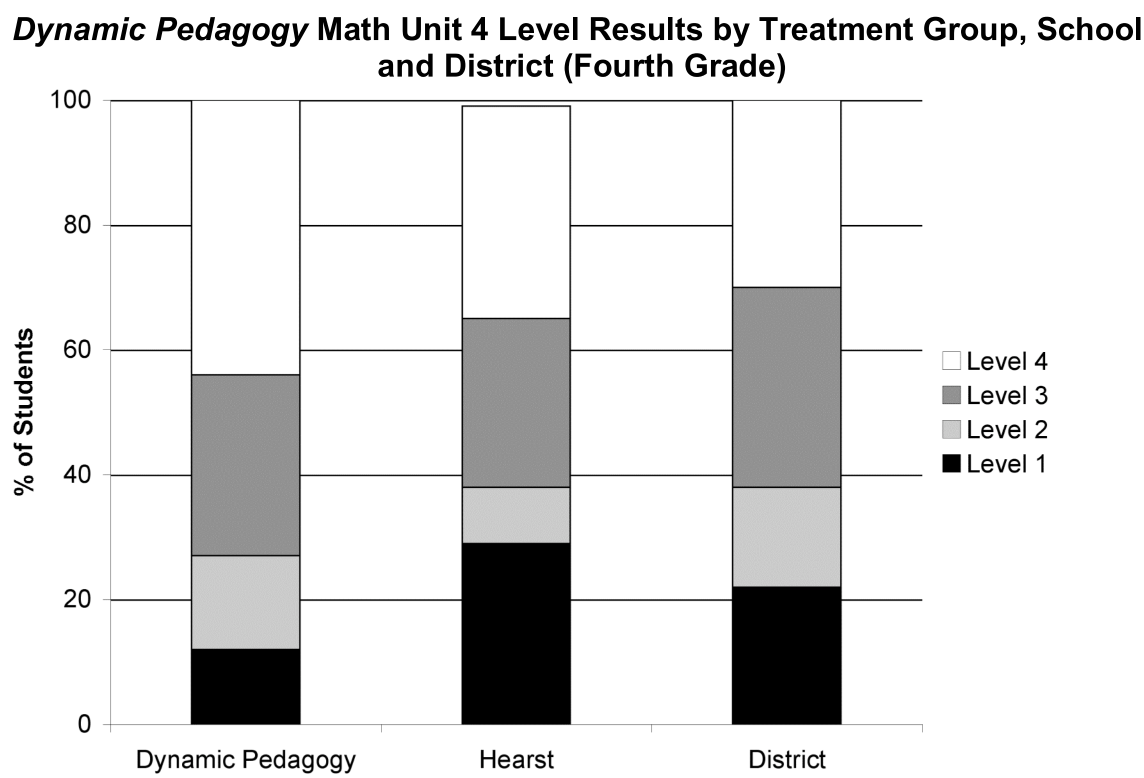
Figure 31. Comparison of treatment *Dynamic Pedagogy* fourth grade State Test results to school and district performance.

Table 47

Fourth Grade Level Analysis for *Dynamic Pedagogy* Math Unit 4

	***Dynamic Pedagogy* Group**			**Hearst**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	4	12	34	34	29	117	121	2	558
2	5	15	34	11	9	117	92	16	558
3	10	29	34	32	27	117	179	32	558
4	15	44	34	40	34	117	166	30	558



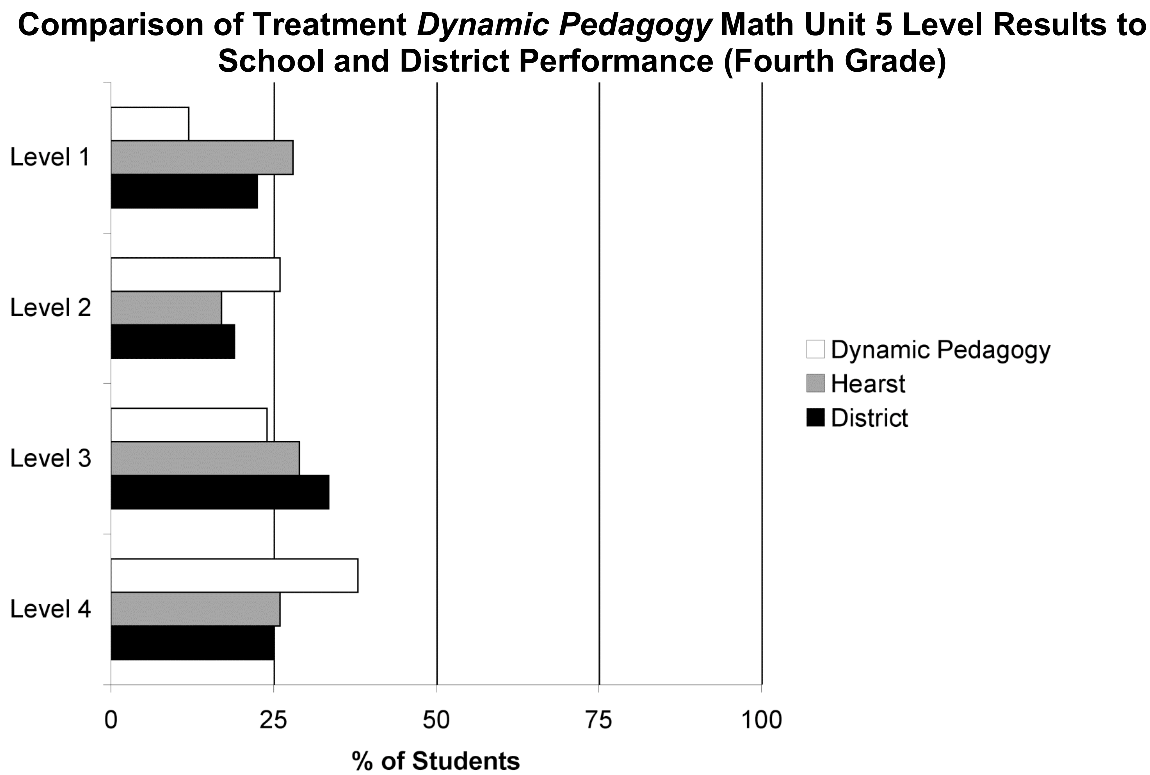


<u>Figure 32.</u> Comparison of treatment *Dynamic Pedagogy* Math Unit 4 test results to school and district performance.

Table 48

Fourth Grade Level Analysis for *Dynamic Pedagogy* Math Unit 5

	***Dynamic Pedagogy* Group**			**Hearst**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	4	12	34	33	2	117	121	22.5	537
2	9	26	34	20	17	117	104	19	537
3	8	24	34	34	29	117	180	33.5	537
4	13	38	34	30	26	117	132	25	537



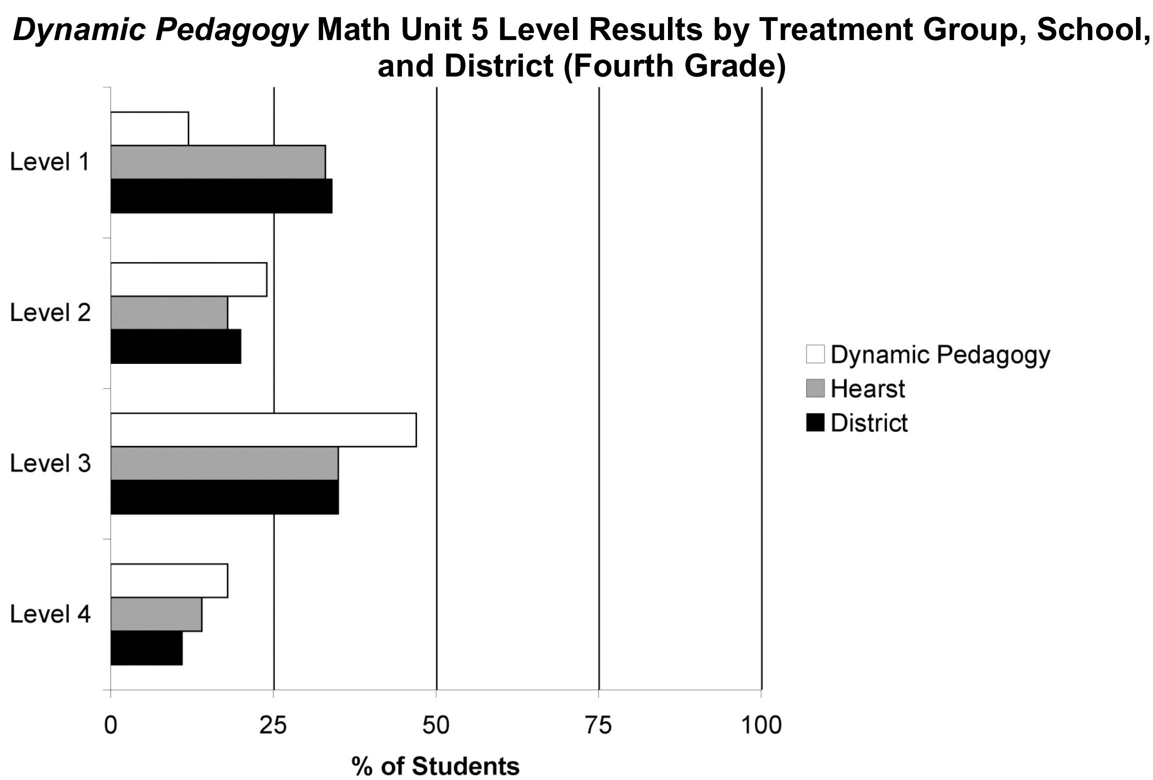
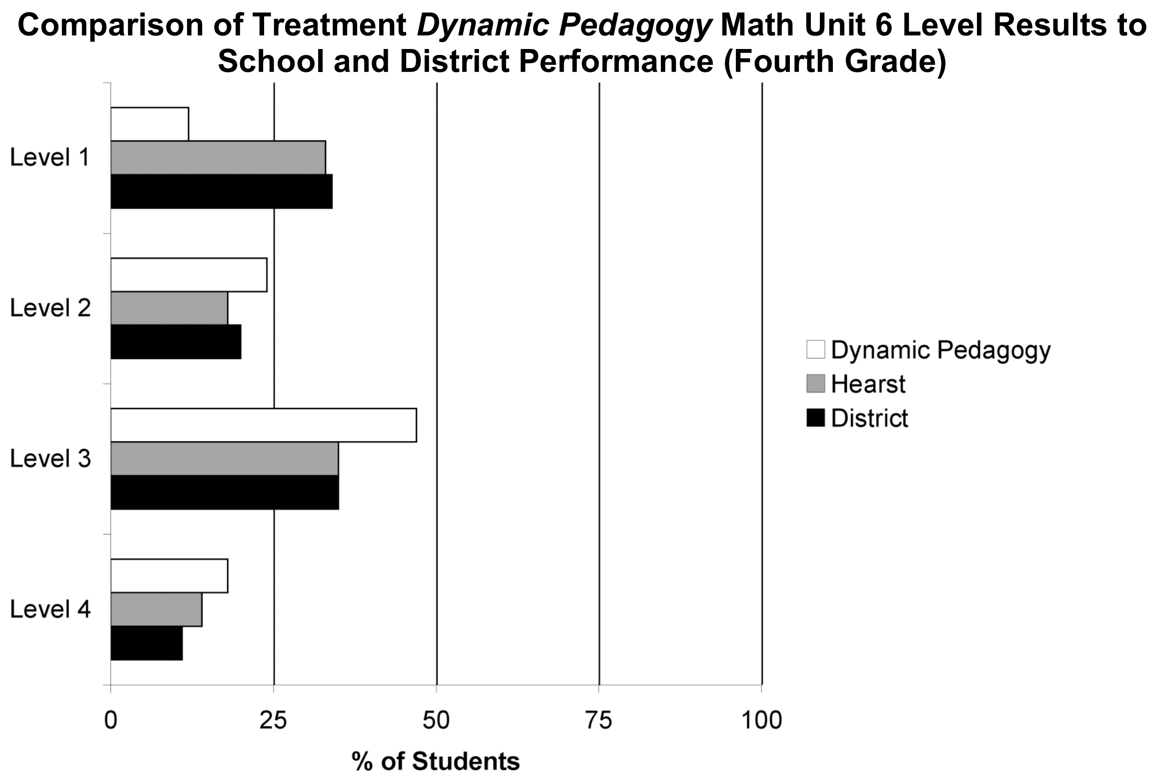


Figure 33. Comparison of treatment *Dynamic Pedagogy* Math Unit 5 test results to school and district performance.

Table 49

Fourth Grade Level Analysis for *Dynamic Pedagogy* Math Unit 6

	***Dynamic Pedagogy* Group**			**Hearst**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	4	12	34	39	33	118	186	34	555
2	8	24	34	21	18	118	112	20	555
3	16	47	34	41	35	118	196	35	555
4	6	18	34	17	14	118	61	11	555



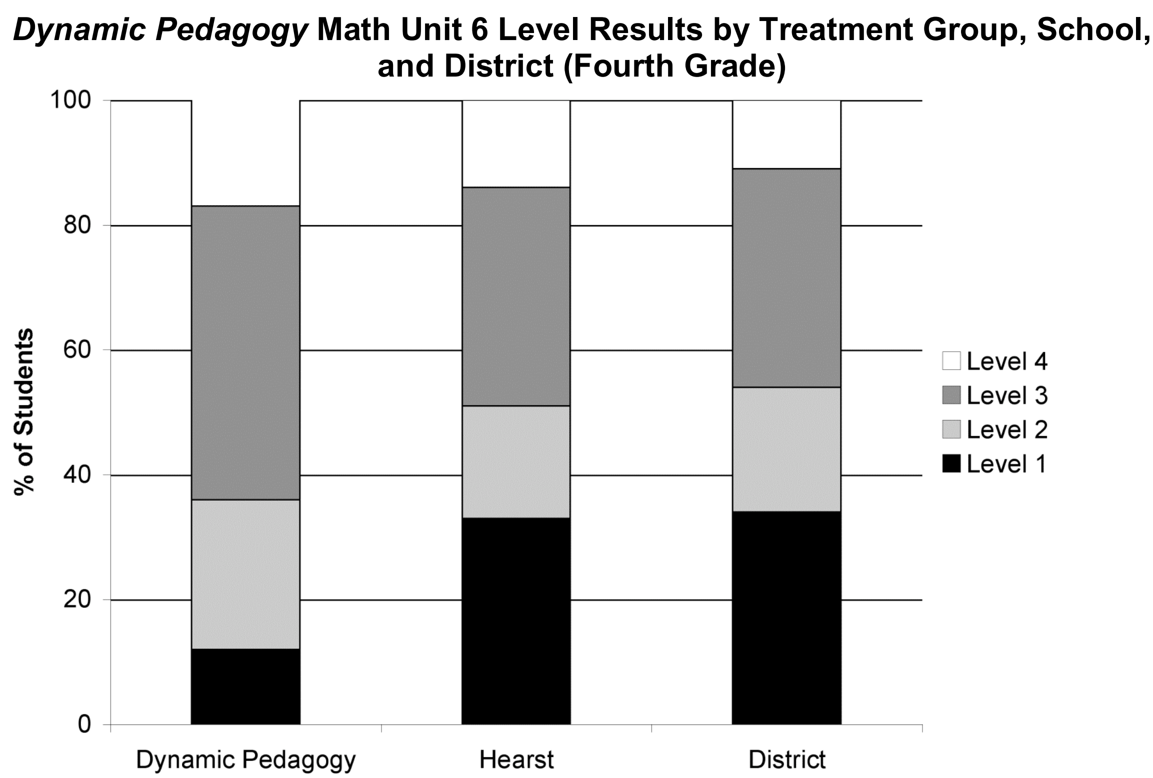
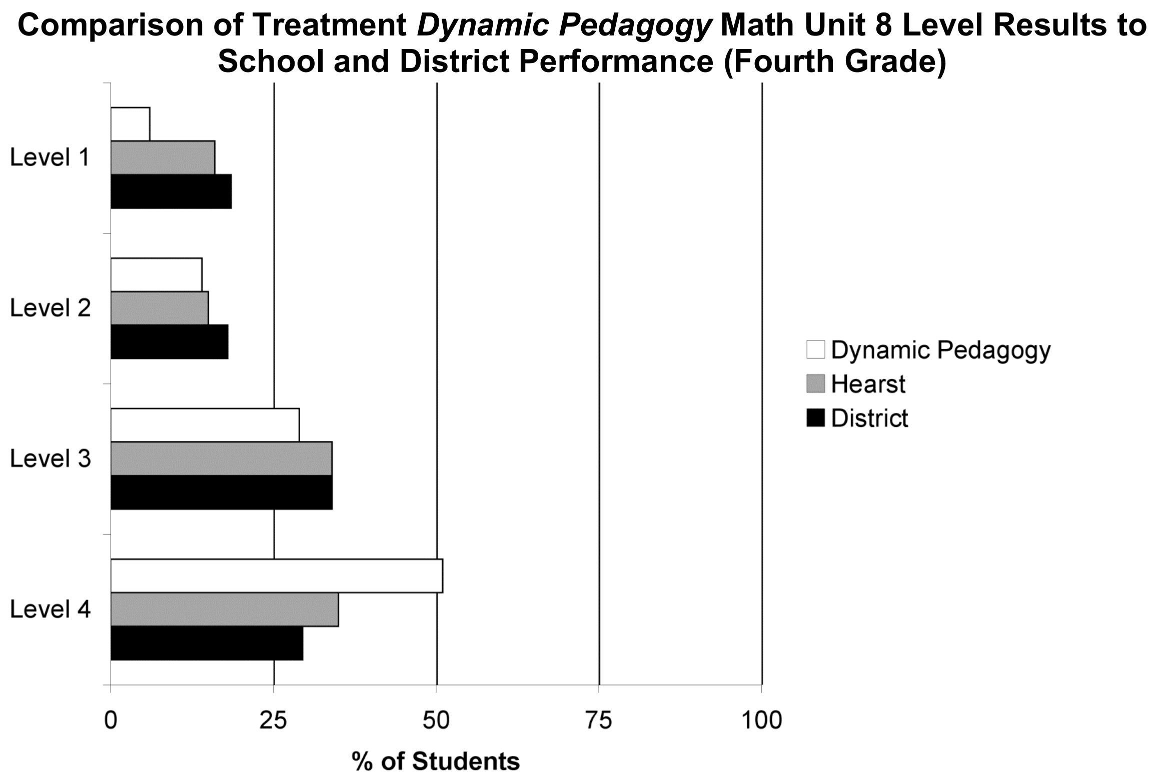


Figure 34. Comparison of treatment *Dynamic Pedagogy* Math Unit 6 test results to school and district performance.

Table 50

Fourth Grade Level Analysis for *Dynamic Pedagogy* Math Unit 8

	***Dynamic Pedagogy* Group**			**Hearst**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	2	6	35	18	16	116	101	18.5	544
2	5	14	35	17	15	116	99	18	544
3	10	29	35	40	34	116	183	34	544
4	18	51	35	41	35	116	161	29.5	544



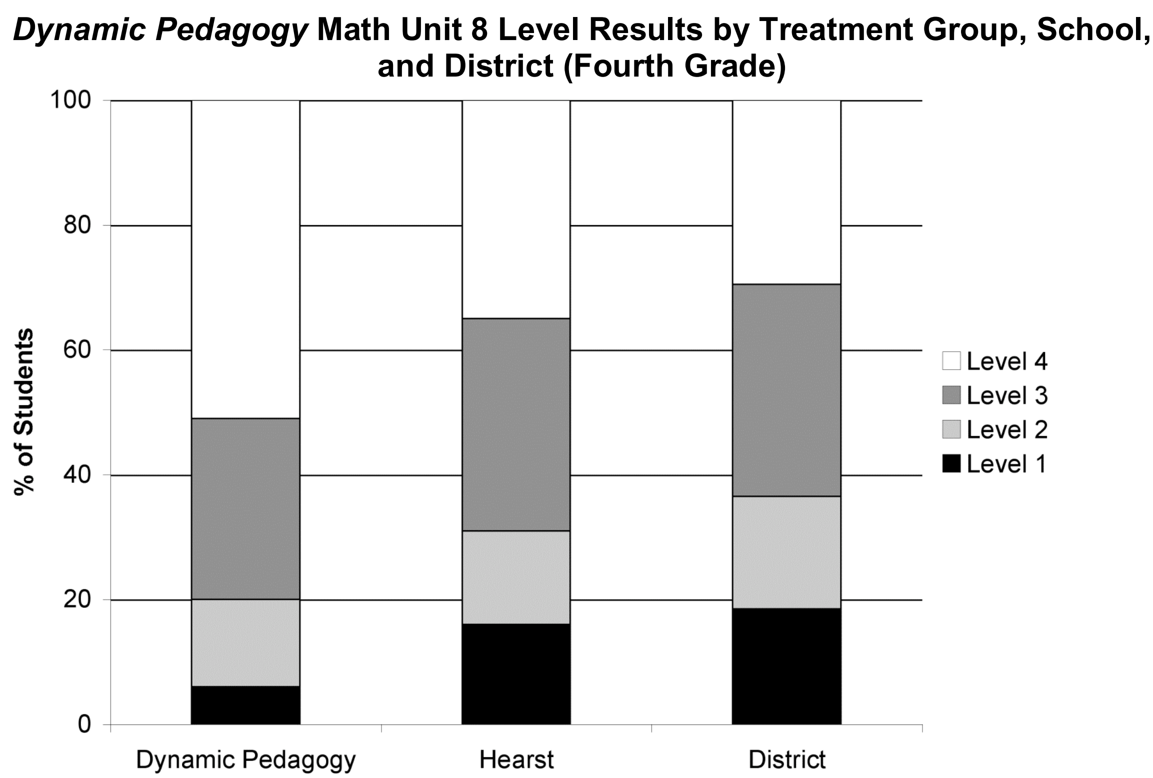
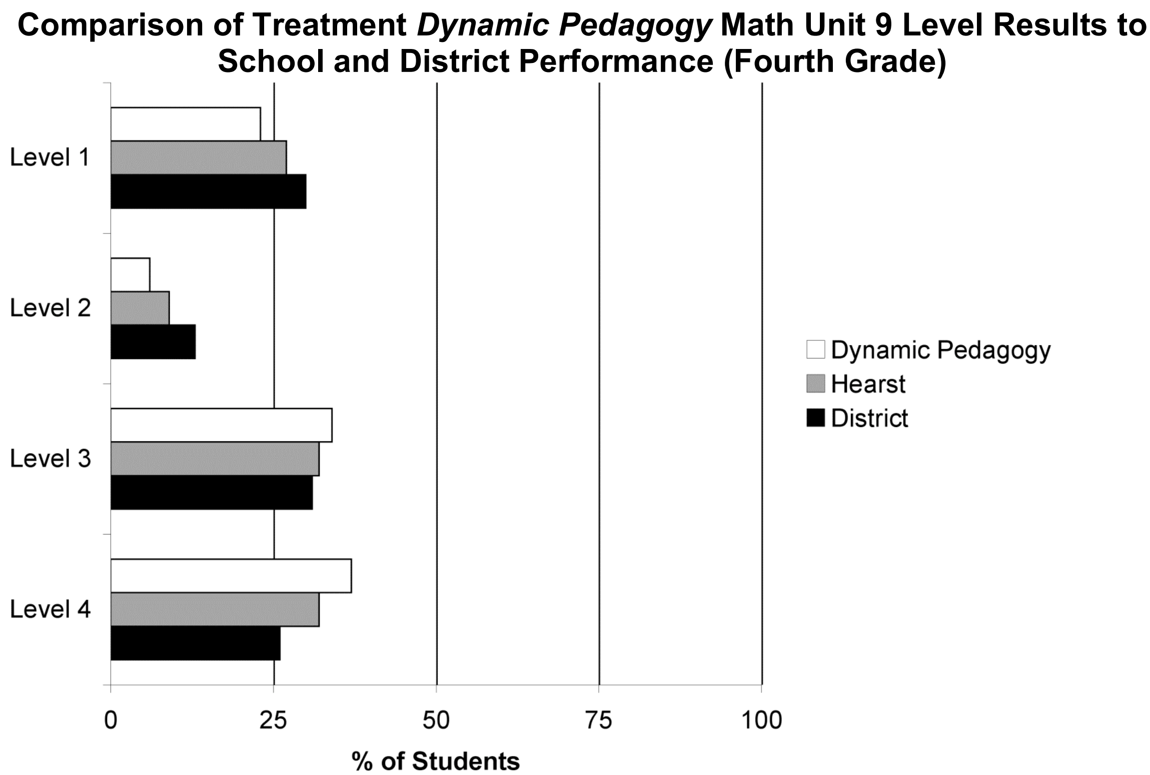


Figure 35. Comparison of treatment *Dynamic Pedagogy* Math Unit 8 test results to school and district performance.

Table 51

Fourth Grade Level Analysis for *Dynamic Pedagogy* Math Unit 9

	***Dynamic Pedagogy* Group**			**Hearst**			**District**		
	f	**%**	***N***	***f***	**%**	***N***	***f***	**%**	***N***
Achievement Level									
1	8	23	35	31	27	114	159	30	534
2	2	6	35	10	9	114	71	13	534
3	12	34	35	37	32	114	166	31	534
4	13	37	35	36	32	114	138	26	534



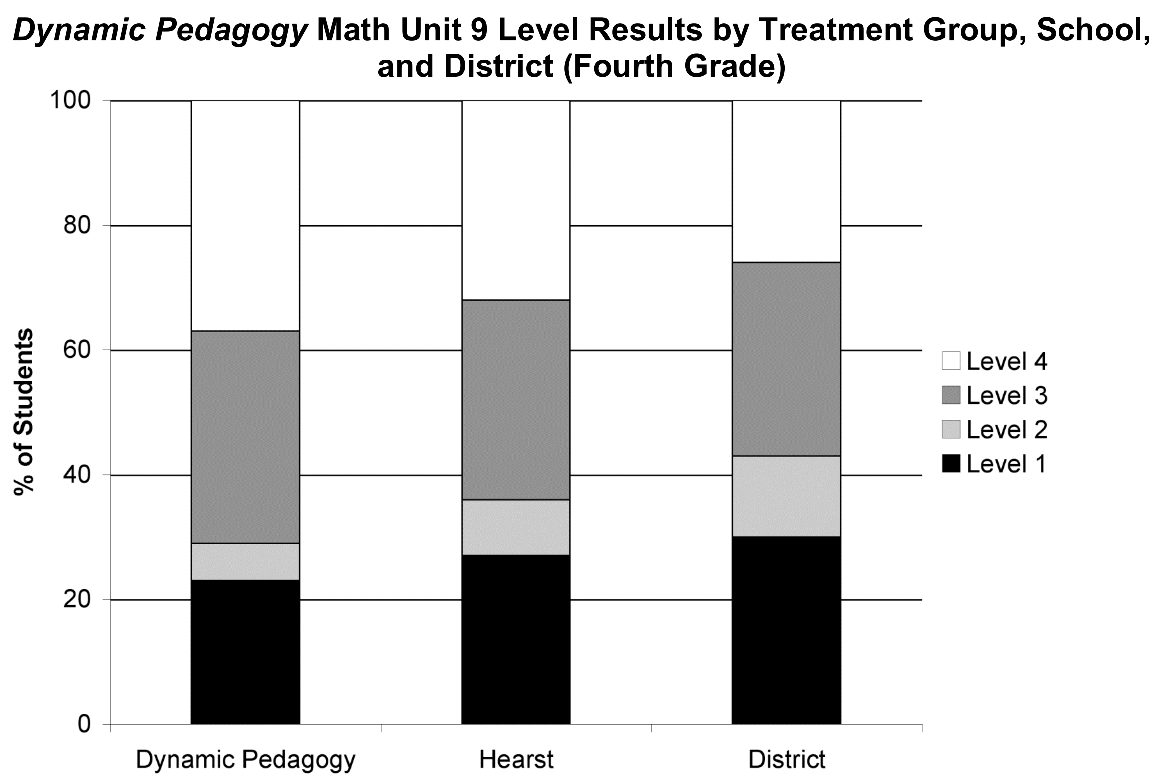


Figure 36. Comparison of treatment *Dynamic Pedagogy* Math Unit 9 test results to school and district performance.

Race/Ethnic Comparisons on the Fourth Grade New York State Mathematics Test

Hearst

Dynamic Pedagogy student scores were also compared to other fourth graders at Hearst by race/ethnicity. The students were grouped as either Asian and White or non-Asian (Native American, African American, and Hispanic students). *Dynamic Pedagogy* Asian and White students had a mean score of 724.50, SD = 58.43 (n = 10), the Asian and White students in the other non-*Dynamic Pedagogy* fourth grade classes in the school had an overall mean score of 671.12, SD = 37.32 (n = 8). Variance for these 2 groups was assumed as the Levene's Test for Equality of Variance was non-significant, $F = .765$, $p = .395$. A t-test showed the difference between these 2 groups to be statistically significant, $t_{16} = -2.237$, $p = .04$. The difference favored the *Dynamic Pedagogy* students by approximately 53 points but, again, caution should be taken with this comparison since the number of students in both the *Dynamic Pedagogy* and non-*Dynamic Pedagogy* groups was very small.

Analysis of *Dynamic Pedagogy* non-Asian students showed a mean score of 687.31, SD = 43.11 (n = 26), whereas the non-Asian students in the other fourth grade classes in the school had an overall mean of 656.59, SD = 43.37 (n = 76). Variance for these 2 groups was assumed as the Levene's Test for Equality of Variance was non-significant, F = .037, $p = .849$. A t-test showed the difference between these 2 groups to be statistically significant, $t_{100} = -3.122$, $p = .002$. The difference favored the *Dynamic Pedagogy* students by approximately 31 points.

Discussion

In this study we put forth a conceptualization of teaching termed *Dynamic Pedagogy* in which teacher decision making and action about the interdependent processes of curriculum, instruction, and assessment are inextricably wedded to student learning. We asked the following questions: (a) How well was the intervention, *Dynamic Pedagogy* implemented?; (b) Did students in *Dynamic Pedagogy* classrooms perform better than their peers in non-*Dynamic Pedagogy* classrooms at the third and fourth grade levels on mathematics achievement measures?; and (c) Were there differences in mathematics achievement at the third and fourth grade levels among race/ethnic groups? Evidence was found for all 3 questions.

Before discussion of these findings, we acknowledge limitations of the study including non-randomization of assignment and small sample sizes of Asian and White children. These limitations do not allow us to infer that the *Dynamic Pedagogy* intervention was the sole reason for the improvement in mathematics achievement of a select group of third and fourth grade children in elementary school level. However, these limitations do not imply that our findings are without educational and scientific importance. After all, given the challenge of significantly improving the academic achievement of ethnic minority children, we believe that the findings described here merit attention from teachers, school administrators, as well as educational researchers.

How Well Was *Dynamic Pedagogy* Intervention Implemented?

Our results indicated that teacher and student behaviors were consistent with the conceptualization of *Dynamic Pedagogy*. Before classroom practice components of *Dynamic Pedagogy* were reflected in teachers' thoughts and decisions about their intended lessons *as well as* the factors that were likely to impede or facilitate student learning. During classroom practice *Dynamic Pedagogy* components were also evident in the reciprocal interactions of teacher and student behaviors. And, finally after classroom practice teachers' *Dynamic Pedagogy* strategies were referenced in teachers' post-lesson reflections about what their practice and its impact on student learning. A brief discussion of these issues follows.

Preplanning Thoughts and Lesson Plans

A review of teachers' preplanning templates and lesson plans revealed evidence of teachers' use of teaching strategies consistent with the conceptualization of *Dynamic Pedagogy* before classroom practice. Before classroom practice, their lesson plans included statements of learning objectives (*instructional strand*) and tasks that required students to use analytical, creative, practical, and memory processes (*curriculum strand*). Evidence that these strategies were in the service of student learning consisted of teachers' descriptions of the out-of school and in-school knowledge and experiences they thought were relevant for the learning outcomes they planned for the children. Also, for the planned lesson, teachers described potential misconceptions and procedural errors that were likely to pose problems for children.

Classroom Practice

Results from the observations of classroom practice indicated that teachers used different combinations of curriculum, assessment, and instruction *Dynamic Pedagogy* strategies in the classroom. In terms of the *curriculum* strand of the model, teachers designed tasks that required students to make connections to their prior in-school and out-of- school knowledge in readiness for the new content to be learned. They read stories and poems to the children related to the lesson. They demonstrated mathematics concepts with charts, diagrams, and tables using transparencies and an overhead projector; they provided opportunities for students to solve mathematics problems using games and other mathematics-related manipulatives; worksheets with word problems embedded in stories and pictorial representations.

For the *instructional* strand of the model, teachers used a variety of scaffolding techniques such as modeling, hinting, elaborating on students' responses, explaining with feedback, and providing opportunities for students to work in small groups and independently. Teachers also monitored students' work in small groups. And for the *assessment* strand of the model, teachers asked students to recall math facts from memory and to think practically by giving examples from their own lives about mathematics concepts; they called on students to explain their thinking about tasks; used different types of probes to check on student working in both whole-group and small-group discourse, as well as through written assignments for in-class seatwork and homework.

Students' responsiveness to the teachers' use of these *Dynamic Pedagogy* strategies was evidenced by the high level of engagement in the activities of the lesson. During whole-group interactions, students were observed raising their hands, responding to the teacher's questions, listening to the exchanges between the teacher and students. During seatwork they were engaged in the conversations with their peers, using manipulatives for the assigned tasks, asking questions and responding to the teacher as she/he monitored their work in small groups. Evidence of their responsiveness was also evidenced in samples of their work that required them to solve practical, analytical, and creative tasks and to document their thoughts and feelings about solving math problems in their journals or on worksheets.

Post-lesson Reflections

Review of teacher-self-assessment questionnaires showed that teachers made reference to *Dynamic Pedagogy* components in their post lesson reflections. They commented on lesson objectives (*instructional strand*) and the strategies they used to check whether students had the prerequisite knowledge and skills to learn the new content of the lesson and whether students were making progress towards the objectives of the lesson (*assessment strand*). Their comments also included judgments as to whether the tasks they made available to students required students to use their memory as well as their practical, analytical, and creative thinking processes (*curriculum strand*). In terms of the relationship of these strategies to student learning, teachers felt that most of the students understood the content of the lesson.

We are encouraged by these results because they offer some evidence of the multidimensionality of pedagogical content knowledge that Shulman and his colleagues (1987; Wilson et al., 1987) advocated almost two decades ago. Consistent with the *Dynamic Pedagogy* model of teaching, participating teachers' knowledge was evidenced in their preplanning thoughts and lesson plans prior to classroom practice. Their knowledge was also evidenced in their interactions with students during classroom practice and in their reflections after classroom practice. These findings add to the knowledge base on the importance of different types of teacher knowledge relevant for student learning and achievement (Artzt & Armour-Thomas, 2002; Ball, 1990; Borko et al., 1992; Brophy & Good, 1986; Ferguson, 1991; Grossman, 1990; Harbison & Hanushek, 1992; Jackson, 1968).

Despite the promise of our findings, we acknowledge some limitations in our methodology. First, our observation protocol was designed to capture the interactions between teachers and students during actual classroom instruction. However, we were unable to capture student-student interactions as they worked in small groups. Nor were we able to record the quiet dialogues between teacher and students as they monitored students' work in these small groups. Yet, we know the value of cooperative learning and the benefits for students when teachers work with small groups of children at a time.

Secondly, we did not measure teacher knowledge of *Dynamic Pedagogy* in the context of its application to the mathematics units targeted in our professional development program with participating teachers. Thus, we had no way of knowing whether the differences observed in the implementation of *Dynamic Pedagogy* in the classroom were related to differential quality of their knowledge of *Dynamic Pedagogy* acquired in professional development.

Did Students in *Dynamic Pedagogy* Classrooms Perform Better on Mathematics Achievement Tests Than Students in Non-*Dynamic Pedagogy* Classrooms at the Third and Fourth Grade Levels?

The results of the pilot year indicated that students in *Dynamic Pedagogy* classrooms showed significant differences on the TerraNova Mathematics Subtest in grade 3 favoring *Dynamic Pedagogy* over non-*Dynamic Pedagogy* with significant *Dynamic Pedagogy* by school interactions.

The positive results for the second year were consistent for a sample of students in one fourth grade school. These students were in *Dynamic Pedagogy* and non-*Dynamic Pedagogy* third classrooms the previous year. Again, the students in *Dynamic Pedagogy* classrooms performed significantly better than students in non-*Dynamic Pedagogy* classrooms. For a new cohort of third grade students we conduct separate independent *t*-test analyses of the mean scores for the *Dynamic Pedagogy* and non-*Dynamic Pedagogy* groups in each school. Results indicated significant differences favoring the *Dynamic Pedagogy* students in each school. The results from analysis of performance by achievement levels also favored students in the *Dynamic Pedagogy* group. In comparison with their peers in other third and fourth grade classrooms and the district, the *Dynamic Pedagogy* group had the highest percentage of students who scored at the highest achievement level (level 4) and conversely, had the lowest percentage of students who scored at the lowest level of achievement (level 1) on the mathematics achievement tests for third and fourth grade, respectively.

Although the design of the study was quasi experimental and therefore does not allow us to infer causality, we think that the results are attributable in part, to teachers' knowledge and use of *Dynamic Pedagogy* concepts and principles in their classrooms. More specifically, we believe that the findings provide some support for our thesis that when teachers center what they know and do in curriculum, instruction, and assessment around student learning before, during, and after classroom practice, significant improvement in students' academic achievement can be expected. These findings are consistent with those of other studies that found a relationship between teacher knowledge and student mathematics achievement (Ball & Bass, 2000; Ball, Hill, & Bass, 2005; Carpenter, Fennema, Peterson, Chiang, & Loef, 1989; Hill, Rowan, & Ball, 2005).

Did Students in *Dynamic Pedagogy* Classrooms Perform Better on District Unit Assessments Than Students in Non-*Dynamic Pedagogy* Classrooms at the Third and Fourth Grade Levels?

Our descriptive analyses revealed some interesting findings about the effects of the *Dynamic Pedagogy* intervention on student performance on district assessments of mathematics units that were incorporated within the *Dynamic Pedagogy* professional development. The average performance of students in the *Dynamic Pedagogy* classrooms on these target unit assessments was consistently higher than their counterparts in the non-*Dynamic Pedagogy* classrooms at both third and fourth grade levels. Even more interesting was the finding that when compared with students in the non-*Dynamic Pedagogy* classrooms across schools and district, the highest percentage of students who scored at the highest level of achievement (level 4) came from the *Dynamic Pedagogy* group. In contrast, the lowest percentage of students who scored at the lowest level of achievement (level 1) on these district assessments were from the *Dynamic Pedagogy* group. These findings suggest that *Dynamic Pedagogy* may be better than regular instruction in promoting performance at the highest level of mathematics achievement. Given the generally severe underrepresentation of African American, Hispanic, and Native Americans students among our highest achievers, (National Task Force on Minority High Achievement, 1999), these results suggest that *Dynamic Pedagogy* as an intervention may hold promise for promoting very high academic achievement among a larger numbers of African American, Hispanic, and Native American children.

Were There Differences in Third and Fourth Grade Mathematics Achievement Among Different Race/Ethnic Groups?

It may be recalled that the school district in which the study was conducted served a high proportion of African American and Hispanic students (70%) and a low proportion of Asian and White students (30%). The results from an independent *t*-test analysis of performance between Asian and White students in *Dynamic Pedagogy* classrooms versus Asian and White students in non-*Dynamic Pedagogy* classrooms showed no significant differences between the 2 groups for Flatland but significant differences between the 2 groups at Homeland, favoring the *Dynamic Pedagogy* group by approximately 70 points. Caution should be taken with this latter comparison, though, since the number of subjects in the non-*Dynamic Pedagogy* group was extremely small (n = 3). In contrast, the results for the comparisons of African American and Hispanic students in *Dynamic Pedagogy* classroom versus African American and Hispanic students in non-*Dynamic Pedagogy* classroom showed significant differences for both schools. The difference favored the *Dynamic Pedagogy* students by approximately 20 points at Flatland and approximately 30 points at Homeland. Race/ethnic comparisons of students in *Dynamic Pedagogy* and non-*Dynamic Pedagogy* fourth grade classrooms at Hearst revealed a similar pattern of performance as at the third grade level. There were significant differences in performance on the mathematics achievement test between Asian and White students in *Dynamic Pedagogy* classrooms versus Asian and White students in non-*Dynamic Pedagogy* classrooms. The difference favored the *Dynamic Pedagogy* students by approximately 53 points but again caution should be taken with this comparison, since the number in both the *Dynamic Pedagogy* and non-*Dynamic Pedagogy* groups was small. A similar significant difference was observed for the African American and Hispanic students in *Dynamic Pedagogy* classrooms versus African American and Hispanic students in non-*Dynamic Pedagogy* classrooms at Hearst with the difference favoring the *Dynamic Pedagogy* students by approximately 31 points.

These results suggest that the *Dynamic Pedagogy* treatment may be affecting race/ethnic groups differently at different grades and at different schools. At the third grade, African American and Hispanic students at Flatland seem to be benefiting from *Dynamic Pedagogy* exposure, but the intervention appeared to have no significant effect on the performance of Asian and White students. At Homeland, the Asian and White students seem to be benefiting more than the African American and Hispanic students as a group. And, at the fourth grade, Asian and White students appear to be benefiting more from the *Dynamic Pedagogy* treatment than their African American and Hispanic counterparts at Hearst. Readers are reminded to interpret these differences with caution because of the small or unequal sample size of the race/ethnic groups. However, this does not necessarily imply that the findings are without merit, since any educational intervention that contributes to the improvement of children's academic achievement irrespective of their race/ethnicity is positive news for schools, communities, and society in general. But, for educators who continue to look for ways of improving the academic achievement of African American and Hispanic students, these findings are particularly noteworthy.

Conclusions

In this study, we developed a new approach to teaching that we call *Dynamic Pedagogy* and explored its impact on the mathematics achievement of minority students at the third and fourth grade levels. The intervention was piloted in 5 K-3 elementary schools in the suburban district of East Ramapo, New York during the 2003-2004 academic year. The next year, the intervention was implemented in 2 K-3 schools and 1 4-8 school within the same school district.

Three assumptions of the model guided our work. The first assumption is that curriculum, instruction, and assessment are interdependent processes. The second assumption of the model is that teacher thoughts and decisions about curriculum-instruction-assessment are centered around learners' strengths and needs before, during, and after classroom practice. And the third assumption of the model is that students are responsive to the teacher's decisions and actions about curriculum, instruction, and assessment in ways that promote their learning.

We found evidence of the efficacy of the model in teachers' preplanning thoughts, lesson plans, classroom practice, and post lesson reflections. Evidence of student responsiveness was seen in students' quality of engagement in classroom activities as well as on their performance on mathematics achievement tests and district assessments of mathematics units that were incorporated in the professional development for participating teachers. Our analysis of the data disaggregated by achievement levels (1, 2, 3, 4) revealed that a higher percentage of *Dynamic Pedagogy* students when compared to their non-*Dynamic Pedagogy* counterparts performed at the highest level of achievement. And, finally, our results showed differential impact of *Dynamic Pedagogy* on the mathematics achievement of different race/ethnic groups. Our results are consistent with research that suggests that what teachers know and do can have a profound impact on student motivation, learning, and achievement.

There are at least 3 implications of this work for future research. First, we should modify our teacher-interaction observation protocol to capture student-student and teacher-student conversations in small groups. We would also need to develop additional measures of student academic engagement beyond samples of their work and observation of their learning behaviors in the classroom. Secondly, we would need to measure teacher knowledge of *Dynamic Pedagogy* in the context of actual mathematics units prior to teachers' lesson planning and classroom practice. And, finally, we would need to identify measures that would more accurately account for differences in student achievement prior to the intervention and to figure out ways to ensure equivalent samples for treatment and comparison groups.

A second line of inquiry is to explore the efficacy of *Dynamic Pedagogy* to increase the number of ethnic minority children who perform at the highest level of achievement. Recent reports have documented that one reason for the achievement gap is the underrepresentation of African American, Hispanic, and Native American children among high achieving students (National Study Group for the Affirmative Development of Academic Ability, 2004; National Task Force on Minority High Achievement, 1999). This means that future studies of *Dynamic Pedagogy* would need to be designed in ways that maximize reliable and valid comparisons of its effects among different race/ethnic groups. Also, more sustained exposure to *Dynamic Pedagogy* beyond the classroom in conjunction with access to educationally-relevant capital may be needed to promote achievement at the highest level for a larger number of African American and Hispanic students.

Finally, a third line of research is to examine knowledge of *Dynamic Pedagogy* principles and concepts among novice and more experienced teachers and to ascertain its influence on their teaching before, during, and after classroom practice. The growing recognition that teacher knowledge is an important marker of teacher effectiveness has led to serious interest among education administrators and policy makers seeking to ensure that teachers in every classroom have the kind of knowledge that contributes to effective teaching and improved student outcomes. Continuing research with the *Dynamic Pedagogy* model holds promise for not only adding to our knowledge base about the multidimensionality of teacher pedagogical content knowledge, but also for contributing to our understanding of the mechanisms by which such knowledge impacts student motivation learning and achievement.

Although the short-term goal was the primary focus of this study, we present in Appendix I a report with the results of our preliminary investigation about the long-term goal of the project.

References

Adams, G. L., & Engelmann, S. (1996). *Research on Direct Instruction: 25 years beyond DISTAR*. Seattle, WA: Educational Achievement Systems.

Armour-Thomas, E., & Szczesiul, E. (1989). *A review of the knowledge base of the Connecticut Competency Instrument*. Hartford, CT: Connecticut State Department of Education, Bureau of Research and Teacher Assessment.

Artzt, A. F., & Armour-Thomas, E. (2002). *Becoming a reflective mathematics teacher: A guide for observations and self-assessment*. Mahwah, NJ: Lawrence Erlbaum Associates.

Ball, D. L. (1990). The mathematical understanding that prospective teachers bring to teacher education. *Elementary School Journal*, *90*, 449- 466.

Ball, D. L., & Bass, H. (2000). Interweaving content and pedagogy in teaching and learning to teach: Knowing and using mathematics. In J. Boaler (Ed.), *Multiple perspectives on the teaching and learning of mathematics* (pp. 83-104). Westport, CT: Ablex.

Ball, D. L., Hill, H. C., & Bass, H. (2005). Knowing mathematics for teaching. *American Educator, 29*(3), 14-46.

Borko, H., Eisenhart, M., Brown, C. A., Underhill, R. G., Jones, D., & Agard, P. C. (1992). Learning to teach hard mathematics: Do novice teachers and their instructors give up too easily*? Journal for Research in Mathematics Education, 23,* 194-222.

Brophy, J., & Good, T. L. (1986). Teacher behavior and student achievement. In M. C. Wittrock (Ed.), *Handbook on research on teaching* (3rd ed., pp. 328-375). New York: Simon & Schuster.

Campione, J. C. (1989). Assisted assessment: A taxonomy of approaches and an outline of strengths and weaknesses. *Journal of Learning Disabilities*, *22*(3), 151-165.

Carpenter, T. P., Fennema, E., Peterson, P. L., Chiang, C. P., & Loef, M. (1989). Using knowledge of children's mathematics thinking in classroom teaching: An experimental study. *American Educational Research Journal*, *26,* 499-531.

Darling-Hammond, L., & Ball, D. L. (1997). *Teaching for high standards: What policymakers need to know and be able to do*. Philadelphia: Consortium for Policy Research in Education Publications, University of Pennsylvania.

Ferguson, R. F. (1991). Paying for public education: New evidence on how and why money matters. *Harvard Journal on Legislation*, *28*, 458-498.

Feuerstein, R., Rand, Y., & Hoffman, M. B. (1979). *The dynamic assessment of retarded performers: The learning potential assessment device theory, instruments, and techniques*. Baltimore: University Park Press.

Flavell, J. H. (1979). Metacognition and cognitive monitoring. *American Psychologist, 34,* 906-911.

Frederiksen, J. R., & Collins, A. (1989). A systems approach to educational testing. *Educational Researcher, 18*(9), 27-32.

Gage, N. L., & Needels, M. C. (1989). Process-product research on teaching: A review of criticism. *Elementary School Journal, 89,* 253-300.

Gickling, E., & Havertape, J. (1981). *Curriculum-based assessment (CBA)*. Minneapolis, MN: National School Psychology In-service training Network.

Gordon, E. W. (2001). Affirmative development of academic abilities. *Pedagogical Inquiry and Praxis, No. 2*. New York: Institute for Urban and Minority Education, Teachers College, Columbia University.

Gordon, E. W. (1998). *Toward a definition of pedagogy*. Working paper prepared for the National Research Council's Committee on Early Childhood Pedagogy.

Grossman, P. L. (1990). *The making of a teacher: Teacher knowledge and teacher education*. New York: Teachers College Press.

Harbison, R. W., & Hanushek, E. A. (1992). *Educational performance for the poor: Lessons from rural northeast Brazil*. Oxford, England: Oxford University Press.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal, 42*(2), 371-406.

Jackson, P. W. (1968). *Life in classrooms*. New York: Holt, Rinehart & Winston.

Meyer, D. K., & Turner, J. C. (2002). Using instructional discourse analysis to study the scaffolding of student self-regulation. *Educational Psychologist, 37*(1), 17-25.

Meyer, L. A. (1984). Long-term academic effects of the Direct Instruction follow-through. *Elementary School Journal, 84,* 380-394.

National Commission on Teaching and America's Future. (1996). *What matters most: Teaching for America's future*. Washington, DC: Author.

National Study Group for the Affirmative Development of Academic Ability. (2004). *All students reaching the top: Strategies for closing academic achievement gaps*. New York: The College Board.

National Task Force on Minority High Achievement. (1999). *Reaching the top*. New York: Author.

Paris, S. G., & Newman, R. S. (1990). Developing aspects of self-regulated learning. *Educational Psychologist, 25*(1), 87-102.

Phillips, M., Crouse, J., & Ralph, J. (1998). Does the Black-White test score gap widen after children enter school? In C. Jencks & M. Phillips (Eds.), *The Black-White test score gap* (pp. 229-272). Washington, DC: Brookings Institution Press.

Schraw, G. (2001). Promoting general metacognitive awareness. In H. J. Hartman (Ed.), *Metacognition in learning and instruction* (pp. 3-16). Dordrecht, Netherlands: Kluwer Academic Publishers.

Schunk, D. H., & Zimmerman, B. J. (1997). Social origins of self-regulatory competence. *Educational Psychologist, 32*(4), 195-208.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15,* 4-14.

Slavin, R. E. (2001). *Educational psychology: Theory and practice*. Boston: Allyn & Bacon.

Sternberg, R. J. (1988). *The triarchic mind: A new theory of human intelligence*. New York: Viking.

Sternberg, R. J. (1986). *Intelligence applied.* Orlando, FL: Harcourt Brace College Publishers.

Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence*. Cambridge, MA: Cambridge University Press.

Stiggens, R. J. (1997). *Student-centered classroom assessment* (2nd ed.). Upper Saddle River, NJ: Merrill/Prentice Hall.

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

Whimbey, A., & Lochhead, J. (1982). *Problem solving and comprehension* (3rd ed.). Philadelphia: Franklin Institute Press.

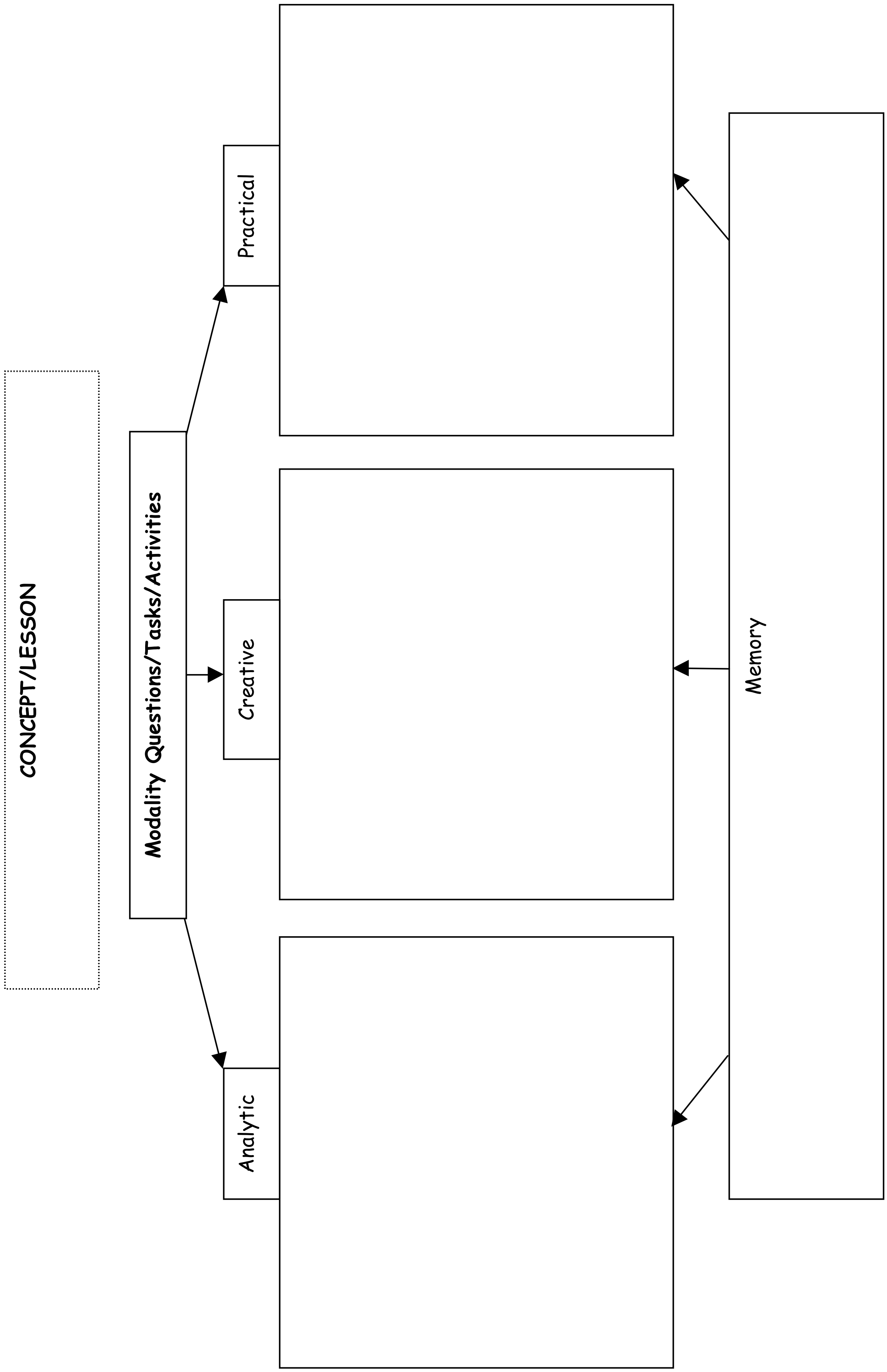
Weinert, F. E., & Helmke, A. (1995). Interclassroom differences in instructional quality and interindividual differences in cognitive development. *Educational Psychologist, 30,* 15-20.

Wilson, S. M., Shulman, L. S., & Richert, A. (1987). 150 different ways of knowing: Representations of knowledge in teaching. In J. Calderhead (Ed.), *Exploring teachers' thinking* (pp. 104-124). Sussex, England: Holt, Rinehart and Winston.

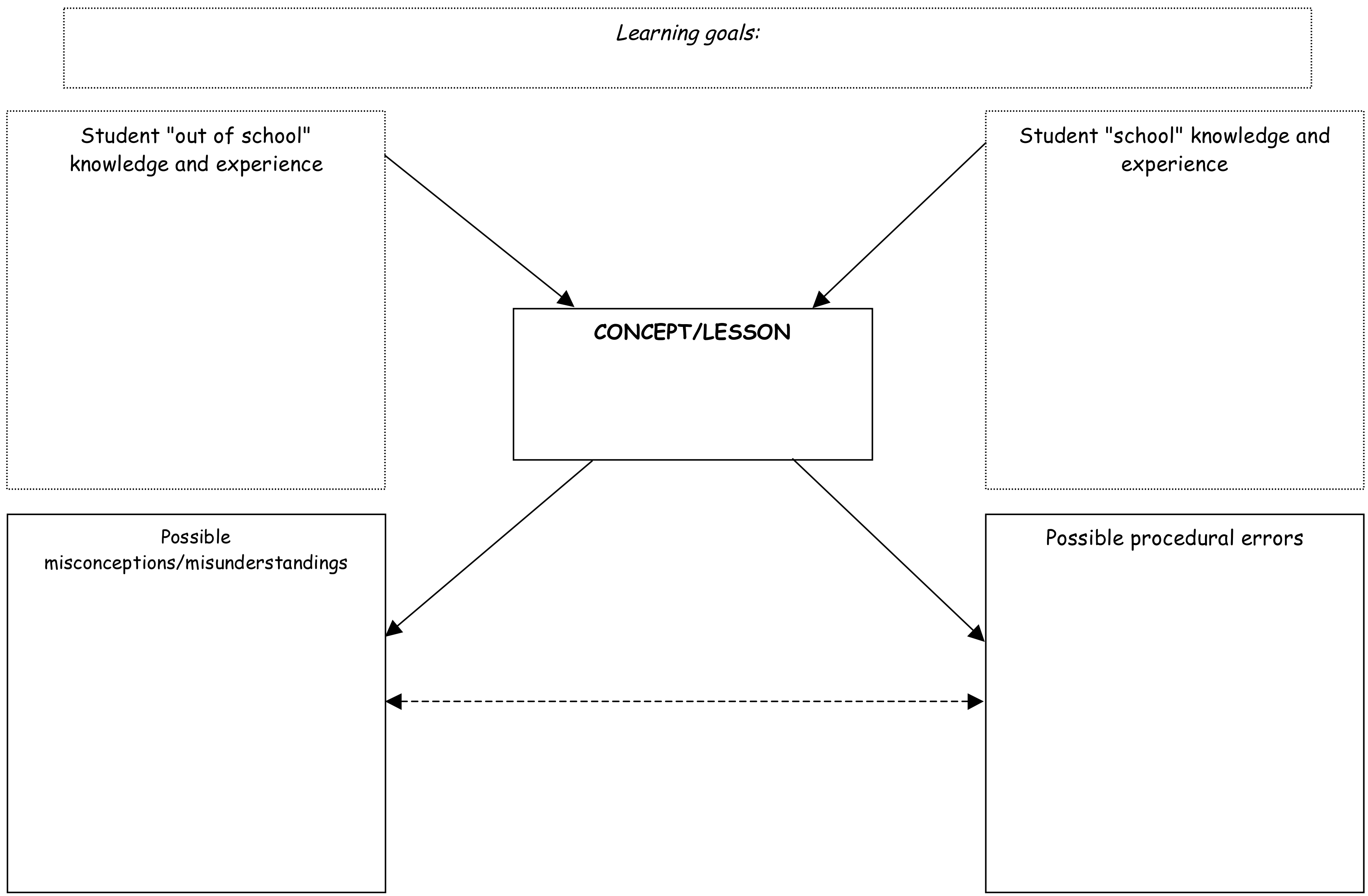
Winne, P. H. (1997). Experimenting to bootstrap self-regulated learning. *Journal of Educational Psychology, 89*(3), 397-410.

Zimmerman, B. J. (1989). A social cognitive view of self-regulated learning. *Journal of Educational Psychology*, *81,* 329-339.

APPENDIX A
Lesson Preplanning Template (1)


CONCEPT/LESSON
Modality Questions/Tasks/Activities
Practical
Creative
Analytic
Memory

APPENDIX B:
Lesson Preplanning Template (2)


Learning goals:
Student "out of school" knowledge and experience
Student "school" knowledge and experience
CONCEPT/LESSON
Possible misconceptions/misunderstandings
Possible procedural errors

APPENDIX C:
Lesson Plan Template

LESSON PLAN
Goals for the unit:

Objectives of the lesson:

Materials:

LESSON PHASES:
Initiation:

LESSON PHASES *continued*:
Development:

Closure:

APPENDIX D:
Dynamic Pedagogy Indicators in the Classroom

Dynamic Pedagogy Indicators in the Classroom

This protocol is designed for observing classes taught by teachers trained in using *Dynamic Pedagogy* methods and strategies. It is designed to assist observers in documenting patterns of behaviors within the context of classroom instruction. The focus is on teacher behaviors, student behaviors, and teacher-student or student-student behaviors. The observer will keep a running record of "what's occurring" (including examples of what the teacher and the students are doing or saying) within each phase of the lesson: *Initiation*, *Development*, and *Closure*.

Using *Dynamic Pedagogy* principles, indicators were developed for guiding observation of teacher-student interactions that may occur in any phase of the lesson (Initiation, Development, and Closure). The *curriculum* component of *Dynamic Pedagogy* consists of 6 indicators each of which describes a critical aspect of a task: cognitive modality (creative, analytical, memory, and practical); difficulty level; sequencing; motivational appeal; mode of representation; and degree of familiarity/novelty. The *assessment* component of *Dynamic Pedagogy* has one indicator with two features: probing with feedback; and probing with wait-time. And, finally, the indicators for the *instructional* component are: scaffolding, modeling, explaining, monitoring, regulating, shared practice, and independent practice.

Curriculum Indicators

The curriculum strand of *Dynamic Pedagogy* consists of the following:

Analytical: Tasks that require students to break down a concept or a skill into its basic elements and to determine its essential features and their relationships. Analytical tasks involve convergent thinking—bringing different pieces of information together to solve a problem with a predetermined answer. Such tasks are unrelated to the real-world or everyday experiences of students. **C-A**

Creative: Tasks that require students to invent, imagine, or discover in a situation that is new or novel to them. Creative tasks involve divergent thinking—beginning with one idea, and taking it in different directions to solve a problem with no predetermined answer. **C-C**

Practical: Tasks that require students to use their real-world experiences or everyday life to generate a response to the question posed. Practical tasks involve either convergent and or divergent thinking, depending on the nature of the problem in a particular situation or context. **C-P**

Memory: Tasks that require students to recall what they know and can do in any modality (creative, analytical, or practical). **C-M**

Assessment Indicators

The assessment strand of *Dynamic Pedagogy* consists of the following:

Declarative: Questions that probe for knowledge of facts, procedures, or strategies in a domain of interest. **A-D**

Procedural: Questions that probe for knowledge of how to perform certain procedures/strategies in a domain of interest. **A-P**

Conceptual: Questions that probe to determine the level of students' understanding of concepts or questions that require students to justify and or explain their understanding of concepts in a domain of interest. **A-C**

Metacognitive: Questions that probe for students' awareness of their own thinking processes and questions about their skill in managing their thinking processes in a given domain of interest. **A-M**

Wait-time: The amount of time allowed by the teacher for student to respond to a question. The more complex the probe (i.e., the cognitive processing demands) the longer the wait time. **A-W**

Other: Questions that probe for clarification, explanation, and/or elaboration of student response; questions that solicit student participation. **A-O**

Instructional Indicators

The instruction strand of *Dynamic Pedagogy* consists of the following:

Scaffolding: Providing guidance and support for learning. It involves a shared understanding between the teacher and the student of a task that is not too easy or difficult but which the student is capable of learning. Prompts, hints, cues are examples of scaffolding techniques. **I-S**

Modeling: Demonstration with verbal descriptions of the thought or action to be imitated. **I-MOD**

Explaining: Giving directions or explicit explanations about a task. **I-E**

Monitoring: Checking to ascertain understanding. **I-MON**

Regulating: Making adjustments to instruction as a result of information gathered through monitoring. **I-R**

Feedback: Responding to students: (e.g., providing positive reinforcement to student response, acknowledging student response, correcting student response). **I-F**

Shared practice: Providing opportunity for students to practice newly acquired skills with assistance from teacher or capable peer. **I-SP**

Independent practice: Providing opportunity for students to practice newly acquired skills without the assistance from teacher or capable peer. **I-IP**

Other: Giving instructions or directions relevant to the lesson. **I-O**

Student Engagement Indicators

Asking questions of teacher **S-Q**

Responding to teacher's question **S-R**

Working on task alone **S-A**

Working on task with peers **S-P**

Demonstrating work on blackboard **S-D**

Watching and listening (whole group) **S-WG**

Watching and listening in small group **S-SG**

Raising hands in response to the teacher's questions **S-RH**

Lesson Phases Indicators

Lesson phases describe a temporal structure within which all the critical teaching-learning experiences unfold over the course of a lesson. Each is described below:

Initiation phase: The teacher asks questions and makes statements that connect to children's prior knowledge and skills to enable their readiness for the objectives of the lesson. **P-I**

Development phase: The teacher asks questions and makes statements that build on what they already know and can do to develop new knowledge and skills. In addition, questions or statements are about students' progress toward the goals and objectives of the lesson. **P-D**

Closure phase: The teacher asks questions and makes statements about achievement of lesson objectives; such questions and statements reinforce or consolidate newly acquired knowledge and skills and require students to demonstrate understanding and skills to other contexts. **P-C**

APPENDIX E:
Teacher-Student Interaction Protocol (T-SIP)

Teacher-Student Interaction Protocol
(Summary of Classroom Observation)

Observer:	**Teacher:**
Date of Visit:	**# of students present:**
Start of observation:	
End of observation:	

Phase of the lesson observed: INITIATION

The purpose of the **INITIATION** *phase of the lesson is to support or help students to get ready for the objectives of the lesson. This means that students must have opportunities for (a) activating their prior knowledge and skills relevant to the new content; (b) arousing their motivation; and (c) becoming aware of their own thinking about what they already know and can do. The teacher may use a combination of diagnostic probes and mediational strategies with creative, practical, or analytical tasks to help student demonstrate readiness for the objectives of the lesson.*

Teacher Curriculum Behaviors

Please circle the number that corresponds to the teacher's use of Dynamic Pedagogy *curriculum indicators*

all	many	some	very few	none
1	2	3	4	5

Notes/Explanation/Examples

Teacher Assessment Behaviors

Please circle the number that best corresponds to the teacher's use of Dynamic Pedagogy *assessment indicators*

all	many	some	very few	none
1	2	3	4	5

Notes/Explanation/Examples

Teacher Instructional Behaviors

Please circle the number that best corresponds to the teacher's use of Dynamic Pedagogy *instructional indicators*

all	many	some	very few	none
1	2	3	4	5

Notes/Explanation/Examples

Student Behaviors

Please circle the number that corresponds to the number of students engaged in the activities during this phase of the lesson

many	some	few
1	2	3

Notes/Explanation/Examples

Please circle the number that best corresponds to the quality of students' engagement in the activities during this phase of the lesson

very high	high	moderate	low	off-task
1	2	3	4	5

Student Behaviors

Please circle the number that best corresponds to the quality of students' engagement of the activities of the lesson

very high	high	moderate	low	off-task
1	2	3	4	5

Notes/Explanation/Examples

Teacher-Student Behaviors

Please circle the number that best corresponds to the quality of teacher-student interactions over the duration of the lesson

very high	high	moderate	low	off-task
1	2	3	4	5

Notes/Explanation/Examples

Phase of the lesson observed: DEVELOPMENT

The purpose of the **DEVELOPMENT** *phase of the lesson is to support or help students to demonstrate progress toward the lesson objectives. This means that students must have opportunities to (a) recognize or make sense of relationships between and among concepts and procedures; (b) understand concepts, processes, and relationships; (c) linking new information with prior knowledge in new ways; (d) to explain their thinking, to make and explore conjectures or hunches; (e) to try out their understanding or practice new skills with peers or under the guidance of the teacher; (f) become aware of their own thinking processes and consciously use their own thinking skills for learning; and (g) sustain their motivation. The teacher may use a combination of learning probes and mediational strategies with creative, practical, or analytical tasks to help or support student to demonstrate progress toward the objectives of the lesson.*

Teacher Curriculum Behaviors

Please circle the number that corresponds to the teacher's use of Dynamic Pedagogy *curriculum indicators during this phase of the lesson*

all	**many**	**some**	**very few**	**none**
1	2	3	4	5

Notes/Explanation/Examples

Teacher Assessment Behaviors

Please circle the number that best corresponds to the teacher's use of Dynamic Pedagogy *assessment indicators during this phase of the lesson*

all	**many**	**some**	**very few**	**none**
1	2	3	4	5

Notes/Explanation/Examples

Teacher Instructional Behaviors

Please circle the number that best corresponds to the teacher's use of Dynamic Pedagogy *instructional indicators during this phase of the lesson*

all	many	some	very few	none
1	2	3	4	5

Notes/Explanation/Examples

Student Behaviors

Please circle the number that corresponds to the number of students engaged in the activities during this phase of the lesson

many	some	few
1	2	3

Notes/Explanation/Examples

Please circle the number that best corresponds to the quality of students' engagement in the activities during this phase of the lesson

very high	high	moderate	low	off-task
1	2	3	4	5

Teacher-Student Behaviors

Please circle the number that best corresponds to the quality of teacher-student interactions over the duration of this phase of the lesson

very high	high	moderate	low	off-task
1	2	3	4	5

Notes/Explanation/Examples

Phase of the lesson observed: CLOSURE

The purpose of the **CLOSURE** *phase of the lesson is to support or help students to demonstrate attainment of the lesson objectives. This means students must have opportunities for (a) reinforcement or consolidation of new knowledge and skills on their own; (b) integration and extension of new knowledge and skills to different contexts or situations on their own; (c) explain their thinking and justify their reasoning; (e) showing awareness of their own thinking and strategies they used in their own learning; and (d) sustaining their motivation. The teacher may use a variety of formative probes and mediational strategies with creative, analytical, and practical tasks in helping students to demonstrate achievement of the objectives of the lesson.*

Teacher Curriculum Behaviors:

Please circle the number that corresponds to the teacher's use of Dynamic Pedagogy *curriculum indicators during this phase of the lesson*

all	**many**	**some**	**very few**	**none**
1	2	3	4	5

Notes/Explanation/Examples

Teacher Assessment Behaviors

Please circle the number that best corresponds to the teacher's use of Dynamic Pedagogy *assessment indicators during this phase of the lesson*

all	**many**	**some**	**very few**	**none**
1	2	3	4	5

Notes/Explanation/Examples

Teacher Instructional Behaviors

Please circle the number that best corresponds to the teacher's use of Dynamic Pedagogy *instructional indicators during this phase of the lesson*

all	many	some	very few	none
1	2	3	4	5

Notes/Explanation/Examples

Student Behaviors

Please circle the number that corresponds to the number of students engaged in the activities during this phase of the lesson

many	some	few
1	2	3

Notes/Explanation/Examples

Please circle the number that best corresponds to the quality of students' engagement in the activities during this phase of the lesson

very high	high	moderate	low	off-task
1	2	3	4	5

Teacher-Student Behaviors

Please circle the number that best corresponds to the quality of teacher-student interactions over the duration of this phase of the lesson

very high	high	moderate	low	off-task
1	2	3	4	5

Notes/Explanation/Examples

APPENDIX F:
Teacher-Student Interaction Rubric (T-SIR)

Teacher-Student Interactions Rubric

Three conditions should be considered in arriving at a judgment about the quality of teacher-student interactions:

Condition One:
The *number* of students with which the teacher is engaged in a given phase of a lesson;

Condition Two:
Whether the quality of the teacher's *pattern of discourse* is in alignment with the purpose of the phase of the lesson under observation;

Condition Three:
The *number* of students engaged in the activities of a given phase of a lesson.

During the phases of the lesson, teachers should. . .

support or help students to demonstrate readiness for the lesson's objectives *(initiation phase)***

support or help students to demonstrate progress toward the objectives of the lesson *(development phase)***

support or help students to demonstrate achievement of the lesson objectives *(closure phase)***

Pattern of discourse is defined as a combination of *Dynamic Pedagogy* indicators (curriculum, instruction, and assessment) that teachers judiciously select and use in response to the students' learning behaviors. In other words, the focus is not on the frequency of use of individual indicators by the teacher but rather on the **selection** of a particular cluster of indicators and how the teacher orchestrates them in supporting students' learning in any given phase of the lesson. Using the reverse, observers can assign a "score" that best captures the range of teacher-student interactions.

Score 4 =	The teacher interacts with many (6-10) children The teacher's use of *Dynamic Pedagogy* indicators is strongly in alignment with the purpose of the given phase of the lesson (i.e., Initiation, Development, and Closure, respectively)
Score 3 =	The teacher interacts with some (3-5) children The teacher's use of *Dynamic Pedagogy* indicators is strongly in alignment with the purpose of the given phase of the lesson (i.e., Initiation, Development, and Closure, respectively) OR The teacher interacts with many children The teacher's use of *Dynamic Pedagogy* indicators is moderately in alignment with the purpose of the given phase of the lesson (i.e., Initiation, Development, and Closure, respectively)
Score 2 =	The teacher interacts with many children The teacher's use of *Dynamic Pedagogy* indicators is weakly in alignment with the purpose of the given phase of the lesson (i.e., Initiation, Development, and Closure, respectively) OR The teacher interacts with some children The teacher's use of *Dynamic Pedagogy* indicators is moderately in alignment with the purpose of the given phase of the lesson (i.e., Initiation, Development, and Closure, respectively)
Score 1 =	The teacher interacts with few (1-2) children The teacher's use of *Dynamic Pedagogy* indicators is weakly in alignment with the purpose of the given phase of the lesson (i.e., Initiation, Development, and Closure, respectively)
Score 0 =	The teacher interacts with students (many, some or few) The teacher's use of *Dynamic Pedagogy* indicators is in non-alignment with the purpose of the given phase of the lesson (i.e., Initiation, Development, and Closure, respectively)

APPENDIX G:
Dynamic Pedagogy Teacher Exit Questionnaire

IUME Dynamic Pedagogy Exit Questionnaire

Please complete the following. We are interested in learning what you think about elementary students, mathematics teaching, and *Dynamic Pedagogy*. Your answers will be used to help us plan future sessions and develop research questions about effective professional development for elementary school teachers. Your answers will be held in complete confidence and seen only by IUME research team members.

Name ____

School where you teach __________________________________ **Grade** _______

I. Please indicate the degree to which you agree with the following statements:

A. The best mathematics students. . .

	Strongly Disagree					Strongly agree
Try really hard when solving mathematics problems	1	2	3	4	5	6
Are good problem solvers	1	2	3	4	5	6
Make all As and Bs in school	1	2	3	4	5	6
Have high standardized mathematics test scores	1	2	3	4	5	6
Solve problems the way that I would solve them	1	2	3	4	5	6
Don't have to work hard to get good grades in mathematics	1	2	3	4	5	6
Have parents who are active and involved	1	2	3	4	5	6
Don't talk a lot in class	1	2	3	4	5	6
Work alone most of the time	1	2	3	4	5	6

B. Some students struggle with mathematics. One thing that *most* influences student improvement in third grade (or fourth grade) mathematics is. . .

	Strongly Disagree					Strongly agree
Student motivation to improve	1	2	3	4	5	6
Practicing procedures	1	2	3	4	5	6
Memorizing skills	1	2	3	4	5	6
Practicing problem solving techniques	1	2	3	4	5	6
Giving remedial work to student	1	2	3	4	5	6
Exposing student to challenging problems	1	2	3	4	5	6
Socioeconomic status of the student's family	1	2	3	4	5	6
Whether or not the student is disruptive in class	1	2	3	4	5	6
Teacher's belief that the student can be a good mathematics student	1	2	3	4	5	6
Student self-diagnosing and correcting their errors	1	2	3	4	5	6

II. Circle the number on the continuum that best represents your opinion about the following:

A. Mathematics is. . .

A dynamic, expanding body of knowledge	1	2	3	4	5	A fixed, unchanging body of knowledge
Working alone to solve problems	1	2	3	4	5	Working collaboratively to solve problems
Predictable	1	2	3	4	5	Surprising
Difficult most of the time	1	2	3	4	5	Easy most of the time
To be appreciated for its beauty	1	2	3	4	5	To be appreciated for its usefulness

B. Learning mathematics requires mostly. . .

Practice	1	2	3	4	5	Intuition
Independent work	1	2	3	4	5	Group work
Good teachers	1	2	3	4	5	Strong students
Trying hard	1	2	3	4	5	Being good at math
Memorizing	1	2	3	4	5	Understanding

C. Good mathematics teaching entails, or depends on. . .

A good textbook	1	2	3	4	5	Use of manipulatives
Teacher direction	1	2	3	4	5	Student participation
Teacher effort	1	2	3	4	5	Student effort
Explicit planning	1	2	3	4	5	Flexible lessons
Helping students to like mathematics	1	2	3	4	5	Helping students to see mathematics as useful
Helping students to self-assess and correct their own mistakes	1	2	3	4	5	Showing students their mistakes and demonstrating how to solve a problem correctly

Please circle the number that represents your opinion of the helpfulness of the following components of *Dynamic Pedagogy* professional development:

	Of little help					Very helpful
Opportunities for discussion of *Dynamic Pedagogy* principles	1	2	3	4	5	6
Opportunities for analysis and reflection of your use of *Dynamic Pedagogy* principles in the classroom	1	2	3	4	5	6
Opportunities for developing your own *Dynamic Pedagogy* lesson plans	1	2	3	4	5	6
Dynamic Pedagogy lesson plans as resources for your use in the classroom	1	2	3	4	5	6
Discussions about examining and analyzing student work	1	2	3	4	5	6
Opportunities to work on mathematics problems collaboratively with fellow teachers	1	2	3	4	5	6
Exploration and discussion of elementary school mathematics concepts	1	2	3	4	5	6
Other (please describe)…	1	2	3	4	5	6

<u>Recommendations for professional development:</u>

Please circle the number that best represents your opinion of the usefulness of completing/providing each of the following components of the *Dynamic Pedagogy* portfolio:

	Not useful					Very useful
Preplanning template	1	2	3	4	5	6
Lesson plan	1	2	3	4	5	6
Teacher self-assessment	1	2	3	4	5	6
Samples of student work (including journal writing)	1	2	3	4	5	6
Student work analysis (categorizing student work)	1	2	3	4	5	6
Teacher –designed assessment	1	2	3	4	5	6

<u>Recommendations for portfolio component:</u>

Please circle the number that best corresponds to the frequency with which you used each of the indicators of *Dynamic Pedagogy* in your classroom practice:

	Infrequently Disagree...					Very frequently
Analytic tasks	1	2	3	4	5	6
Creative tasks	1	2	3	4	5	6
Practical tasks	1	2	3	4	5	6
Memory tasks	1	2	3	4	5	6
Modeling strategies	1	2	3	4	5	6
Scaffolding strategies	1	2	3	4	5	6
Explaining	1	2	3	4	5	6
Monitoring	1	2	3	4	5	6
Regulating	1	2	3	4	5	6
Shared practice (students)	1	2	3	4	5	6
Independent practice	1	2	3	4	5	6
Declarative probing (Questions that elicit knowledge of facts, procedures)	1	2	3	4	5	6
Procedural probing (Questions that seek knowledge of how to perform certain procedures)	1	2	3	4	5	6
Conceptual probing (Questions that seek understanding of math concepts)	1	2	3	4	5	6
Metacognitive (questions that seek children's awareness and control of their own thinking)	1	2	3	4	5	6
Wait-time (sufficient time for student to respond to teacher questions)	1	2	3	4	5	6

Please circle the number that represents your opinion of the frequency with which you used the following phases to organize your classroom practice:

	Infrequently Disagree...					Very frequently
Initiation	1	2	3	4	5	6
Development	1	2	3	4	5	6
Closure	1	2	3	4	5	6

Please circle the number that represents your opinion of the impact of *Dynamic Pedagogy* on each of the following aspects of your teaching:

	Weak impact	....	....	....	....	Strong impact
Knowledge of how children learn	1	2	3	4	5	6
Knowledge of mathematics content	1	2	3	4	5	6
Knowledge of instructional strategies	1	2	3	4	5	6
Skill in developing a lesson plan	1	2	3	4	5	6
Skill in classroom practice	1	2	3	4	5	6
Skill in evaluating your own classroom practice	1	2	3	4	5	6
Beliefs about how children learn	1	2	3	4	5	6
Beliefs about the content of mathematics	1	2	3	4	5	6
Beliefs about the teacher's role in student learning	1	2	3	4	5	6

What kind of impact do you think *Dynamic Pedagogy* has had on your students'. . .

	Negative impact	....	.... *no impact*	....	....	Positive impact
Mathematics performance on assessments	1	2	3	4	5	6
Mathematics problem-solving skills	1	2	3	4	5	6
Mathematics conceptual understanding	1	2	3	4	5	6
Mathematics procedural skill	1	2	3	4	5	6
Metacognitive ability (awareness and control of their own thinking)	1	2	3	4	5	6
Ability to explain their thinking to others	1	2	3	4	5	6
Attitudes about doing mathematics	1	2	3	4	5	6
Other *(please describe):*	1	2	3	4	5	6

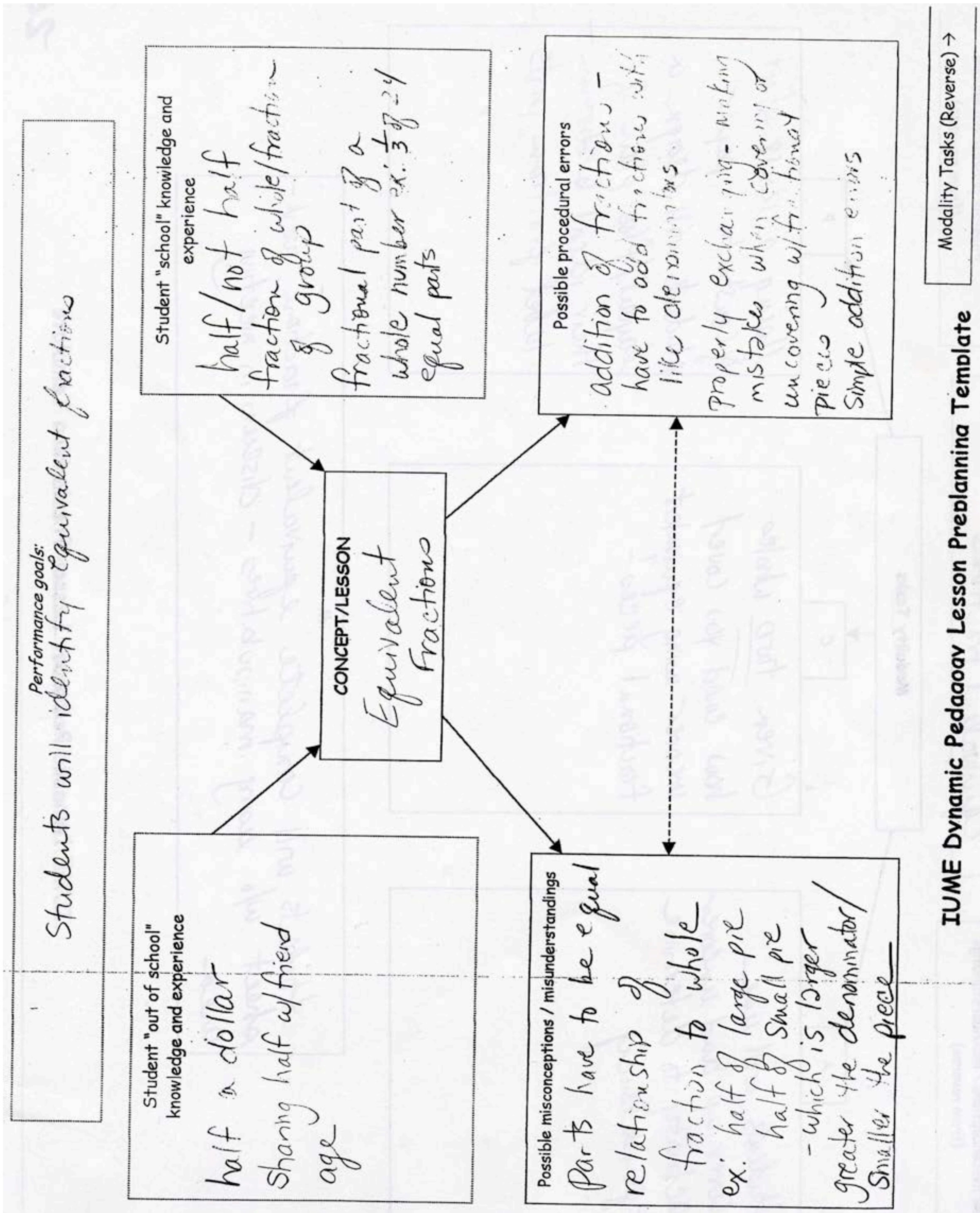
What recommendations would you make to us in continuing *Dynamic Pedagogy* in East Ramapo? ***(Please use reverse if necessary)***

Other comments: *(please use reverse side if necessary)*

THANK YOU VERY MUCH FOR COMPLETING THIS QUESTIONNAIRE. WE APPRECIATE YOUR FEEDBACK.

APPENDIX H:
Teacher Portfolio Samples

Portfolio Sample Year I Teacher



ossible misconceptions / misunderstandings
(from reverse)

Equivalent fractions

Possible procedural errors
(from reverse)

Modality Tasks

A

Students will use cover up and uncover activity to determine equivalency

C

Given ~~two~~ wholes how could you cover/uncover using equivalent fractional pieces?

P

Using a 12x18 sheet of construction paper students will design a layout/floor plan of their ideal bedroom + label fraction parts

M

Students will complete equivalent fraction worksheet w/o using manipulatives - discuss in meeting area

IUME Dynamic Pedagogy Lesson Preplanning Template

LESSON PLAN

Goals for the unit:

Students will explore fractions

Objectives of the lesson:

Students will identify equivalent fractions

Materials:

Student made fraction sets

LESSON PHASES:

Initiation:

In meeting area students will review their knowledge of equivalent fractions

LESSON PHASES *continued:*

Development:

- Review of equivalent fractions — Cover up game
- Introduce fraction uncover game (play 1 or 2 rounds)
- As playing game begin to record fraction number sentences

Closure:

- What did you learn about equivalent fractions?
- Students will share/give examples of their findings
- Students will complete journal entry re: what was learned
  what are equivalent fractions

TEACHER SELF-ASSESSMENT

How did the lesson go?

CURRICULUM

For most of the students, the tasks...

• Were too easy	just right	too hard	
• Were sequenced appropriately:		YES	NO
• Provided sufficient motivation:		YES	NO

• There were enough NOVEL tasks	NONE	A FEW	A LOT
• There were enough tasks with FAMILIAR features	NONE	A FEW	A LOT
• Were there creative tasks	NONE	A FEW	A LOT
• Were there analytical tasks	NONE	A FEW	A LOT
• Were there practical tasks	NONE	A FEW	A LOT
• Were there memory tasks	NONE	A FEW	A LOT

INSTRUCTION

In this lesson the following teaching and learning strategies were present during some phase of the lesson

	Not at all	a little	a lot
Explicit or direct instruction	1	2	3
Teacher modeling	1	2	3
Teacher-student scaffolding	1	2	3
Student-student scaffolding	1	2	3
Small-group scaffolding	1	2	3
Shared practice of knowledge/skills	1	2	3
Independent practice of knowledge/skills	1	2	3
Application of knowledge and skills to other contexts	1	2	3

CIRCLE AS MANY AS APPLY:

Did I use probes in the following ways (with a few students, with most students, with all students, or not at all)?:

	NO	WITH FEW	WITH MOST	WITH ALL
Check for prior developed /emerging knowledge and skills	1	2	3	4
Check for misconceptions	1	2	3	4
Check for procedural mistakes	1	2	3	4
Check for conceptual misunderstandings	1	2	3	4
Solicit elaboration of student ideas	1	2	3	4
Encourage the connection of ideas	1	2	3	4
Check for student awareness of their own thinking	1	2	3	4
Check for student use of metacognitive strategies	1	2	3	4

NOTES

What worked really well?

The children exploring equivalent fractions using the cover game and writing their findings. Needing time to express findings & thoughts.

What didn't work at all?

Time to explore 1/8 + 1/16 more in-depth.

What proportion of students really understand the material? (CIRCLE ONE):

ALL	LESS THAN HALF
MOST	A FEW
HALF	NONE

LESSON: Equivalent fractions - gce **DATE:** 3/22/04

(concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ___4 solve probs A P C ✓ 5 write/explain/justify	L concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ___4 solve probs A P C ✓ 5 write/explain/justify	S: concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ✓ 4 solve probs A P C ✓+ 5 write/explain/justify	K concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ___4 solve probs A P C ✓− 5 write/explain/justify	concrete, everyd ___1 definition abstract,mathemat ___2 procedure ___3 solve probs (1) A P ___4 solve probs A P C ___5 write/explain/justi
Je, concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ✓ 4 solve probs A P C ✓ 5 write/explain/justify	S' concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ___4 solve probs A P C ✓+ 5 write/explain/justify	K concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ✓ 4 solve probs A P C ✓+ 5 write/explain/justify	concrete, everyday ___1 definition abstract,mathematical ___2 procedure ___3 solve probs (1) A P C ___4 solve probs A P C ___5 write/explain/justify	concrete, every ___1 definition abstract,mathemat ___2 procedure ___3 solve probs (1) A P ___4 solve probs A P C ___5 write/explain/justi
J Pairs concrete, everyday ___1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C M ___4 solve probs A P C over 5 write/explain/justify	Judson concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ___4 solve probs A P C ✓+ 5 write/explain/justify	L concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ___4 solve probs A P C ✓ 5 write/explain/justify	concrete, everyday ___1 definition abstract,mathematical ___2 procedure ___3 solve probs (1) A P C ___4 solve probs A P C ___5 write/explain/justify	concrete, every ___1 definition abstract,mathemat ___2 procedure ___3 solve probs (1) A P ___4 solve probs A P C ___5 write/explain/justi
T. verbal concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ___4 solve probs A P C always 5 write/explain/justify	L concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ___4 solve probs A P C ✓ 5 write/explain/justify	S concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ___4 solve probs A P C ✓ 5 write/explain/justify	concrete, everyday ___1 definition abstract,mathematical ___2 procedure ___3 solve probs (1) A P C ___4 solve probs A P C ___5 write/explain/justify	concrete, every ___1 definition abstract,mathemat ___2 procedure ___3 solve probs (1) A P ___4 solve probs A P C ___5 write/explain/justi
K. K concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ✓ 4 solve probs A P C ✓+ 5 write/explain/justify	N. concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ✓ 4 solve probs A P C ✓+ 5 write/explain/justify	J. concrete, everyday ✓ 1 definition abstract,mathematical ✓ 2 procedure ✓ 3 solve probs (1) A P C ___4 solve probs A P C ✓− 5 write/explain/justify	concrete, everyday ___1 definition abstract,mathematical ___2 procedure ___3 solve probs (1) A P C ___4 solve probs A P C ___5 write/explain/justify	concrete, every ___1 definition abstract,mathemat ___2 procedure ___3 solve probs (1) A P ___4 solve probs A P C ___5 write/explain/justi

NAME

Teacher

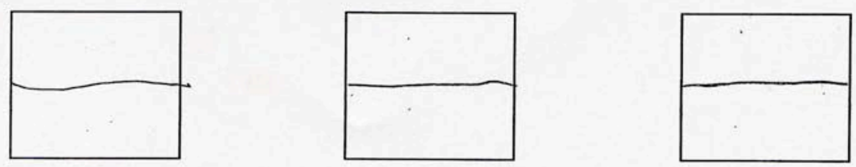
TASK 1.

Partial understanding

Part 1.

Good

Here are 3 square cookies.



Six children want to share these cookies.

(1) **Show** how the children can share these cookies by drawing on the cookies above.

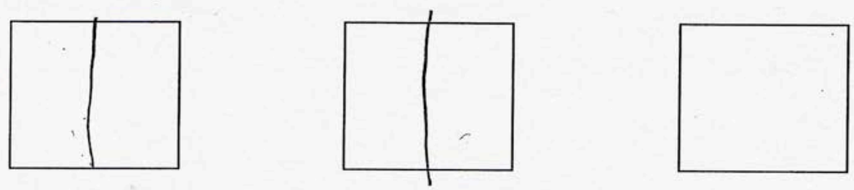
(2) How much of each cookie will each child get? **Write** your answer as a fraction in the sentence below:

Each child will get $\frac{1}{2}$ of each cookie.

Part 2.

Doesn't understand

Here are 3 square cookies.



How can **four** children share these three cookies?

Use the picture above to think about this question. Explain your answer here:

There are 4 kids who want's cookies
so I dived up the 3 cookies
then each kide will one
pices of a cookie

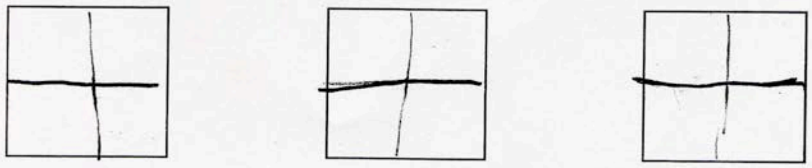
IUME-Dynamic Pedagogy Task

NAME______________________ Teacher ______________________

TASK 1.

Poor understanding
Pictures in Part 2
ok.

Part 1.
Here are 3 square cookies.



Six children want to share these cookies.

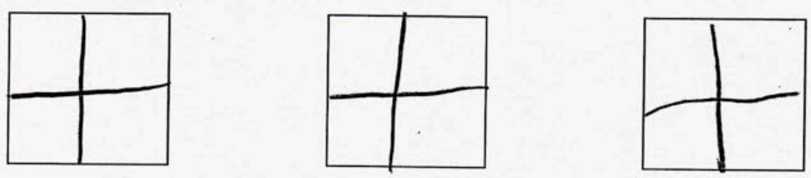
(1) **Show** how the children can share these cookies by drawing on the cookies above.

(2) How much of each cookie will each child get? **Write** your answer as a fraction in the sentence below:

Each child will get $\frac{2}{6}$ of each cookie.

Part 2.

Here are 3 square cookies.



How can **four** children share these three cookies?

Use the picture above to think about this question. Explain your answer here: I think that 4 children Should get 3 cookies each.

NAME ______________________ Teacher ______________________

TASK 1.

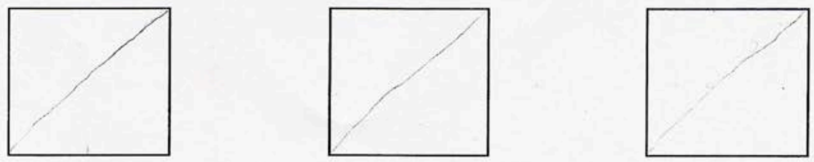
3

Very Good understanding

Interesting division (diagonally)

Part 1.

Here are 3 square cookies.



Six children want to share these cookies.

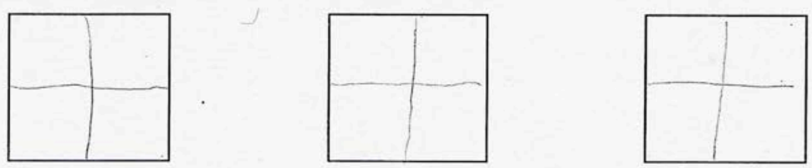
(1) **Show** how the children can share these cookies by drawing on the cookies above.

(2) How much of each cookie will each child get? **Write** your answer as a fraction in the sentence below:

Each child will get $\frac{1}{2}$ of each cookie.

Part 2.

Here are 3 square cookies.



How can **four** children share these three cookies?

Use the picture above to think about this question. Explain your answer here: I got the answer by deviding each cooki into 4 eqaal squares

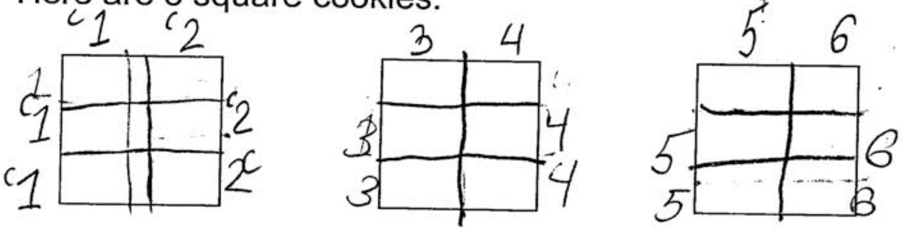
NAME B Teacher

WOW!! Interesting way to solve & divide.

TASK 1. 6 2/3 ??

Part 1.

Here are 3 square cookies.



Six children want to share these cookies.

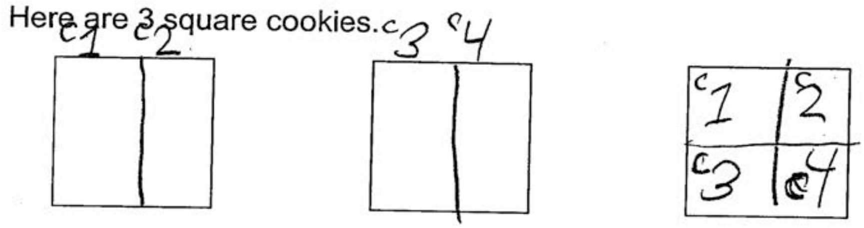
(1) **Show** how the children can share these cookies by drawing on the cookies above.

(2) How much of each cookie will each child get? **Write** your answer as a fraction in the sentence below:

Each child will get 3/18 of each cookie.

Part 2.

Here are 3 square cookies.



3

How can **four** children share these three cookies?

Use the picture above to think about this question. Explain your answer here: They can share these cookies by diviediing 2 in 1/2 and divieding the third one in 4ths, Interesting. Doesn't add fractions with like denominators

Journal

What are equivalent fractions?

They are fractions that makes the whole like 2 1/16 = 1/8. or 2 1/8 = 1/4.

What did you learn about equivalent fractions from this activity?

that 2 1/4 can make 1/2 and 2 1/2 makes 1 whole

Name ________________ Date 3-22-04
Class 3-w Math

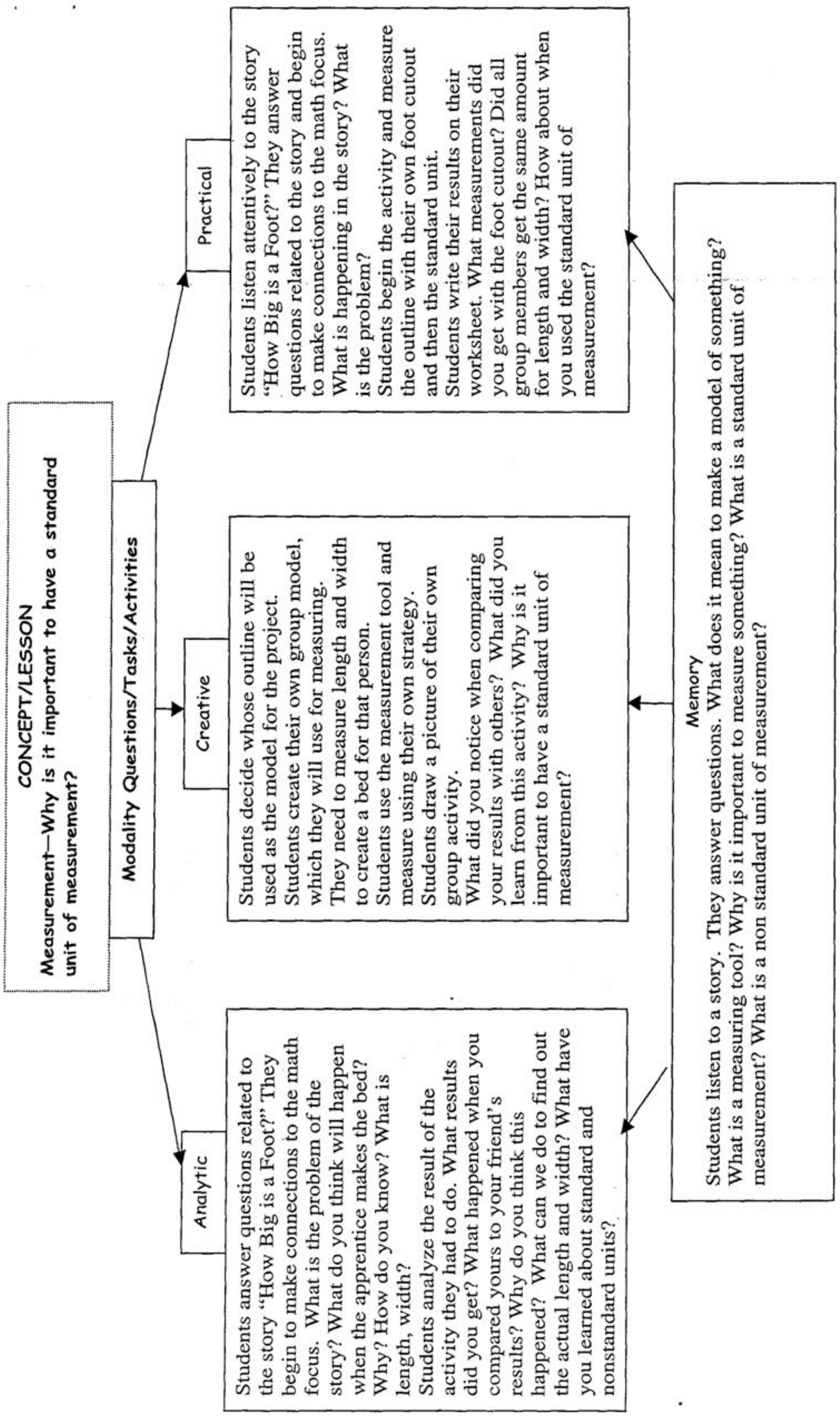
Equivalent Fractions

These are the number sentences that are equivalent to **1 whole.**

$\frac{2}{4} + \frac{1}{16} + \frac{1}{2} =$ 1 whole
$\frac{1}{2} + \frac{1}{2} =$ 1 whole
$\frac{1}{8} + \frac{1}{8} + \frac{1}{8} + \frac{3}{16} + \frac{2}{4} =$ 1 whole

- Limited understanding
- Unable to put concept into words
- Number sentences not always correct

Sample Portfolio- Year II Teacher



IUME Dynamic Pedagogy: Brainstorming about Modality Tasks

Learning goals:

Students will recognize that the size of the unit used for measurement will affect the outcome of the measurement.

Students will understand the importance of using a standard unit of measurement.

Student "out of school" knowledge and experience

Following directions carefully

Students are able to sit and listen to a story that is read to them.

Understanding that there is a problem to be solved.

Students can make decisions and work cooperatively in groups,

CONCEPT/LESSON

Measurement—Why is it important to have a standard unit of measurement?

Student "school" knowledge and experience

Students are able to follow directions carefully.

Students are able to sit and listen to a story being read and they can make connections to it.

Students can look for a solution to solve the problem.

Students have used measurement tools in school.

Students can make decisions and work in cooperative groups.

Possible misconceptions / misunderstandings

-Students think that the nonstandard unit is actually the standard one.

- Confusion in understanding what is length and width. They might think they are the same.

-Understanding what a unit is.

-Students think that the only measuring tool we use is our feet.

Possible procedural errors

-Students use measuring tool incorrectly.

-Students use only one tool to measure for the whole group instead of individually.

-Students record data incorrectly, such as writing length size for the width or vice versa, recording nonstandard measurement in the area for standard measurement, etc.

-Students use all the units together at the same time for measuring.

IUME Dynamic Pedagogy: Lesson Preplanning Template

Teacher Self-Assessment Survey

In reflecting upon your lesson, rate your performance in the following areas of classroom practice:

LESSON OBJECTIVES

	Not at all true		somewhat true		Very true
I checked whether students have the prerequisite knowledge and skills to learn new content	1	2	3	4	5
I checked whether students were making progress toward the objectives of the lesson	1	2	3	4	5
I checked whether students achieved the objectives of the lesson	1	2	3	4	5

CURRICULUM

I used the following types of tasks or questions to engage the students in the activities of the lesson:	Not at all true		somewhat true		Very true
CREATIVE	1	2	3	4	5
ANALYTICAL	1	2	3	4	5
PRACTICAL	1	2	3	4	5
MEMORY	1	2	3	4	5

INSTRUCTION

I used the following instructional strategies to engage students in the activities of the lesson:	Not at all true		somewhat true		Very true
Modeling	1	2	3	4	5
Explaining	1	2	3	4	5
Monitoring	1	2	3	4	5
Regulating	1	2	3	4	5
Shared practice	1	2	3	4	5
Independent practice	1	2	3	4	5

ASSESSMENT

I used the following types of probing to engage students in the activities of the lesson:	Not at all true	somewhat true			Very true
Declarative probing (questions that seek knowledge of facts)	1	2	3	4	5
Procedural probing (questions that seek knowledge of how to perform certain procedures)	1	2	3	4	5
Conceptual probing (questions that seek understanding of math concepts)	1	2	3	4	5
Metacognitive probing (questions that seek students' awareness of their own thinking)	1	2	3	4	5
Metacognitive probing (questions that seek students' control of their own thinking)	1	2	3	4	5
I allowed sufficient time for students to respond to my questions	1	2	3	4	5
I encouraged students to explain their answers to my questions	1	2	3	4	5
I encouraged students to justify or give reasons for their answers to my questions	1	2	3	4	5

LESSON PHASES

I provided activities for each of the following phases of the lesson	Not at all true	somewhat true			Very true
Initiation	1	2	3	4	5
Development	1	2	3	4	5
Closure	1	2	3	4	5

NOTES

What worked really well?

The students used the models of their footprints for measuring and ~~most~~ most were using them accurately.)

What didn't work at all?

I should have assigned students to go to a certain group after working in their own.

What proportion of students understanding the material (circle one):

All most half less than half few none

IUME Dynamic Pedagogy—Lesson Planning

Teacher Self Assessment

Samples of Student Work

Name [illegible] Date 4/29/05

"How Big Is A Foot?"
By Rolf Myller

Directions:

- Trace a rough outline around one member of your group.
- Then measure the length and width of the outline as if to make a bed.
- Record the measurements on paper.
- Compare your amounts with other members of the group.
- If time allows, go to another group and measure their outline.

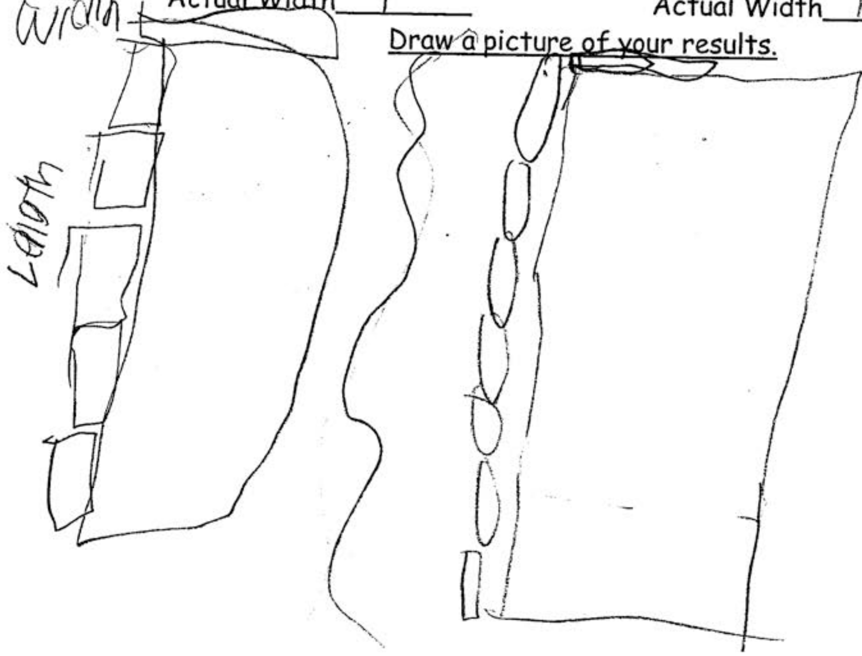
Outline # 2
Length 6 1/2
Width 1

Actual Length 5
Actual Width 1

Outline#
Length 6 1/2
Width 1 1/2

Actual Length 3 1/2
Actual Width 1 foot

Draw a picture of your results.



Name 1 ____ Date April 29

"How Big Is A Foot?"
By Rolf Myller

Directions:

- Trace a rough outline around one member of your group.
- Then measure the length and width of the outline as if to make a bed.
- Record the measurements on paper.
- Compare your amounts with other members of the group.
- If time allows, go to another group and measure their outline.

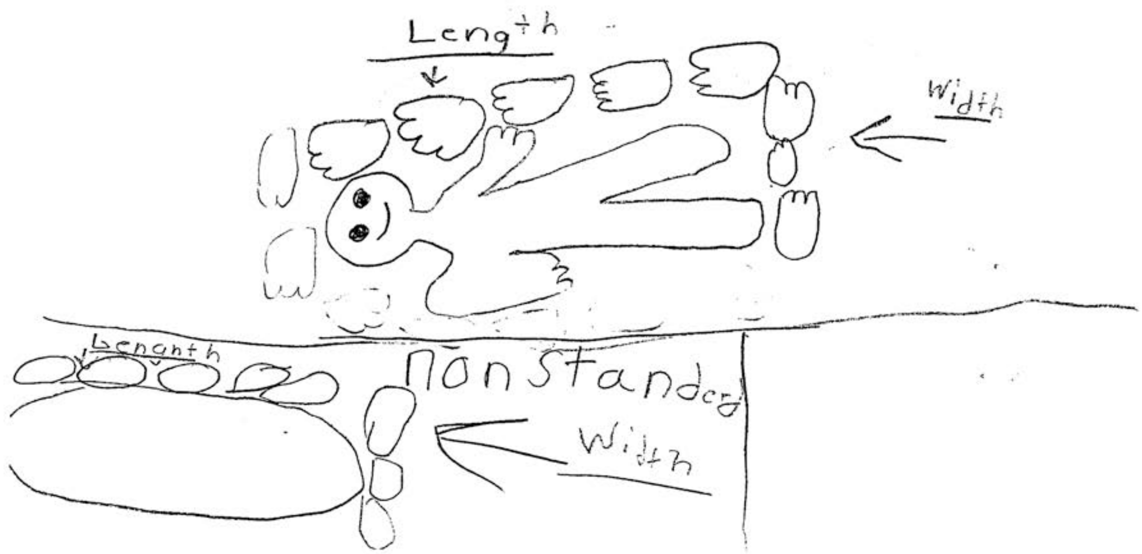
Outline # 5
Length 7½
Width 2

Actual Length 5
Actual Width 2

Outline# 5
Length 6½
Width 3½

Actual Length 5
Actual Width 3½

Draw a picture of your results.

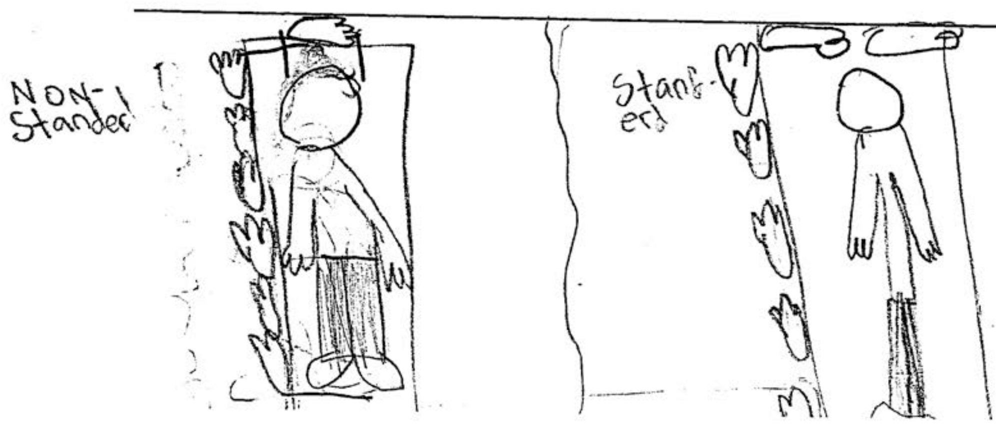


Name__________ Date 4/29/05

"How Big Is A Foot?"
By Rolf Myller

You had a chance to measure an outline with nonstandard and standard units. What did you learn from this activity? Write your answer below.

I learned that nonstanderd units are not the same size. I also learned that standerd units are the same size forever. Rulers are standerd foot units. Big feet have lower measures than small feet. All feet are not the same size Some are small, some are big, and some are medium. length means long, width means wide. 1ruler is one foot.



Name____________ Date April 29

"How Big Is A Foot?"
By Rolf Myller

You had a chance to measure an outline with nonstandard and standard units. What did you learn from this activity? Write your answer below.

I learned that If there's a big foot it's a lower unit number and if it's a little foot it's a big unit numbr. I also learned numbers are measuerment and shows are nonstanderd units and standardunit's do not change.

Appendix I
Intellective Competence Report

Toward an Understanding of Intellective Competence: Construct Validation

FINAL REPORT

April 2006

Edmund W. Gordon & **Eleanor Armour-Thomas**
Principal Investigator **Co-Principal Investigator & Director**

IUME Institute for Urban and Minority Education
Teachers College, Columbia University

TABLE OF CONTENTS

Introduction

Although performance on standardized measure of achievement tests remains the primary barometer for making evaluative judgments about children's knowledge and skills in a domain of interest, e.g., mathematics, it is by no means the only index for ascertaining how well students benefit from their schooling experiences. Over the years there has been increased interest in concepts such as self-regulated learning (Zimmerman, 1989), developing expertise (Sternberg & Grigrienko, 2002), and intellective competence (Gordon, 1998; 2002) as other indices for defining the successful learner. In this study, we sought an understanding of *Intellective Competence* (IC), a construct coined by Gordon (1998; 2002) to define one's capacity and disposition to adaptively and efficiently use one's cognitive, affective, and situative processes to engage and solve both common and novel problems. For Gordon, learning for the acquisition of domain-specific knowledge and skills (e.g., mathematics proficiency) is not an end in of itself. Rather, he considers such products as instrumental to the development of intellective competence, the ultimate purpose of learning.

Objectives

Our preliminary investigation of Gordon's Intellective Competence (IC) construct consisted of the following objectives:

1. Development of a conceptual framework for organizing indicators of the construct;
2. Conducting a grounded theory analysis to ascertain empirically evidence for the construct;
3. Creating self-report measures of IC; and
4. Investigating students' use of IC on mathematics tasks.

Conceptual Framework

Although the construct is still emerging, Gordon contends that intellective competence involves more than intelligence. It is a broader construct that includes specific characteristics such as the ability and disposition to:

- Perceive, recognize, and generate patterns and relationships between stimuli;
- Utilize verbal, numeric, logical, and analogical reasoning;
- Bring order to the chaos of information and stimuli encountered in one's environment;
- Explore, inquire, and make sense of one's environment in the service of problem solving and sense making; and
- Know, understand, and purposefully deploy one's affective, cognitive, and situative processes in the pursuit of learning, problem solving, and esthetic expression.

A literature review was conducted to compare Gordon's intellective competence construct to the construct of intelligence. The literature review resulted in the specification of several indicators to capture the characteristics of intellective competence, as outlined above. In addition, further discussion with Gordon about the construct guided the development of componential characteristics of intellective competence. Students' solutions to *Dynamic Pedagogic* mathematics problems were also examined to help revise and generate the characteristics of the construct. After careful analysis, we suggest that IC may be conveniently categorized into three main components: affective, cognitive, and situative (see Table 1).

- *Affective*—primarily defined as social competence (SC);
- *Cognitive*—which includes content-area ability, in this study, mathematics ability (MA); communicative ability (CA); logical reasoning (LR); primary/secondary/tertiary signals (PSTS); organizing and reorganizing information (ORI); information representation (IR); and metacognition and metacomponential strategies (MMS); and
- *Situative*—is best described as contextual sense making (CSM).

Table 1

Intellective Competence Indicators

AFFECTIVE
Social Competence (SC)
1. Disposition to adapt to the demands of ordinary challenges 2. Disposition to adapt to the demands of novel situations 3. Balanced disposition toward dependence/independence 4. Disposition to function independently and use others as resources as necessary 5. Relating easily with peers 6. Helping, cooperating, sharing with others 7. Caring for others
COGNITIVE
Mathematical Ability (MA)
1. Understanding mathematical problems 2. Solving mathematical problems correctly 3. Using computation (e.g., multiplication, division, subtraction, addition, and counting) skills effectively 4. Understanding numbers as symbols of position and value 5. Using operations (multiplication, division, subtraction, addition) effectively and understanding the differences in their functions
Communicative Ability (CA)
1. Comprehends word problems 2. Communicating effectively with others 3. Conveying thoughts effectively 4. Using symbols in verbal communication 5. Using a wide variety of words 6. Understanding a wide variety of words 7. Using metaphors

Logical Reasoning (LR)

1. Filtering out relevant and irrelevant information
2. Integrating information
3. Comparing and contrasting information
4. Demonstrating inductive reasoning
5. Demonstrating deductive reasoning
6. Ability to order information

Primary/Secondary/Tertiary Signals (PSTS)

1. Using various symbolic representations
2. Primary—concrete objects
3. Secondary—labels for concrete objects; meaning of objects through words and pictures
4. Tertiary—use of formulas

Organizing and Reorganizing Information (ORI)

1. Bringing order to chaos
2. Deconstructing alternative meaning from structured information
3. Relational analysis
4. Taxonomic analysis
5. Generating patterns and relationships between stimuli
6. Ranking information
7. Sifting information for degrees of relevance

Information Representation (IR)

1. Using signs or symbols to convey information
2. Using signs or symbols to understand and solve problems

Metacognition and Metacomponential Strategies (MMS)

1. Knowledge of mental processes
2. Awareness of thinking processes
3. Using self-regulatory strategies of planning
4. Using self-regulatory strategies of monitoring
5. Using self-regulatory strategies of evaluation
6. Using appropriate problem-solving strategies
7. Making mental representations of the problem

SITUATIVE

Contextual Sense Making (CSM)

1. Capacity to utilize environmental and contextual clues to understand the environment
2. Making sense of environment in the service of problem solving
3. Exploring the environment in relation to the phenomenon that is to be understood
4. Seeking explanations in relation to the context
5. Seeking necessary knowledge in relation to the context
6. Making use of available materials
7. Shaping the environment

Methodology

Student work samples from mathematics tasks designed for the *Dynamic Pedagogy* pilot study were studied to help develop the list of major indicators of IC. After preliminary analysis, the indicators were refined and a new battery of 4 mathematical tasks (aligned with school district, state, and NCTM content standards) was designed. A team of researchers using a common protocol administered 2 of the mathematical tasks (both focusing on fractions) to children in dyads. Items on the protocol included questions about students' problem-solving and solution strategies. Students were also asked to give examples of when they used similar strategies outside of school.

In the first problem, students were asked to explain: How can 4 children share these 3 cookies? Students used a worksheet which contained 3 squares representing 3 square cookies. In the second task, students were asked to explain: Which is larger, 1/2 or 2/3? Following the completion of the mathematics problems, students were asked to answer the following questions:

1. How did you feel when doing these problems?
2. Did you like one problem better than the other?
3. How do you feel when you are doing mathematics problems in class?
4. Can you give me an example of when you do mathematics outside of school?
5. If a mathematics problem seems too hard for you, what do you do?

Three different interviewers conducted focus groups with different pairs of students. A total of 22 students were interviewed for approximately 20 minutes. Following the focus groups, each interviewer transcribed each interview.

Grounded Theory Analysis

A total of 9 verbatim transcriptions, ranging in 5 to 7 pages long, were coded sentence by sentence using a grounded theory approach. An attempt was made to develop sub-themes using the language of the interviewer and students. After each sentence was coded with a sub-theme, the number of occurrences for each sub-theme was calculated. Sub-themes were then grouped into 5 categories: 1) Student Responses 2) Student Talk 3) Student Engagement 4) Interviewer Questions and 5) Interviewer Talk. In the last step of the analysis, the most frequently cited codes were grouped and frequencies were re-calculated and ranked.

Grounded Theory Results

A total of 5 core themes emerged across all of the 9 transcriptions. Specifically, the data indicate that the majority of students' responses were related to:

1. Providing Own Examples
2. Explaining Reasoning
3. Clarifying
4. Elaborating on Peer's Answers
5. Drawing a Picture to Solve Problems.

Table 2 depicts the results as summary of results from the grounded theory analysis.

Table 2

Grounded Theory Analysis Summary

Indicator	Sub-Indicators	Frequency	Rank
1.0 Student Reponses	1.1 Provides Own Example	**42**	**1st**
	1.2 Explains Reasoning	**40**	**2nd**
	1.5 Clarifies	**30**	**3rd**
	1.3 Draws Picture to Solve Problem	**24**	**5th**
	1.4 Elaborates	**23**	
	1.6 Explains Solution	**21**	
	1.7 Confirms Own Answer	**16**	
	1.8 Elaborates on Peer's Answer	**27**	**4th**
	1.9 Confirms Peer's Answer	**23**	
	1.10 Demonstrates Using Symbols/Picture	**14**	
	1.11 Solves Using Fractions	**23**	
	1.12 Solves Using Division	**12**	
	1.13 Repeats Peer's Answer	**10**	
	1.14 Communicates Reaction to Tasks	**13**	
	1.15 Likes Math/Favorite Subject	**13**	
2.0 Student Talk	2.1 Provides Information (Unrelated to Protocol)	**9**	**1st**
	2.2 Clarifies Directions	**3**	
3.0 Student Engagement	3.1 Answers Question (Without Hesitation)	**21**	**1st**
	3.2 Students Working Together/Take Turns	**15**	**2nd**
	3.3 Hesitates to Answer	**6**	

Analysis of Intellective Competence on Math Tasks

Because we were interested in determining whether or not *Dynamic Pedagogy* was linked to students' Intellective Competence, we administered the following tasks:

1. What is the perimeter of the playground?
2. What is the area in square units of the playground?
3. Think about how the playground can be shared by the two classes. Draw a boundary line of the playground below. Explain why you chose this boundary line.
4. Lisa says she can eat 1/2 of a pizza. Jordan says she can eat 1/3 of a pizza. Who can eat more pizza, Lisa or Jordan? How do you know?
5. Mr. Walker ordered 3 pizzas and he cut all of them into six equal parts. Each person in the class ate two slices. There is 1/3 of one pizza left over. How many people ate pizza in Mr. Walker's class today?

These tasks were administered to children in *Dynamic Pedagogy* and non-*Dynamic Pedagogy* classrooms. A random sample of 60 students' tasks was analyzed: 41 students from *Dynamic Pedagogy* classrooms, and 19 from non-*Dynamic Pedagogy* classrooms. The math tasks were scored using a structured list of 9 intellective competence indicators: 1) social competence 2) mathematical ability 3) communicative ability 4) logical reasoning 5) primary/secondary/tertiary signals 6) organizing and reorganizing information 7) information representation 8) metacognition and metacomponential strategies and 9) contextual sense making.

Of the 9 different intellective competence indicators, three did not apply to the math tasks being scored: social competence, metacognition and metacomponential strategies, and contextual sense making. Students' mathematical performance on the tasks was also evaluated by the research team (which comprised 2 faculty members in mathematics education and psychology and 3 doctoral students—2 in mathematics education and 1 in psychology). Descriptive analytic memoranda were written to describe trends and patterns in IC indicators for each task and students' performance on each task (and sub-task) was scored on a scale of 1-low to 4-high, using a common rubric. Table 3 shows the average performance of *Dynamic Pedagogy* versus non-*Dynamic Pedagogy* students on each sub-task.

Table 3

<u>Description of Intellective Competence for Each Task</u>

		Total			*Dynamic Pedagogy*			Control	
Task	*N*	Mean	Std. Deviation	*N*	Mean	Std. Deviation	*N*	Mean	Std. Deviation
Perimeter	60	2.37	0.84	41	2.51	0.81	19	2.05	0.85
Area	60	2.63	0.74	41	2.66	0.73	19	2.58	0.77
Playground	59	2.44	0.93	40	2.45	0.93	19	2.42	0.96
More pizza	60	2.28	0.78	41	2.20	0.81	19	2.47	0.70
How many	59	1.58	0.77	41	1.66	0.73	18	1.39	0.85

Describing Intellective Competence

The clinical interviews and mathematical tasks revealed that our initial indicators seemed to comprehensively describe Gordon's Intellective Competence construct. From the clinical interviews, 5 core themes emerged. Specifically, the data indicated that the majority of students' responses were related to providing own examples, explaining reasoning, clarifying, elaborating on peer's answers, and drawing a picture to solve problems. For example, 1 of the items on the mathematical task asked students to explain which fraction is greater: 2/3 or 1/2. This excerpt from one interview shows that this student is explaining his reasoning in a sophisticated way:

> *Interviewer 3*: So why is 2/3rds larger?
>
> *Student 1*: It is larger because 2/3rds is more than 1/2 because pieces in a circle of 1/3rd are bigger than 1/2 when it is two 1/3rds. . . because it equals more than 1/2 does.

This example also shows that the student understands fractions in a way that goes beyond mere computation. Although the goal of the grounded theory analysis of clinical interviews was to determine if additional or new factors related to IC emerged, this example reflects at least 3 major IC components: mathematics ability (MA), communicative ability (CA), and logical reasoning (LR).

In addition, the present study indicates that we have obtained preliminary evidence that IC is positively related to mathematics performance. When conducting correlational analyses of the number of IC indicators present in students' work on mathematics tasks and their overall score on the mathematics tasks, we found a statistically significant correlation of .78 ($p < .05$).

Conclusions

Future research can help to determine, definitively, if students who have the opportunity in school to develop intellective competence improve their performance on standardized mathematics assessments. Furthermore, future studies can help to determine if there are differences in intellective competence for students of different genders and ethnic groups.

References

Gordon, E. W. (2001). Affirmative development of academic abilities. *Pedagogical Inquiry and Praxis, No. 2*. New York: Institute for Urban and Minority Education, Teachers College, Columbia University.

Gordon, E. W. (1998). *Toward a definition of pedagogy*. Working paper prepared for the National Research Council's Committee on Early Childhood Pedagogy.

Gordon, E. W. (1991). Human diversity and pluralism. *Educational Psychologist*, *26,* 99-108.

Sternberg, R. J., & Grigorenko, E. L. (2002). *Dynamic testing: The nature and measurement of learning potential*. Cambridge, MA: Cambridge University Press.

Zimmerman, B. J. (1989). A social cognitive view of self-regulated learning. *Journal of Educational Psychology*, *81,* 329-339.

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
Katherine Ferrise
Nancy Heilbronner

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

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

Also of interest from the

Research Monograph Series

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

The Effects of Grouping and Curricular Practices on Intermediate Students' Math Achievement
Carol L. Tieso

Developing the Talents and Abilities of Linguistically Gifted Bilingual Students: Guidelines for Developing Curriculum at the High School Level
Claudia Angelelli, Kerry Enright, and Guadalupe Valdés

Development of Differentiated Performance Assessment Tasks for Middle School Classrooms
Tonya R. Moon, Carolyn M. Callahan, Catherine M. Brighton, and Carol A. Tomlinson

Society's Role in Educating Gifted Students: The Role of Public Policy
James J. Gallagher

Middle School Classrooms: Teachers' Reported Practices and Student Perceptions
Tonya R. Moon, Carolyn M. Callahan, Carol A. Tomlinson, and Erin M. Miller

Assessing and Advocating for Gifted Students: Perspectives for School and Clinical Psychologists
Nancy M. Robinson

Giftedness and High School Dropouts: Personal, Family, and School Related Factors
Joseph S. Renzulli and Sunghee Park

Assessing Creativity: A Guide for Educators
Donald J. Treffinger, Grover C. Young, Edwin C. Selby, and Cindy Shepardson

Also of interest from the

Research Monograph Series

Implementing a Professional Development Model Using Gifted Education Strategies With All Students
E. Jean Gubbins, Karen L. Westberg, Sally M. Reis, Susan T. Dinnocenti, Carol L. Tieso, Lisa M. Muller, Sunghee Park, Linda J. Emerick, Lori R. Maxfield, and Deborah E. Burns

Teaching Thinking to Culturally Diverse, High Ability, High School Students: A Triarchic Approach
Deborah L. Coates, Tiffany Perkins, Peter Vietze, Mariolga Reyes Cruz, and Sin-Jae Park

Advanced Placement and International Baccalaureate Programs for Talented Students in American High Schools: A Focus on Science and Mathematics
Carolyn M. Callahan

The Law on Gifted Education
Perry A. Zirkel

School Characteristics Inventory: Investigation of a Quantitative Instrument for Measuring the Modifiability of School Contexts for Implementation of Educational Innovations
Tonya R. Moon, Catherine M. Brighton, Holly L. Hertberg, Carolyn M. Callahan, Carol A. Tomlinson, Andrea M. Esperat, and Erin M. Miller

Content-based Curriculum for Low Income and Minority Gifted Learners
Joyce VanTassel-Baska

Reading Instruction for Talented Readers: Case Studies Documenting Few Opportunities for Continuous Progress
Sally M. Reis, E. Jean Gubbins, Christine Briggs, Fredric J. Schreiber, Susannah Richards, Joan Jacobs, Rebecca D. Eckert, Joseph S. Renzulli, and Margaret Alexander

Issues and Practices in the Identification and Education of Gifted Students From Under-represented Groups
James H. Borland

The Social and Emotional Development of Gifted Students
Carolyn M. Callahan, Claudia J. Sowa, Kathleen M. May, Ellen Menaker Tomchin, Jonathan A. Plucker, Caroline M. Cunningham, and Wesley Taylor

Also of interest from the

Research Monograph Series

Promoting Sustained Growth in the Representation of African Americans, Latinos, and Native Americans Among Top Students in the United States at All Levels of the Education System
L. Scott Miller

Evaluation, Placement, and Progression: Three Sites of Concern for Student Achievement
Samuel R. Lucas

Latino Achievement: Identifying Models That Foster Success
Patricia Gándara

Modern Theories of Intelligence Applied to Assessment of Abilities, Instructional Design, and Knowledge-based Assessment
Robert J. Sternberg, Elena L. Grigorenko, Bruce Torff, and Linda Jarvin

Giftedness and Expertise
Robert J. Sternberg, Elena L. Grigorenko, and Michel Ferrari

Academic and Practical Intelligence
Robert J. Sternberg, Elena L. Grigorenko, Jerry Lipka, Elisa Meier, Gerald Mohatt, Evelyn Yanez, Tina Newman, and Sandra Wildfeuer

Developing Creativity in Gifted Children: The Central Importance of Motivation and Classroom Climate
Beth A. Hennessey

Intelligence Testing and Cultural Diversity: Concerns, Cautions, and Considerations
Donna Y. Ford

Equity, Excellence, and Economy in a System for Identifying Students in Gifted Education: A Guidebook
Joseph S. Renzulli

The Feasibility of High-end Learning in a Diverse Middle School
Catherine M. Brighton, Holly L. Hertberg, Tonya R. Moon, Carol A. Tomlinson, and Carolyn M. Callahan

The Law on Gifted Education (Revised Edition)
Perry A. Zirkel

Also of interest from the

Research Monograph Series

Nurturing Talent in Underrepresented Students: A Study of the Meyerhoff Scholars Program at the University of Maryland, Baltimore County
Beatrice L. Bridglall and Edmund W. Gordon

The Schoolwide Enrichment Model Reading Study
Sally M. Reis, Rebecca D. Eckert, Fredric J. Schreiber, Joan Jacobs, Christine Briggs, E. Jean Gubbins, Michael Coyne, and Lisa Muller

Identifying Academically Talented Minority Students
David F. Lohman

Teachers' Guide for the Explicit Teaching of Thinking Skills
Deborah E. Burns, Jann Leppien, Stuart Omdal, E. Jean Gubbins, Lisa Muller, and Siamak Vahidi

Multiple Case Studies of Teachers and Classrooms Successful in Supporting Academic Success of High Potential Low Economic Students of Color
Carol Ann Tomlinson, Holly Gould, Stephen Schroth, and Jane Jarvis

Advanced Placement and International Baccalaureate Programs: A 'Fit' for Gifted Learners?
Holly Hertberg-Davis, Carolyn M. Callahan, and Robin M. Kyburg

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. Tonya Moon
Dr. Carol A. Tomlinson
Dr. Catherine M. Brighton
Dr. Holly L. Hertberg-Davis

Yale University

Dr. Elena L. Grigorenko, 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. Linda Jarvin