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A Study To Ascertain the Effects of the Connected Mathematics Project on Student Achievement in the Buffalo Public Schools

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A STUDY TO ASCERTAIN THE EFFECTS OF THE CONNECTED MATHEMATICS PROJECT ON STUDENT ACHIEVEMENT IN THE BUFFALO PUBLIC SCHOOLS

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by
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>
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CHAPTER 1

Introduction

Overview

Mathematics education in the United States is seen as a very important issue. In an era of high technology and fast information, the work force and the citizenry need the intellectual skills certainly in order to thrive, and increasingly in order to survive. Since the early twentieth century, what shape mathematics education should take in the classroom has been argued by two opposing factions. One faction, the traditionalist, consists of those who agree with the way mathematics is being taught in the classroom (Latrell, 2005). The other faction, the reformists, believes that the way math is taught needs drastic reforming (Latrell, 2005).

The traditionalist typically believe, in short, that basic arithmetic skills (i.e. algorithms for adding, subtracting, multiplying and dividing) should constitute the major part of mathematics education in the elementary grades. These skills are to be developed by much practice. These prepare students to engage in higher mathematics.

The reformists believe, in essence, that the poor performance in mathematics of the masses of students nationwide is due to the abstract and irrelevant nature of mathematics as taught by the traditionalist. Reformists subscribe to the belief that learning is relevant to the learner, and math is no exception. Math should be taught using contexts to which the learner can relate. In so doing, the learner is able to process the concepts based on his experience providing for a more profound comprehension.

This ideological struggle has persisted from the beginning of the twentieth century and continues more fervently than ever today. Today it has acquired the appellation the "math wars".

The Current Reform Effort

According to the results from assessments, such as the National Assessment of Educational Progress (NAEP), the Second International Mathematics Study (*SIMS*) and the Third International Mathematics and Science Studies (*TIMSS*), students' knowledge and skill beyond basic computation was greatly lacking (Carpenter et al., 1978; McKnight et al., 1987; National Center for Educational Statistics, 1996).

In 1981, the US Secretary of Education, T. H. Bell, commissioned the National Commission on Excellence in Education (Commission). The Commission, after 18 months of work, produced the alarming report called *A Nation at Risk: The Imperative for Educational Reform* (1983). In this report to the Secretary of Education (and to the people of the U.S.) facts were provided to substantiate the title. Scholastic Aptitude Test (SAT) scores consistently regressed from 1963 to 1980. The "average math score dropped nearly 40 points" (National Commission on Excellence in Education, p. 8 - 9). "One third [of 17 year olds] can solve mathematics problems requiring several steps" (National Commission on Excellence in Education, p. 9). Four-year public institutions of higher learning experienced a 72 percent increase in remedial math courses from 1975 to 1980.

McKnight, et al. (1987) state that curriculum in the United States is "characterized by rote learning" (p. 81) and "lacks focus" (p. 87). Curriculum in the U.S. does not facilitate in-depth study of mathematics. Furthermore, instruction is dominated by memorization without mathematical comprehension. The pedagogical perspective of learning is that teachers impart their knowledge to students (McKnight, et al., 1987)

The National Council of Teachers of Mathematics (NCTM) responded to the state of affairs in mathematics education in 1989 by publishing *the Curriculum and Evaluation Standards for School Mathematics*[1] (the *1989 Standards*). This document presented a vision for K-12 mathematics that promotes the *Commission's* definition of excellence by "set[ting] high expectations and goals for all learners" (National Commission on Excellence in Education, 1983, p. 12) and encouraging all stake holders to "[try] in every way possible to help students reach them" (National Commission on Excellence in Education, 1983, p. 12 - 13). In order to accomplish this objective NCTM outlined five goals for all students: "(1) that they learn to value mathematics, (2) that they become confident in their ability to do mathematics, (3) that they become mathematical problem solvers, (4) that they learn to communicate mathematically, and (5) that they learn to reason mathematically" (NCTM, 1989, *Introduction*). The ensuing effort to achieve the mark set forth by NCTM is referred to as the reform effort or the standards-based movement. The instruction and curricula that were being used in the classroom prior to any new curricula based on the NCTM standards was and is referred to as traditional.

In order to accomplish these ambitious goals, new curricula needed to be developed. A curriculum would need to focus on problem solving. Basic skills, such as paper and pencil computation with traditional algorithms and symbol manipulation of basic algebra as promoted by the traditionalists would no longer be the primary goal of mathematics instruction (NCTM, 1989). The traditional teacher would stand at the board

[1] Since I retrieved all of the NCTM *Standards* publications from the NCTM website, the page numbers are absent. All citations will therefore reference to the table of contents. The appropriate link in the table of contents will be used in the citation for direct quotes to distinguish specific location.

and disseminate mathematical knowledge while the students absorbed as much information as possible. Students when prompted by the teacher would, ideally on quick recall, regurgitate the facts provided by their teacher. The reform teacher would pose problems developmentally consistent with the students' ages that were immersed in context graspable by the students. Students would work cooperatively toward solutions. Working in groups would provide opportunities to communicate and elucidate their ideas fostering mathematical comprehension (NCTM, 1989).

The Connected Mathematics Project

One curriculum created in response to the NCTM *1989* Standards is the *Connected Mathematics Project* (CMP*)*. This project was funded by the National Science Foundation (NSF). The authors of this curriculum are James T. Fey, University of Maryland, William M. Fitzgerald, Michigan State University (Deceased), Susan N. Friel, University of North Carolina, Glenda Lappan, Michigan State University, and Elizabeth Difanis Phillips, Michigan State University. The authors made great effort to develop a curriculum that would be accessible to all students by using problems set in real world contexts to help students see the connections amongst various mathematical concepts (Connected Mathematics Project, n.d., *Authors and staff*).

Connected Mathematics is a middle school curriculum designed for grades six through eight. The developers of the CMP curriculum utilized the criteria enumerated by NCTM for evaluating a curriculum. "Instructional resources should focus on: goals, objectives, and mathematical content; relative emphases of various topics and processes and their relationships; instructional approaches and activities; articulation across grades; assessment methods and instruments; availability of technological tools and support materials" (NCTM, 1989, *Evaluation Standard 12*, ¶1). The CMP curriculum employs "instruction [that] focuses on inquiry and investigation of mathematical ideas embedded in rich problem situations" (Connected Mathematics Project, n.d., *Guiding Principles,* ¶5)

Each grade level has eight units with each unit focusing on a particular mathematical topic. As the appellation of the curriculum denotes, these units focus on a particular concept, but connections to related ideas are also exposed as prognostication in prior units and further developed and reinforced in subsequent units. In order for the teacher to deliver the instruction as intended as well as address the diverse needs of students, the units are supplemented with "teachers [sic] guides . . . additional practice and skills workbooks, assessment resources, teaching transparencies, manipulative kits, a special needs handbook for teachers, and a parent guide.... CD-ROMS for assessment, lesson planning and student activities" (Connected Mathematics Project, n.d., *Components of CMP*).

For the sixth grade curriculum, four units focus on developing number sense and operations; two units are on geometry; one unit on probability and one unit on statistics. The seventh grade curriculum consists of two units that deal with proportional reasoning; three on algebraic concepts; and one each of probability, statistics and geometry. The eighth grade curriculum contains six units that develop algebra skills as well algebraic thinking, one each of geometry and statistics (Connected Mathematics Project, n.d., *Contents in Brief by Unit*). There is a clear progression from sixth to eighth grade towards algebra.

Each lesson, called an investigation, consists of three components: (a) launch, (b) explore and (c) summation. The launch component entails the teacher ensuring that students comprehend both the context of the problem and "mathematical challenge within that context" (Ridgeway, Zawojewski, Hoover and Lambdin, 2003, p. 195). The explore component students work individually then in groups toward a solution to the proposed problem or to explore the mathematical concept being presented. For the summation, groups share with the class their results and a class discussion ensues; after which, students write their reflections of what they learned (University of Washington, 2001).

Problems for application, connections and extensions (ACE) are at the end of each lesson. The application problems provide reinforcement for the current unit. The connections bring together the present lesson with the past lessons in order to provide opportunity to make the connections necessary for mathematical comprehension. The extensions provide additional learning opportunities to explore concepts thus further fortifying students' depth of knowledge. These ACE's facilitate the differentiated instruction necessary to serve the diverse instructional needs of students. Moreover, the teacher's guide contains questions for further practice if needed. Most of the units contain a project that can serve to help students learn that answers and results to problems are often not immediately evident (University of Washington, 2001).

Effects of CMP on Student Performance on State Assessments

In 2001, the federal government mandated through the No Child Left Behind Act (NCLB, 2001) that each state develop a set of standards for mathematics. These standards were to be challenging and rigorous in content as well as set high expectations for all students to achieve. Concomitantly, in order to measure student achievement, each state was also required to create a uniform means of assessing all public school students statewide with the same measuring tool. The assessment must be aligned with the state standards and should have attached to it rewards and punishments for high and low performing schools, respectively (NCLB, 2001). Furthermore, part of the accountability is that each school must demonstrate a determined level of progress annually called adequate yearly progress (AYP).

For a school or for a district, most often, the primary purpose of adopting a new curriculum is to improve student performance on a state assessment. There are new and still mounting pressures on schools to perform well on state assessments. At the behest of the federal government, the consequences of poor performance can be dire. It is therefore particularly imperative that when a curriculum is adopted its efficacy be immediately evaluated.

Various research efforts have been implemented to discover the effects of using *Connected Mathematics* on student performance on state assessments. The results reported by many were positive (Cain, 2002; Ridgeway et al., 2003; Riordan & Noyce, 2001; University of Washington, 2001). However, considerable controversy abounds regarding much of the results exalting this curriculum as having had a positive effect on student performance (Bishop, 1997; Klein, Askey, Milgram, Wu, Scharlemann, & Tsang, 1999; Latrell, 2005; Reys, 1998; Tsang, 1999).

The challenge for each school, district or state is, to the best of their ability, to decide the most educationally expedient course of action for their students. Since both proponents and opponents of the CMP curriculum make cogent arguments, often the decision makers decide to try the curriculum and see if student performance on the state assessment is affected.

This Study: CMP in Buffalo, NY

Buffalo, NY is the second largest urban district in the state of New York. The district serves approximately 38,000 students. Approximately 58% of the Buffalo students are Black, approximately 27% are White, approximately 13% are Hispanic and approximately 2% are Native American, Asian or Pacific Islander. The school district's poverty rate is the fourth highest in the State with approximately 50% of the students living in families at or below the poverty level (U.S. Census Bureau, n.d.). Of the 9,785 middle school students who took the 2006 assessment, 86% were low income. The high poverty rates contribute heavily to low academic achievement (Payne, 2001). The Buffalo school district has been faced with the same dilemma as many other urban districts nationwide with similar demographic features - what is the best way to improve student performance on state assessments?

The Buffalo school district presently (school year 2006-2007) uses CMP for all sixth, seventh and eighth grade students. Prior to adopting the CMP curriculum, the district utilized the *Transitional Math* (University of Chicago School Mathematics Project [UCSMP], 1983) as a text for grades 7 and 8. The UCSMP (1983) was considered by administration to be aligned with the state standards and in the spirit of the NCTM *Standards* (NCTM, 1989, 2000). However, teachers were directed by administration that the state standards were the primary consideration regarding instruction. The textbook was to be used as a tool not the curriculum. Consequently, some teachers used the textbook exclusively; some used it sparingly or not at all; the remainder used some amalgam of UCSMP and other materials. The implementation of CMP was phased in. From 2002 to 2006, 10 out of 34 schools used CMP curriculum during this time. These schools were chosen because they received a Comprehensive School Reform grant that had money for professional development; there were no academic criteria involved in the selection. The teachers in the CMP group were given specific CMP units and investigations to teach. These were selected by the district math support teachers as the units and investigations that followed the state standards. It is desirable to see if the CMP curriculum in the Buffalo Public Schools precipitated better results on the state assessment.

The Research Question

Do students in the Buffalo, NY school district who receive instruction in classes using *Connected Mathematics* perform better on the NY State assessment than students who receive instruction in classes using the standards as the primary consideration for instruction?

This study examines the seventh and eighth grade results from the 2006 NY State Mathematics Assessment in order to ascertain if there are any significant differences between students taught using *Connected Mathematics* and those students taught by teachers following the New NYSED Mathematics Standards. This study will refer to these as the "standards" students. Additionally, the results from the 2005 eighth grade assessment will also be examined to look for significant differences between the CMP students and the non-CMP students. Finally, the grade 8 2005 and 2006 assessments will be examined to see if there are significant differences in the percent of students meeting the standards. The first seventh grade assessment was given in 2006 as a result of the NCLB (2001). There are no prior seventh grade assessments. This study considers the results of the state assessments. It does not examine teacher instruction - i.e. the extent to which teachers follow either curriculum.

CHAPTER 2

Literature Review

Introduction

This chapter will first examine the need giving rise to the CMP curriculum by explicating the historical context of the math wars. The proponents and opponents of the CMP curriculum will be addressed. Lastly, the utilization and impact of the measuring tools (standardized tests and state assessment) in the continuing struggle to improve student performance in New York State will be reviewed.

Historical Point of Reference for Traditional vs. Reform

Thorndike and Traditional Instruction

The current math war is a continuation of a century old saga in education. What many today know as traditional math instruction (the instruction that most parents and teachers today received) was solidified in the first score of the twentieth century by the very influential educational psychologist, Dr. Edward Thorndike. Thorndike conducted research on animals and how they learn. This research eventually led him to conceive his learning theory of connectionism (Kearsley, 1994). According to connectionism, learning occurs when a stimulus produces a response (S-R is used to denote this combination of stimulus and response). Associations or bonds form whenever S-R occurs. The strength of these associations or bonds is determined by the nature of the response, positive or negative, and the frequency of their occurrence. Consequently, these bonds can be strengthened by providing rewards and with practice. Thorndike also proffered that "a series of responses can be chained together to satisfy some goal"

(Kearsley, 1994, ¶2). Connectionism was put into practice throughout the realm of education.

Thorndike published a book, *The Psychology of Arithmetic* (1922) describing in great detail his mathematical pedagogical perspective. Thorndike held that efficiency and accuracy of computation were the main goals of elementary mathematics education. Furthermore, he purported that the drudgery of deductive reasoning in math was developmentally misplaced at the elementary levels because the intricacies and complexities required more bonds than necessary to actually achieve the desired results The "extra baggage" militated unacceptable inaccuracies in computation. Only after mechanical mastery would the very gifted be able to engage in deductive reasoning.

In the introduction, Thorndike poses an illuminating interrogative that encapsulates his emphasis in mathematical instruction: "What can be done toward reducing the function to terms of particular situation-response connections, whose formation can be more surely and easily controlled" (Thorndike, 1922, xiii)? He was concerned with eliminating the unnecessary in mathematics learning in order make the learning more tenable. Rote learning and extensive drill he concludes are the most effective, most efficient, most accurate and therefore the best way to teach mathematics at the elementary levels.

Thorndike believed that education was to help students acquire the intellectual and moral skills needed to exert a positive influence for the good of society on the perpetually changing world (Thorndike, 1912). So, ideally problem solving in math should present problems that students will contend with as adults. However, he goes on to express that reality is not ideal, so in order to avoid practicing problem solving for the sake of strengthening the reasoning faculties (as was held in the nineteenth century), it is therefore best to focus on numbers abstracted from the objects presented in problems in order to strengthen the bonds of accurate computation. The objects to which the numbers were attached in the contexts of problems can effectively be taught later by ensuring that the problems being posed are genuine.

Thorndike admonishes against presenting concocted problems in order to develop reasoning skills. Reasoning cannot be developed regardless of the reality of that which is being reasoned about. "...Efficient discipline of reasoning requires that the pupil reason about matters of real importance" (Thorndike, 1922, p. 20).

Out of Thorndike's painstakingly operose exposition on mathematical learning in the elementary levels came much of the method of instruction employed in the traditional classroom. The teacher as the center of instruction should provide copious practice for pupils to master the mechanics of arithmetic. Numbers should be abstracted from the objects and reapplied at the end. Problem solving to develop reasoning skills should be reserved mostly for the gifted.

Dewey and Contemporary Reform

John Dewey was the leading figure of the other school of thought at the turn of the twentieth century. Dewey, and his coauthor, McLellan, assert that mankind's increasing eagerness to know has militated a misplaced merit and emphasis on facts belying their worthlessness "as stored knowledge or for developing power, [unless and until] they have been subjected to the discriminating and formative energy of the intelligence" (McLellan & Dewey, 1895; p. 2). Having stored a myriad of facts in memory without connecting them creates inert knowledge. In the context of the classroom, acquiring unconnected facts cloyingly can "burden the mind and check the growth of its higher powers" (p. 2). Furthermore, all learning is related to human activity. Subject matter is not naturally divided into topics, such as math, history, literature, chemistry, etc. All things in the world exist in "organic unity....It is some urgent need of man's activity" (p. 20) that causes him to organize and categorize facts. Consequently, it is incumbent on the teacher to imbue instruction with those human interests. In the realm of math, Dewey held that it is imperative for the teacher to employ in her mathematical pedagogy the knowledge of both the psychological stages of development through which children pass as they age and the human activity that gave rise to math. Instruction that should be based on the natural psychical development of the child is referred to as "child-centered".

In this light, Dewey conceived of number as the result of the human activity of measuring. Number is only necessary as a result of human interest in economizing effort and energy precipitated by limited resources such as land, time, food, materials (McLellan & Dewey, 1895). Quantity, therefore, is the valuation of some means to an end. Dewey defines balance (or equation) to mean using exactly the amount of means required to accomplish an end – not too little, not too much. The need imposed by limits forces the need to accomplish balance. Number arises from this need. Number gives a precise description of quantity in contrast to the gross descriptions such as more, less, greater, lesser.

> That which fixes the magnitude or quantity which, ..., needs to be measured is some activity or movement, internally continuous, but externally limited. That which measures this whole is some minor or partial activity into which the

original continuous activity may be broken up (analysis), and which repeated a certain number of times gives the same result (synthesis) as the original continuous activity (McLellan & Dewey, 1895, p. 52).

Dewey conceives number ultimately as the ratio of the whole unit to its homogenous component unit. Intrinsic to his conceptualization of numbers as measurements are all of the operations: addition, subtraction, multiplication, division, fractions and ratio.

This concept of number is based in human activity. Dewey felt that instruction in math should reflect this natural and rational concept if students were to develop the ability to reason and acquire the mental and moral power that education is to impart. He differentiated between his method and the traditional method, which conceptualizes number as external to and independent of man's activity. While acknowledging the need for drill in both methods, he discriminated two types of drill. The drill for the traditional method "is that of ability to hold the mind fixed upon something external, and of ability to carry facts by sheer force of memory" (McLellan & Dewey, 1895, p. 88). The drill of Dewey's method led to "discipline [consisting] in the orderly and effective direction of power already struggling for expression or utterance" (p. 88). Furthermore, he asserts, the mental power acquired by forming the habit of analysis and synthesis eliminates the need to dragoon number facts into memory as with the traditional method.

Like Dewey, those who subscribe to the reform pedagogical perspective believe that math separated from its pragmatic, humanly germane aim ultimately vitiate learning. At the secondary levels in particular students constantly question the applicability for learning the mathematics being studied (NCTM, 2007). Reformists hold that the emphasis placed by traditionalists on memorizing number facts is mathematically impoverished. It disinterests students, dulls their natural curiosity, and fails to promote the puissance provided by engaging in mathematical reasoning. Moreover, it leads to a lack of reasoning due to connection deprivation on one hand and a stunted paltry reasoning, when attempted, caused by spurious conclusions, the fruit of invalid generalizations ensuing from immersion in contrived classroom realities exploring the abstract in the absence of the guidance and the grounding of experience.

Math Wars in the Present

The previous exposition on Thorndike and Dewey provide a nucleus for the ideologies of both sides of the current math war. Thorndike's view of learning is that of external forces acting upon the student imposed by the teacher. Connections are made between situations and responses. These connections can be strengthened via dogged repetition (practice) and positive results (rewards). These connections represent learning having occurred. Pedagogical practice under this view is typically teacher-centered, implying that the teacher actively disseminates information while the students passively receive the information. Many of the traditional arguments can be viewed at www.mathematicallycorrect.com.

Dewey's view of learning is that it is an innate, natural effect of human curiosity and psychological development and growth occurring through the process of human activity of employing means to achieve ends (McLellan & Dewey, 1895)

. This view manifests itself in what is termed child-centered classroom, implying the natural psychological and developmental propensities of the child are used to present activities requiring the child to employ various means to achieve a desired end. Realistic activities engage the child's natural desire to develop intellectual power by appealing to his unavoidable curiosity. Many of the reform arguments can be viewed at www. Mathematicallysane.com.

The twentieth century was a time of great growth in all areas of human endeavor. Education policymakers have always been very concerned with insuring that American students are prepared to meet the challenges of the new age – whether it is the industrial age or the technological age. All have been concerned with making sure that students are being taught based on the most effective mathematics pedagogy available. Most people have fallen into one of two camps, traditionalist or reformist – like politics there are moderates on both sides.

Throughout the twentieth century, each camp has had their time to shine (Latrell, 2005). In particular, the 1920s through the 1950s were dominated by the Dewey camp – reformist. The 1950's ushered in the "new math" era dominated by mathematicians. While opposed to the rote drill typically associated with traditional instruction, they carried Thorndike's view of abstraction to an untenable extreme; invoking a vision of mathematics education completely incognizant of pedagogy; employing highly abstract and complicated mathematics without any concrete experiential, problem-solving to ground it. This brought the back-to-basics movement in the early 1970's. This movement reverted to focusing on the rote drill in order to teach arithmetic and algebra dawned in Thorndike's era. Eventually, the poor performance of American students on national and international assessments produced an increasing call for comprehension over memorization. To many, this sounded like the new math of the fifties and consequently has been christened the "new new-math". In 1989, NCTM published its view of mathematics education as comprehension through problem solving – *The Curriculum and Evaluation Standards for School Mathematics*.

At present, the landscape of math education is dominated by the reformist under the leadership of the influential NCTM (Latrell, 2005). This push for reform as presented in the NCTM *Standards* (1989, 1991, 1995, 2000) is led primarily by math educators who are experts in how students learn math in particular. The reform position of making sense of math by permeating pedagogical practice with real-world contexts and application using discovery-learning has been ferreted out by the research efforts of math educators and educational psychologists. In addition to focusing on problem solving using discovery learning, the virtually ubiquitous use of calculators is encouraged by the NCTM (whose leadership are the math educators) with the notion that higher ordered mathematical thinking is not contingent on the ability to multiply two 3-digit numbers on paper (NCTM, 1989). In sum, reformists have sought to completely overhaul mathematics education – how it is taught; how it is learned; and what is taught.

On the other hand, the traditionalists assiduously assert that de-emphasizing practice on symbolic manipulations associated with the basics of arithmetic and algebra is producing a grave deficit in students' ability to be successful at the higher levels of mathematics particularly in higher education (Wu, 1996). Traditionalists in no way think that the previous math system was performing acceptably. The problem with the old way, according to traditionalist, is that teachers were not teaching for understanding (Latrell, 2005; Wu, 1996). Traditionalist recognized that this had a great deal to do with teachers' lack of understanding of the fundamental concepts of mathematics (Ma, 1999). Traditionalist would therefore like to fix this problem of mindless mechanical manipulations by having the concepts underlying the mechanical manipulations be taught more comprehensively.

The experts who disagree with the reform concept of math education and subscribe to the traditionalist view consists heavily, but not solely, of mathematicians who are professors (Latrell, 2005). Research regarding the efficacy of the NCTM standards (1989, 1991, 1995,2000) and their accompanying curricula by people representing this group is little to none because math professors engage in research in mathematics, not in math education (Latrell, 2005). Moreover, there is little to no funding for educational research based on alternate view points (Wu, 1997). Organizations that represent mathematicians, such as the American Mathematical Society, primarily publish research about mathematics not education. This has caused a gross imbalance; mathematicians' views, and the views of traditionalist in general, are underrepresented in the designing of reform curricula. This has led to an imbalance of perspective with regards to the desired outcomes – all students developing mathematical power by being able to solve real world problems greatly outweighing the need to be able to perform mechanical manipulations requisite for college level math learning.

So, mathematicians have conducted no major research regarding the efficacy of CMP. They have been relegated by circumstance to critiquing the research or to simply proffering professional opinions based on experience rather than research.

Connected Mathematics: A **Reform Curriculum**

The National Science Foundation (NSF) has funded many projects, including CMP to develop curricula and much of the research needed to evaluate these curricula. The problem is "that the vast majority of research studies done about NCTM-oriented [reform] curricula are conducted by the very people who designed the curriculum" (Latrell, 2005, p. 45). With that said, researchers make every attempt to be objective.

The CMP has conducted research on their curriculum as have others. CMP reports the following on their website:

> CMP is an effective middle school curriculum that is **accessible to all** students.
>
> CMP students do as **well as, or better than, non-CMP students on tests of basic skills.**
>
> CMP students **outperform non-CMP students on tests of problem- solving ability, conceptual understanding, and proportional reasoning.**
>
> CMP students can use **basic skills** to solve important mathematical problems and are able to **communicate their reasoning and understanding.**
>
> By the end of grade 8, CMP students show a considerable ability to solve non-routine algebra problems and demonstrate a strong understanding of linear functions and a beginning understanding of exponential and quadratic functions [boldface retained from website] (CMP, n.d., *Past Reports*).

Reform Proponents on CMP

Ridgeway, et al. (2003) who conducted research on the field tests in 1994-1996, found that students instructed using the CMP curriculum performed significantly better than students instructed using traditional methods in sixth, seventh and eighth grades as measured on three assessment tools, the Iowa Test of Basic Skills (ITBS), the Balanced Assessment (BA) and the Michigan Educational Assessment Program (MEAP), the state assessment for seventh graders. The BA was chosen to measure the higher order thinking that traditional assessments do not measure. The authors suggest that the first year of

CMP may not produce any gains in the area of basic skills, but results show that over a period of three successive years, students basic skills as measured by ITBS improved significantly. The results from the BA and the MEAP showed the CMP students consistently outscored non-CMP students.

The results from Michigan state assessment (MEAP) show that the percent of students achieving satisfactory scores steadily increase, which the authors attribute to the implementation of the CMP curriculum (Ridgeway et al, 2003). They cite as noteworthy the increase from 44.4% to 78.8% of students at a particular school scoring satisfactorily from the inception of the assessment in 1991 to the fifth administration given in 95-96 school year. This they attribute to the implementing of the CMP curriculum in 1993. Furthermore, this school consistently had outperformed the state – also attributed to the usage of the CMP curriculum and a resultant increased retention of knowledge over summer.

Judith Cain, a veteran teacher in Lafayette Parish, Louisiana, conducted a study for the purpose of formative evaluation of CMP to check its viability as a catalyst for positive change in her district (Cain, 2002). The CMP group scored better than the non-CMP group on both the ITBS and had a higher percentage of students to pass the Louisiana Education Assessment Program (LEAP 21). Consequently, the district adopted the curriculum for all of its middle schools.

Ben-Chaim, Fey, Fitzgerald, Benedetto, and Miller (1998) studied the efficacy of CMP on enabling students to develop proportional reasoning skills. The researchers gathered their data in the 1994-1995 school year. This study used problems apparently developed by the researchers (it did not say where they got the problems from) for the purpose of the study. The researchers omit demographic information about participants of the study except to state what city and state from which the samples were taken. The results were that the CMP students very significantly outscored the non-CMP students. It is notable that the sample sizes were small (124 and 91) making generalizations difficult. The authors also infer that the type of instruction used in the CMP classroom, discovery-learning, leads to better understanding because the students had not been taught how to do the types of problems presented on the measure.

Riordan and Noyce (2001) examined the effect implementation of the CMP curriculum had on student performance on the Massachusetts state assessment in 1999. The sample size of over 7,000 was sufficiently large. Although their sample was more than 80% white and more than 80% did not receive free/reduced lunch, they examined subgroups based on race/ethnicity and SES. The results were that CMP students performed better the non-CMP students. Also, each subgroup (minorities and low SES) in the CMP group scored significantly better than their respective counterparts in the traditional group. Furthermore, the difference for each subgroup was greater than that for whites – although for Asians and Blacks, this difference was not statistically significant due to the small numbers.

Reform Opponents on CMP

As previously stated, mathematicians who oppose both the NCTM standards and the resulting curricula are restricted from conducting research in mathematical education; they need to conduct research in their areas of mathematical expertise; time is limited (Latrell, 2005). This does not mean, however, that these people do not have a vested interest in K-12 education. They very much desire the success of students at the elementary and secondary levels in order to produce future mathematicians. Consequently, they have published their objections and opinions in both peer reviewed journals and on the internet in an attempt to make their concerns heard by the math educator led reform effort. The traditionalist perspectives and opinions presented herein are those of experts in their respective fields, not in lieu of peer reviewed scholarship, but in its aforementioned absence.

Objections to NCTM Standards: Lemma for Objection to CMP

The *1989 Standards* precipitated the development of new curricula as well as formative and evaluative research about these curricula. These curricula are basically embodied in the materials (textbooks) that are used in the classrooms. Curricula is also impacted ,if not more so, by what the states and districts do because states and districts purchase curricula. California being the most populous state in the nation heavily influences what curriculum designers put in their materials and textbooks.

California has been one of the volatile theaters in the math wars. California in 1992 published its standards in the *Mathematics Framework for California Public Schools*. The standards were based on the vision put forth by the NCTM *1989 Standards*. According to Wu (2001), these standards placed too much stress on pedagogy and not enough stress on accuracy of content.

Student performance continued to be very low. In 1996, the California state legislature formed the Academic Content and Performance Standards Commission (ACPSC) to write the state standards to be submitted to the State Board of Education for approbation (Wilson & Davis, 2006). The math standards were the only proposed standards to be substantially revised (i.e., rejected) by the State Board of Education. This was because the proposed math standards were similar to the previous standards (California State Board of Education,1992) in that the proposed standards placed more emphasis on pedagogy than content, and they were replete with mathematical inaccuracies. The State Board of Education took preemptive action and recruited four mathematicians from Stanford to write the math standards (*Background Information*, n.d.). These standards proposed by the Stanford professors have been reviewed and certified to be mathematically correct. The focus of these standards is on content and not pedagogy. Pedagogy and a host of other issues are covered in the framework. The thought is that the standards should clearly and completely state what mathematics should be learned and when; not how it should be learned or taught. The "how's" belong in the framework, which is where they are. The endorsement of these standards by over 100 mathematicians in California (Background Information, n.d.) exemplifies the position of math experts nationwide.

Professor Wu (1997) expresses that too much cooperative learning is taking place, and that learning is suffering as a consequence. "When cooperative learning rules, teachers cannot share their insights with students or warn them against pitfalls" (p. 950). He also raises serious concerns about the degeneration of future K-12 teacher content knowledge if technical (procedural) skills will be more inadequate than that of current teachers.

Again, traditionalists are not against more efficacious pedagogical practices, they simply maintain that this cannot be accomplished without mathematics education undergirded by completely correct mathematics. "What is missing in the reform is the commitment to teach mathematics, in all its guises, without violating its integrity" (Wu, 1997, p. 953). The reform movement abdicates mathematical precision as produced by traditional procedures for a call for reasoning (process) to replace precision. This is imbued in the NCTM standards and many state standards that have patterned their standards after the NCTM standards (Wu, 1996). This traditionalists in general and mathematicians in particular find absolutely unacceptable.

One of the tools used to accentuate discovery-learning is open-ended questions. The philosophy employed is to provide a prompt that allows students to use their judgment in order to fill in missing pieces of the problem and then arrive at a solution using correct mathematical processes. This approach imposes particular requirements on the teacher if it is to be educationally valuable by helping students to develop power. The teacher must make sure that the question is completely lucid- i.e. the interpretation of the question regarding context and mathematical concept should be crystal clear to students. In order for this to happen, the teacher must possess a thorough understanding of the concepts with all of the connections involved; and the teacher must understand the varied ways in which the concept can be taught using the problem at hand. This is what Shulman (1986) calls pedagogical content knowledge. If the teacher does not have the required pedagogical content knowledge, the results can be disastrous. Teachers can and have developed mistaken notions about what makes a problem good material for instruction. Teachers have developed the notion that a good problem allows students to make up their own questions and then to answer them and a bad one requires one answer (Wu, 1996). Conclusions such as these drawn by teachers belie the need to be extra-careful in designing a document such as the standards to lead the direction of mathematical instruction and learning. It is impossible for students to develop power as indicated in the *1989 Standards* if the mathematics presented in the standards is not completely correct and if the mathematics presented by the teacher is not completely correct. Traditionalists note this shortcoming with the NCTM standards and NCTM-like state standards.

Criticisms of CMP

Given the educational milieu in the era of NCLB, states and citizens are particularly concerned with student performance on state assessments and on standardized achievement vehicles used by colleges (Scholastic Aptitude Test [SAT]). Given the plethora of reform curricula claiming to be a remedy to the math education woes, research documenting their effectiveness is more important than ever before. As previously mentioned, most of the research on the reform curricula is conducted by the designers of the curricula. Not surprisingly, the results seem to always come back as positive.

The U.S. Department of Education Institute of Education Sciences (IES) established the What Works Clearinghouse (WWC) to provide the public with information on the reliability of the research recommendations by conducting meta-analyses. In order for the WWC to review the results of any research, the research must meet the evidence standards (WWC2, 2002, Standards, ¶1). The WWC reviewed a total of 22 research efforts regarding CMP. Three of them met evidence standards with reservations. The other 19 failed to meet the standard. The three that met the standards with reservations[2] were Ridgeway et al. (2003), Riordan & Noyce (2001), and Schneider (2000).

Once the evidence standard has been met, the results are then examined. The results are considered in the context of the study by itself and in the context of all of the research on the particular intervention. In the Ridgeway et al. study (2003), the researchers concluded that CMP had positive effects; the WWC concluded that CMP had an indeterminate effect due to too small average effect size. The Riordan & Noyce (2001) study was noted showing positive effects; no further comments were made apparently implying that this research was considered by WWC to indeed have had significant effect. WWC did make a note however in the technical appendix stating that none of the CMP classes used all eight units of the intended curriculum (WWC3, 2007). The Schneider (2000) study showed no statistical effects on the Texas state assessment. WWC found that the putative effect size for this study indicated no significant effect. Overall the CMP curriculum was determined to have mixed effects (WWC1, 2002; WWC4, 2007)

Dr. Wayne Bishop of California State University, Los Angeles informally reviewed the report of the Ridgeway et al. (2003) research and concluded that the results from the ITBS test were clearly suspect (Bishop, 1997). He cites the non-CMP sixth grade group ending with a mean score of 8.6 and the following year the eighth grade score ended with the same mean score of 8.6. This indicates that the study groups are very different types of students or the traditional curricula used is not in fact traditional. Therefore, accepting the results as valid is not plausible.

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[2] "...strong quasi-experimental studies that have comparison groups and meet other WWC Evidence Standards, as well as randomized trials with randomization, attrition, or disruption problems and regression discontinuity designs with attrition or disruption problems" (WWC2, 2002, *WWC Evidence Standards*).

The above analysis of research professing the benefits of CMP is much needed in order to help make good decisions regarding adopting curriculum. Professor Milgram from Stanford University undertook an analysis of the curriculum itself (Milgram, n.d.). Milgram concluded that "overall, the [CMP] program seems to be very incomplete…aimed at underachieving students rather than normal or higher achieving students" (Milgram, n.d., *Overall conclusions*, ¶1). He takes exception to standard algorithms never being provided for fraction arithmetic. He states, "Precise definitions are never given" (¶2, second bullet). The practice needed to master basic algebra skills is greatly lacking. In all, Professor Milgram found the curriculum lacking in the content and rigor necessary to prepare students for studies in higher level mathematics. He finishes with a remonstration of the Ridgeway et al. (2003) study citing an anonymous mathematician's opinion that the reason for the increase in the scores is due to certain schools dropping out and another school adopting CMP for the entire middle school; these changes, to which he alludes, resulted in an obvious shift in the proportion of top math performers in the non-CMP group relative to those in the CMP group. Dr. Milgram reproves the report of this research as displaying disingenuous data analysis.

Along the same lines, Reys of the University of Missouri-Columbia addressed Tsang of Michigan State University in a letter (Reys, B., 1998) taking grave exception to a letter that Tsang wrote to the Piano Independent School District Board of Trustees in which Prof. Tsang admonished the board against Reys' study because three of the four researchers were associated with publishers of CMP. In her letter to Tsang, Reys chided Tsang for making an analogy between Reys' research and that conducted by the tobacco companies regarding the deleterious effects (or the lack thereof) of tobacco.

In a rejoinder, Tsang enumerated her reasons (based on her experience as a parent) for essentially warning that the research could not be trusted (Tsang, 1999). Tsang explains that Reys' position as the director of a center that is associated with the publisher of CMP makes it unethical for her to report research on CMP to be used for curricular adoption decisions. Tsang then cites "a series of 'drill and kill' books authored by [Reys] and currently published by Dale Seymour [CMP publisher]" (Tsang, 1999, ¶5). Tsang states that parents have been purchasing these drill-and-kill books in order to supplement the CMP curriculum, which de-emphasizes drill and kill. Tsang is clearly accusing Reys of engaging in a hustle. On one hand she promotes materials that de-emphasize drill-and-kill, and on the other hand she sells drill-and-kill books. On a personal note, Tsang ends her diatribe by stating that education experts lack a professional and ethical standard calling into question the research extolling reform curricula as positively impacting students' test scores and the mathematical knowledge attained that is not measured on the standardized tests.

Testing and Assessment in the Context of Reform

In response to poor student performance on mathematical national and international testing measures, NCTM spearheaded the event of new standards for learning math using discovery-learning and problem-solving. This precipitated the development of new curricula. The objective of this reform is for students to learn mathematics more thoroughly. The public generally equate this objective with performing better on standardized testing measures.

Given a decade of reform efforts with at best indeterminate results, Congress passed NCLB (2001) in which all states are mandated to develop challenging and rigorous content standards. By law these standards must clearly state what math students are expected to know. In addition, states are required to implement measuring tools (tests) to be used statewide in grades three through eight in order to assess the progress of student achievement; each student, school, district and state are to incur consequences (rewards and punishments) according to these test results. These tests are by definition high stakes.

Local and state policymakers invoke these state tests first because they are required by federal law, but secondly in order to spur improvement – "that which is tested gets taught" (American Educational Research Association, 2000) They proceed on the idea that a well designed test will have a trickle-down effect; the high stakes test will impel districts, schools and teachers to make structural, curricular and instructional adjustments in order for students to achieve adequately on the state tests (Romberg, Zarinnia, and Collis, 1990). This idea permeates the current K-12 educational environment.

The Need to Reform High Stakes Tests (State Assessments)

In the first half of the twentieth century education was used as a filter (Bloom, Hastings, and Madaus, 1971). Students not qualified for college were filtered out. Five percent went to college and 95% dropped out along the way to college. The controlling philosophy was that the rare student was college material, and the role of the education system was to identify which students were college material. That is, educators made decisions about students based on predictions of what that student would become in the future. Evaluation in the form of standardized tests were used as a means to this end by categorizing students – A student, B student, C, D or F student. The purpose of identifying those students that are college material was the function of standardized tests in education (Joint Committee on Testing, 1962).

Bloom et al. (1971) recognized the elitism entrenched in the aforementioned view and proffered a contrasting view; education should develop students, not make predictions about their future. Evaluation should therefore be used (a) to "contribute to improvement of teaching and learning" (p. 8) and (b) to ensure that all students learn that which is purported to be important by the relevant authorities. Nearly a decade earlier the Joint Committee on Testing (1962) admonished that a "standardized test is an indirect measurement of only a segment of the performance of a pupil at a particular time" (p. 9) Furthermore, the act of combining subscores into a net score poses the problem of two students with the same score having two different profiles. This beckons careful attention to the interpretation and usage of standardized test scores.

Clearly, these inequities permeated mathematics education and mathematics testing. The much hailed "old-reliables" (SAT, ITBS) are considered such because of established high reliability. In order "to make these quantitative devices as reliable as possible, the range of tasks must be as narrow as possible" (Joint Committee on Testing, 1962, p. 10).

The emphasis in math education reform is altered from rote memorization of paper-pencil procedures to problem-solving using discovery learning based on constructivist principles of acquiring knowledge through assimilating and accommodating new information into existent cognitive structures. This type of learning entails "growth in making generalizations, in forming concepts, and in developing understanding of all phenomena in depth" (Joint Committee on Testing, 1962, p. 23).

This reformed view of mathematics education beckons for alterations to the tests used to measure acquisition of mathematical knowledge and skills particularly in light of the fact that high stakes testing determine what is taught and emphasized in instruction (Joint Committee on Testing, 1962; Romberg et al., 1990).

Standards and Assessment in New York State

In 1984, the New York State Board of Regents (the Regents) approved the *Action Plan to Improve Elementary and Secondary Education Results in New York* (*The Plan*; NY State Education Department [NYSED], 1983). This plan evaluated progress since the 1974 state plan for education in New York. *The Plan* seeks to eliminate the grave inequities as decried by Bloom et al. (1971). *The Plan* establishes ten goals for students that, while stated in terms of behavioral objectives, capture some of the essence of mathematics reform. Goal number one with selected subgoals states the following:

1. Each student will master communication and computation skills as a foundation to:

   1.1 Think logically and creatively.

   1.2 Apply reasoning skills to issues and problems.

   1.7 Use current and developing technologies for academic and occupational pursuits.

   1.8 Determine what information is needed for particular purposes and be able to acquire, organize and use that information for those purposes (NYSED, 1983, p. 6).

Under the 1974 Goals, graduates from high school were required to complete one math course (not necessarily algebra) and to pass the Regents Competency Test (RCT;

NYSED, 1983). The RCT was a test of minimal mathematical knowledge and skills that one graduating from high school should be able to demonstrate. The 1984 action plan continued the use of the RCT, but it added the requirement of one extra math class for a local diploma and of two extra math classes for a regents diploma. At the elementary level the Pupil Evaluation Program (PEP) Test was administered at third and sixth grades. Promotion was not contingent upon reaching the minimum requirement. No significant changes occurred from the 1974 plan to the 1984 plan.

In 1991, the Regents published their *New Compact for Learning* (The Compact, 1991). The goal of "progress[ing] towards proficiency and mastery" (p. 6) had supplanted the language of minimum competency as the primary objective for success. Buzzwords such as assessment and accountability were invoked for the first time in the state's action plan. State assessment was the new name for regents test. For the first time, serious consequences for schools were attached to poor student performance. Regarding instruction, the Regents wisely noted that, "No one style of teacher or teaching is best for all students…" (NYSED, 1991, p. 8). The Compact clearly demonstrated the transformation from minimal achievement, which set lower expectations for and by lower SES students, to a more equitable perspective of expecting all students to reach the same higher standard. At this time in 1991, no changes in testing had occurred.

In a 1995 update report, the Curriculum and Assessment Council to the Commissioner of Education consisted of seven Curriculum and Assessment Committees (CAC) that were charged with developing the standards and framework in each of their respective academic disciplines. The report gives the Board's definition of a framework as "a broad description of the principles, topics, and modes of inquiry or performance in a discipline which provides the basic structure of ideas upon which a curriculum is based" (NYSED, 1995, p. 5). Learning standards are then described as having "two major components: the content standard and the performance standard" (NYSED, 1995, p. 5). According to the report, the Math, Science and Technology (MST) standards were the first to be approved in March, 1993. This is not surprising because NCTM led the educational community in being the first discipline to publish its standards in 1989.

Once the content standards were approved, the performance standards were developed in order to set the mark indicating what level of performance represents acceptable mastery of each content standard. The performance standards included providing exemplars of assessment problems. Developing the performance standards led to the development of the assessment. The result is a bank of problems from which a picture develops that educators as well as test developers can use to design assessments based on the standards. It is the Regents responsibility to approve all tests to be used by the state for the purpose of assessing student performance (NYSED, 1995).

The early stages of constructing new state assessments were besieged by the need and the desire to align these assessments with the then newly developed state standards. Multiple choice testing measures a narrow set of skills and encourages cursory learning of material (Joint Committee on Testing, 1962). Deep thinking was discouraged due to the high-stakes value of getting the correct answer. It has been recognized by the masses that alternatives to multiple choice high-stakes testing is greatly needed. Alternatives have been offered such as constructed response and extended response where appropriate development, justification, and explications must accompany answers. Other alternatives are performance-based assessment where the student is assessed based on some task or performance demonstration of understanding. Both of these are more desirable in that they don't provide visual triggers like the multiple-choice. Moreover, they present the opportunity for a student to demonstrate his knowledge in a situation much more closely related to the learning environment (Bryant, 1999).

The problem is that alternative assessments are unreliable for a few reasons. Chief among them is that alternative assessments are extremely susceptible to rater bias. Different raters will rate the same problem very differently. Even the same teacher may rate the same problem differently on Monday than he will on Tuesday. Also, lack of consistency between teachers, schools and districts is very difficult to avert. A few states have moved towards implementing alternative assessment. Others, such as the tumultuous California, attempted alternative assessment but met with the aforementioned antagonism from parents. This convinced the policy makers to adopt more traditional measures (Bryant, 1999).

The need for alternative assessment is palpable, but not yet plausible in New York State. Clearly, reliability is pertinent; yet the query must be posed, how much is reliability worth when the reliable information is not the information sought? Continuing research will hopefully ferret this out.

Nonetheless, in 1999, NY administered its first set of new assessments. These new assessments were the first statewide assessments that were based on the new standards. Also, these assessments were given to all public school students at the appropriate grade level. At the elementary level, this assessment immediately replaced the PEP Tests, which were administered to students in the third and sixth grades. The elementary state assessments of English and language arts (ELA) and mathematics were given to fourth grade students; the middle level assessments of ELA and math were given to eighth grade students. The RCT and the Course I, II & III exams would be phased out over five years to be replaced with the Math A and Math B Assessments.

The NY State Grade 8 Assessment

The first offering of the new state math assessments was in 1999. The New York State CAC decided to go with a mix of multiple-choice, constructed response and extended response problems on all math assessments including the eighth grade assessment. The idea was evidently to capture as much of the assessment aims promulgated in The Compact as possible without foregoing reliability. This assessment was based on the same content and performance standards from its beginning in 1999 to 2005. In 2005, the Board approved a revision of the MST standards (NYSED [a], 2005; NYSED [b], 2005). The state math standards were rewritten to more closely mirror the *Principles and Standards* (NCTM, 2000). The new standards brought one other modification. Due to the revisions made at the high school level, much of the algebra that was previously assessed on the Math A Exam was moved into the seventh and eighth grade bands (NYSED(b), 2005). This resulted in more traditionalist type algebra problems on the 2006 Grade 8 Assessment. This change requires caution in obviating invalid inferences from the comparison of the proportions of grade 8 students meeting the standard in 2005 and 2006.

Summary

There is a math war being waged between the reformists and the traditionalists. This war is not exactly new; John Dewey (reformist) and Edward Thorndike (traditionalist) were two colossal icons of the early twentieth century who each proffered views of mathematical learning that mirrored the current clash of pedagogical perspectives.

The contemporary reformists, led by math educators, are working to transform mathematics education from an enterprise dominated by mechanical arithmetic and algebraic procedures where students perfunctorily perform operations with little to no comprehension of the mathematical structures that give rise to these procedures. They employ the latest cognitive research on learning to math education. This research indicates that the learner is the center of learning and must construct their own knowledge; the teacher cannot impart her mathematical knowledge to the student. The teacher's responsibility is metamorphosed into providing students with learning problems/activities that enable students to search for solutions in a social setting (working with other students). This experience enables and encourages students to construct meaning through reflection upon their experiences. This is called discovery learning. This mode of instruction and learning fosters a much deeper, connected and comprehensive knowledge. Students develop higher-ordered thinking where they can apply their knowledge, analyze novel situations and synthesize solutions – the intellectual skills wanted in today's workplace. Reformists believe that CMP is a curriculum that will facilitate this type of learning.

Traditionalist (professionally represented by mathematicians) purport that while reform is necessary, the energies have been misplaced. There is no need to dispense with the arithmetic and algebraic procedures. The problem is and always has been that teachers lack the depth of knowledge required to adequately provide meaningful instruction that would enable students to learn the connections and the mathematics underneath the procedure. Furthermore, this teacher lack of knowledge will only exacerbate the problem when curriculum is enacted requiring that students make connections that the teachers themselves have not made. Traditionalists therefore prescribe development of the teachers' knowledge as a first step to remedying the problem. Teachers do not have the requisite knowledge to teach in the manner reformists propose.

In order to provide evidence supporting their claims regarding the effectiveness of CMP, reformists have conducted much research. The research shows that students do no worse regarding computational skills and significantly better regarding problem solving skills requiring application, analysis and synthesis. Traditionalists dismiss this research as biased and unethically publicized as impartial and effective.

An indispensable part of learning is assessment. Standardized testing was developed to enable valid comparisons. A result has been that they help maintain the old system of inequitable selection. Hilton states that these tests

> "force students to answer artificial questions under artificial circumstances; they impose severe and artificial time constraints; they encourage the false view that mathematics can be separated out into tiny water-tight compartments; they teach the perverted doctrine that mathematical problems have a single right answer and that all other answers are equally wrong; they fail completely to take account of mathematical process, concentrating exclusively on the 'answer' " (Hilton, 1981, p. 79).

Hilton reflects Dewey's philosophy that school learning like all other learning should occur in the context of human activity of employing a means to accomplish an end. The ends should be natural, thus precipitating means that are natural; that is, non-contrived activity will enable the mind to work in concert with its own innate propensities. Reformists recognize that to amend the curriculum and not the force that drives the curriculum is inefficacious and fatuous. The obstacle in implementing alternate assessments is that they are not reliable or cost effective. This challenge still remains.

Great efforts have been undertaken in various states to make this change. New York Board of Regents in 1993 approved the then new math standards. In 1999, the first state math assessments were given that were based on the new standards. This immediately did away with the old PEP Tests that were administered at the third and sixth grades. These were replaced with the elementary assessments given at the fourth grade and the middle level assessments given at eighth grade, respectively. The high schools would phase out the old exams over a period of five years. Due to the continuous effort to improve all aspects of education in NY State, the CAC revised the MST. The state mathematics standards now closely mirror the NCTM standards (2000) – actually the five content strands and the five process strands are those of NCTM (2000). The revision in the high school exam structure forced a trickle down of material from algebra into the eighth grade curriculum and assessment. This was first assessed in May, 2006. This warrants caution in comparisons between the previous 2005 assessment and the 2006 assessment.

CHAPTER 3

Methodology

The Study

This study examines two groups of students: (a) the experimental group whose teachers followed the Connected Math Project (CMP) and (b) the control group (which will often be referenced as the standards group) whose teachers used the New York State Standards as the guideline along with various other sources of instruction. The state assessment is based on the state standards, which ensued from the reform effort. The objective is to determine if students taught using a well constructed curriculum (such as CMP), born from the same reform effort as the state standards, perform worse than, as well as or better than their counterparts who were instructed based on the state standards.

The NY State Assessment scores are examined for 2006 seventh and eighth grade and 2005 eighth grade. The raw scores excluding names were retrieved from the Buffalo Public Schools by special request. The data used was each student's school, scaled score and performance level.

Interpreting the Scores

New York State Education Department (NYSED) defines four levels of performance, Level 1 through Level 4, into which each student is placed according to his/her scaled score. Levels 3 and 4 indicate having met the standard. Levels 1 and 2 indicate performing below standard. Each student falls into one of the performance levels according to his/her scaled score (See Appendix A for definition of and score range for each performance level).

Recent History of Curriculum and Instruction in the District

In 2001-2002, the Buffalo Public Schools used the *Transitional Math Book* (UCSMP, 1983) at the seventh and eighth grade levels as a textbook. Teachers were told by administration during professional development workshops in essence that the textbook is not the curriculum; it is a guide. Teachers were directed by their administrators that the performance indicators given in the NY State Core Curriculum were the benchmarks for which teachers were to strive.

In the 2002-2003 school year, ten schools piloted some units from the Connected Mathematics Project. In the 2003-2004 school year, these ten schools began using the CMP full time. The other schools continued teaching based on the state standards. In 2005-2006 school year, state testing occurred in grades three through eight. Prior to 2006, the middle grade assessment was given solely at the eighth grade level.

The Need to Compare Similar Schools

The Buffalo School District is comprised of ethnic and socioeconomic diverse students. Some schools have entrance exams and achievement requirements while others do not. Some schools have a much higher percentage of students beneath the poverty line (as measured by percent of students receiving free lunches) than others. In the Buffalo District, the majority of these economically poor students are minorities (NYSED[e],2006). Students steeped in poverty are at a distinct academic disadvantage due to lack of resources (Payne, 2001; No Child Left Behind Act, 2001). This lack of resources is manifested in poor and minority students scoring far below their more advantaged and majority peers.

These disparities render comparisons between schools difficult at best. School A with a low to average needs student population will more than likely perform better than school B with a poor population regardless of curriculum.

In order to assist those interested in comparing schools, New York State defines *similar schools* based on school organization and the needs to resource capacity (N/RC) index. This index takes into account the type of municipality in which the school is located (rural, big city, suburban, etc…) and combines it with the "single factor most highly correlated with educational need [which] is population poverty" (NYSED [e], 2006). The other factor impacting on poor performance taken into to account by the N/RC is "proportion of students with limited English proficiency" (NYSED [e], 2006). NYSED defines a high N/RC to mean that a school has high needs and few resources; this corresponds to low socioeconomic status (SES). Low N/RC indicates that a school has low needs and ample resources.

Schools in the same group are considered to be proportionately affected by poverty level and/or limited English proficiency level. The state uses the N/RC to organize schools into low, medium and high needs groups (NYSED [e], 2006). There are many other groups, but Group 5 and Group 6 are the only groups used in this study. The state defines Group 5 as an elementary school organization in large cities (other than NY City) having middle range needs with moderate resources and Group 6 as an elementary school organization in large cities (other than NY City) having high needs with little resources.

Study Groups

Each seventh and eighth grade student in the district belongs to either the CMP group or the standards group. These two groups were compared district wide for each of the NY State Grade 8 Assessments, 2005 and 2006 as well as for the NY State Grade 7 Assessment, 2006. For the eighth grade, the change in percentage of students who met the standard (scored level 3 or 4) from 2005 to 2006 was computed for each group and compared to give a between year perspective.

In order to compensate for the ethnic and socioeconomic diversity in a district the size of Buffalo, this study compares the CMP group to the standards group within Group 5 and within Group 6. These are the only groups that contained both two or more CMP schools and two or more standards schools. Group 5 is never compared to Group 6 because the difference in N/RC index indicates that the SES of the students would disproportionately have a negative effect on Group 6. The between year comparison is done at the eighth grade for each of Group 5 and Group 6.

Procedure

The histograms in Appendix B, Figures B1, B2 and B3 show that the data for the entire district is fairly symmetric and approximates a normal distribution for Grades 7 & 8, 2006 and for Grade 8, 2005. The large population insures that sampling will be normally distributed. In order to examine whether there are significant differences in the means of the CMP group and the standards group, z-tests are performed on the differences (See Appendix C regarding z-test). Likewise, z-tests are performed on the differences of proportions of students to meet the standard to see if there are significant differences in the means.

The null hypothesis for each measure is that the difference between the means for the CMP group and the standards group is zero. All z-tests are performed at the .05 and .01 levels. Since the means were consistently below the median as shown in the box plots in Figures B4 through B9, the medians were examined for differences by comparing the proportions of scores in each group above the median of the two groups being compared combined.

Data Analysis

Grade 8 2005 Assessment

District

District Mean Comparison

The first comparison to examine is between the mean of the CMP group and the mean of the standards group. The CMP group mean is lower than the standards group. This deficit is, however, not significant at the one percent level (Table 1).

Table 1
NY State Grade 8 Assessment 2005: Comparing Means of CMP Group & Standards Group for the District

	District (Population)	CMP group	Standards group
Mean (μ)	693.09	691.13	693.87
N	3031	867	2164
σ^2	1291.09	1221.32	1318.07

Result	
z	-1.90
z(α=0.01)	-2.58
p value	0.06

District Comparison of Percentage of Students Meeting Standard

The comparison of sample proportions revealed that the null hypothesis of the proportion of students meeting the standard would be equal for the experimental group and the control group is rejected. The 21 % of students to meet the standard in the CMP group was significantly less than the 26% of the standards group to meet the standard (Table 2).

Table 2

NY State Grade 8 Assessment 2005: Comparing Percentage to Meet Standard[a] of CMP Group & Standards Group Districtwide

	District (Population)	CMP group	Standards group
% that Met Standard	0.25	0.21	0.26
N	3031	867	2164
σ^2	0.19	0.17	0.19

Result	
Z	-3.03
z(α=0.01)	-2.58
p value	0.00

[a]Meet the standard means the student scored in the level 3 or 4 range on the state assessment. N = number of students in the group.

District Median Comparison

Examining the box plot (*Figure B6*), it appears that the medians are the same and that the distributions are the same with the exception of the maximum scores. In order to test the equality of the median, the percentage of scores falling above the median were tested. The median of the CMP and the median of the standards group are not significantly different. For both groups, virtually half of each respective group scored on each side of the median.

Table 3

State Grade 8 Assessment 2005: Using the Sign Test to Check for Statistical Differences in the Median Districtwide

M = 696

	# of data not equal to M	Proportion greater than M
CMP	839	0.49
Standards	2106	0.51
Z	-1.22	
z(α=0.01)	-2.58	
P	0.22	

Note. M = the median of the combined groups, CMP and standards (which is the entire district).

Grade 8 Assessment 2005 - Group 5 Schools

Group 5 Mean Comparison

In comparing the means of the CMP group scores and the standards group scores of students attending schools in Group 5, there is no significant difference (Table 4). The CMP group mean again was lower than the standard group mean.

Table 4
NY State Grade 8 Assessment 2005: Comparing Means of CMP Group & Standards Group in Group 5

	Group 5	CMP group	Standards group
Mean (μ)	690.95	692.79	688.44
N	1030	436	594
Σ^2	1279.99	1551.50	1075.29

Result	
Z	-1.93
z(α=0.01)	-2.58
p value	0.05

Group 5 Comparison of Percentage of Students Meeting the Standard

Within Group 5, CMP group had two percentage points below that of the standards group to meet the standard. This difference was insignificant (See Table 5).

Table 5
NY State Grade 8 Assessment 2005: Comparing Proportion to Meet Standard of CMP Group & Standards Group in Group 5

	CMP group	Standards group	Group 5
% that Met Standard	0.21	0.23	0.22
N	436	595	1031.00
σ^2	0.16	0.18	0.17

Result	
z	-0.86
z(α=0.01)	-2.58
p value	0.19

Group 5 Median Comparison

The box plots of the CMP and standards of Group 5 clearly show that the standards group median is higher than that of the CMP group (see Figure B7). The top whiskers indicate equal maximums, but the CMP group has more outliers on the bottom of the data. Although the CMP group shows slightly lower than the standards group in this measure, the difference is not significant (see Table 6).

Table 6
State Grade 8 Assessment 2005: Using the Sign Test to Check for Statistical Differences in the Median in Group 5

MEDIAN (M)	696	
	# of data not equal to M	Proportion greater than M
CMP	425	0.47
Standards	577	0.52
Z	-1.62	
z(α=0.01)	-2.58	
P	0.11	

Grade 8 Assessment 2005 - Group 6 Schools

Group 6 Mean Comparison

The comparison between the CMP group and the standards group within Group 6 reveal that null hypothesis is accepted. There is no significant difference between the means (see Table 7).

Table 7
NY State Grade 8 Assessment 2005: Comparing Means of CMP Group & Standards Group in Group 6

	Group 6	CMP group	Standards group
Mean (μ)	691.21	687.15	692.03
N	815	137	678
σ^2	1043.90	645.40	1116.59
Result			
z	-1.61		
z(α=0.01)	-2.58		
p value	0.11		

Group 6 Comparison of Percentage of Students Meeting the Standard

The difference in the means of the CMP group within Group 6 and the standards group within Group 6 showed no significant difference. There is, however, a significant difference in the proportion of students who met the standard. As shown in Table 8, the CMP group had 14 percentage points less than the standards group to score at level 3 or level4.

Table 8

NY State Grade 8 Assessment 2005: Comparing Proportion to Meet Standard of CMP Group & Standards Group in Group 6

	CMP group	Standards group	Group 6
% that Met Standard	0.08	0.22	0.19
N	137	678	815
σ^2	0.07	0.17	0.16

Result	
z	-3.66
z(α=0.01)	-2.58
p value	0.00

Group 6 Median Comparison

A visual comparison of the CMP group box plot and the standards group box plot (see Figure B7) reveals that the middle half of the CMP group is below the middle half of the standards group. In fact, the upper quartile of the CMP group is slightly above the median of the standards group.

Also apparent in the box plots is that the distance between the medians is about the same as the difference in means. One would predict that the medians are not significantly different. The sign test exposes that the medians are in fact significantly different despite the insignificant difference in the means (see Table 9).

Table 9
State Grade 8 Assessment 2005: Using the Sign Test to Check for Statistical Differences in the Median in Group 6

MEDIAN (M)	694	
	# of data not equal to M	Proportion greater than M
CMP	135	0.45
Standards	651	0.62
z	-3.50	
z(α=0.01)	-1.96	
p	0.00	

Grade 8 2006 Assessment

District

District Mean Comparison

In 2006, the mean of the CMP group was significantly lower than the standards group - even at the one percent level (see Table 10).

Table 10
NY State Grade 8 Assessment 2006: Comparing Means of CMP Group & Standards Group Districtwide

	District (Population)	CMP group	Standards group
Mean (μ)	623.88	621.06	625.29
N	2761	922	1839
σ^2	1475.99	1052.22	1682.46
Result			
z	-2.73		
z(α=0.01)	-2.58		
p value	0.00		

District Comparison of Percentage of Students Meeting Standard

The comparison of sample proportions revealed that the null hypothesis of the proportion of students meeting the standard would be equal for the experimental group and the control group is rejected. The 15 % of students to meet the standard in the CMP group was significantly less than the 24% of the standards group to meet the standard (see Table 11).

Table 11
NY State Grade 8 Assessment 2005: Comparing Proportion to Meet Standard of CMP Group & Standards Group Districtwide

	District (Population)	CMP group	Standards group
% that Met Standard	0.21	0.15	0.24
N	2761	922	1839
σ^2	0.17	0.13	0.18
Result			
z	-5.36		
z(α=0.01)	-2.58		
p value	0.00		

District Median Comparison

Examining the box plot (*Figure B8*), it appears that the difference in medians is about the same as the difference in means. The sign test discloses that the median of the CMP is indeed significantly below the median of the standards group (see Table 12).

Table 12
State Grade 8 Assessment 2005: Using the Sign Test to Check for Statistical Differences in the Median Districtwide

MEDIAN (M)	628	
	# of data not equal to M	Proportion greater than M
CMP	892	0.46
Standards	1799	0.52
z	-2.95	
z(α=0.01)	-2.58	
p	0.00	

Note. M = the median of the combined groups, CMP and standards (which is the entire district).

Grade 8 Assessment 2006 - Group 5 Schools

Group 5 Mean Comparison

In comparing the means of the CMP group scores and the standards group scores of students attending schools in Group 5, like the 2005 results, there is no significant difference (Table 13). The CMP group mean is lower than the standard group mean.

Table 13
NY State Grade 8 Assessment 2006: Comparing Means of CMP Group & Standards Group in Group 5

	Group 5	CMP group	Standards group
Mean (μ)	622.27	620.12	623.99
N	1024	456	568
σ^2	1218.48	1172.85	1252.70

Result	
z	-1.77
z(α=0.01)	-2.58
p value	0.08

Group 5 Comparison of Percentage of Students Meeting the Standard

Within Group 5, CMP group has two percentage points below that of the standards group to meet the standard. This difference is insignificant (See Table 14).

Table 14
NY State Grade 8 Assessment 2006: Comparing Proportion to Meet Standard of CMP Group & Standards Group in Group 5

	CMP group	Standards group	Group 5
% that Met Standard	0.17	0.18	0.18
N	456	568	1024
σ^2	0.14	0.15	0.15

Result	
z	-0.76
z(α=0.01)	-2.58
p value	0.45

Group 5 Median Comparison

Visual inspection of the medians based on the box plots of the CMP group and the standards group of Group 5 indicate that the standards group median is only slightly higher than that of the CMP group (see Figure B9). The standards group shows a higher maximum. Although the CMP group shows slightly lower than the standards group in this measure, the difference is not significant (see Table 15).

Table 15

State Grade 8 Assessment 2006: Using the Sign Test to Check for Statistical Differences in the Median in Group 5

MEDIAN (M)	626	
	# of data not equal to M	Proportion greater than M
CMP	445	0.48
Standards	548	0.53
Z	-1.61	
$z(\alpha=0.01)$	-2.58	
P	0.11	

Grade 8 Assessment 2006 - Group 6 Schools

Group 6 Mean Comparison

The comparison between the CMP group and the standards group within Group 6 reveal that null hypothesis is rejected. The CMP group mean is significantly below the standards group mean (see Table 16).

Table 16

NY State Grade 8 Assessment 2006: Comparing Means of CMP Group & Standards Group in Group 6

	Group 6	CMP group	Standards group
Mean (μ)	623.81	613.36	626.94
N	598	138	460
σ^2	1108.66	747.65	1178.56

Result	
Z	-4.20
z(α=0.01)	2.58
p value	0.00

Group 6 Comparison of Percentage of Students Meeting the Standard

There is a significant difference between the CMP group and the standards group in the proportion of students who met the standard. As shown in Table 17, the CMP group had 19 percentage points less than the standards group to score at level 3 or level 4.

Table 17

NY State Grade 8 Assessment 2006: Comparing Proportion to Meet Standard of CMP Group & Standards Group in Group 6

	CMP group	Standards group	Group 6
% that Met Standard	0.05	0.24	0.19
N	138	460	598
σ^2	0.05	0.18	0.16

Result	
z	-4.85
z(α=0.01)	-2.58
p value	0.00

Group 6 Median Comparison

Visually examining the CMP group box plot and the standards group box plot (see Figure B9) reveals that the middle half of the CMP group is below the middle half of the standards group. In fact, the upper quartile of the CMP group is only about on par with the median of the standards group.

Also apparent in the box plots is that the distance between the medians is about the same as the difference in means. Based on the significant difference in the means, one would expect that the medians are also significantly different. The sign test verifies that the medians are in fact significantly different (see Table 18).

Table 18

State Grade 8 Assessment 2006: Using the Sign Test to Check for Statistical Differences in the Median in Group 6

MEDIAN (M)	626	
	# of data not equal to M	Proportion greater than M
CMP	134	0.31
Standards	444	0.56
z	-5.13	
$z(\alpha=0.01)$	2.58	
p	0.00	

Grade 7 2006 Assessment

District

District Mean Comparison

The seventh grade district mean comparison does not have the significant difference in means that the eighth grade 2006 results showed. Districtwide, the mean of the CMP group is not significantly lower than the standards group (see Table 19).

Table 19
NY State Grade 7 Assessment 2006: Comparing Means of CMP Group & Standards Group Districtwide

	District (Population)	CMP group	Standards group
Mean (μ)	621.32	619.45	622.25
N	2924	966	1958
σ^2	1497.99	1267.15	1609.28

Result	
Hypothesized difference	0
z	-1.84
z(α=0.01)	-2.58
p value	0.07

District Comparison of Percentage of Students Meeting Standard

Despite the lack of significant differences in the means, the comparison of sample proportions revealed that the null hypothesis of the equal proportions of students meeting the standard in each group is rejected. The 19 % of students to meet the standard in the CMP group was significantly less than the 25% of the standards group to meet the standard (see Table 20).

Table 20

NY State Grade 7 Assessment 2006: Comparing Proportion to Meet Standard of CMP Group & Standards Group Districtwide

	District (Population)	CMP group	Standards group
% that Met Standard	0.23	0.19	0.25
N	2924	966	1958
σ^2	0.18	0.16	0.19

Result	
Hypothesized difference	0
Z	-3.12
z(α=0.01)	-2.58
p value	0.00

District Median Comparison

Examining the box plot (see *Figure B4*), it appears that lower half of the plots are identical including the medians. The sign test discloses that the medians are not statistically different (Table 21).

Table 21

State Grade 7 Assessment 2006: Using the Sign Test to Check for Statistical Differences in the Median Districtwide

MEDIAN (M)	624	
	# of data not equal to M	Proportion greater than M
CMP	917	0.50
Standards	1893	0.51
Z	-0.67	
z(α=0.01)	-1.96	
P	0.50	

Grade 7 Assessment 2006 - Group 5 Schools

Group 5 Mean Comparison

Comparison of the means of the CMP group scores and the standards group scores of students attending schools in Group 5 reveal no significant difference (Table 22). The CMP group mean is only a tiny bit higher than the standard group mean.

Table 22
NY State Grade 7 Assessment 2006: Comparing Means of CMP Group & Standards Group in Group 5

	Group 5	CMP group	Standards group
Mean (μ)	620.35	621.27	620.35
N	1143	515	628
σ^2	1249.11	1361.62	1249.11
Result			
z	0.43		
z(α=0.01)	2.58		
p value	0.66		

Group 5 Comparison of Percentage of Students Meeting the Standard

Within Group 5, the percentage of students to meet the standard is two points higher for the CMP group. This difference is, nonetheless, not statistically significant (See Table 23).

Table 23
NY State Grade 7 Assessment 2006: Comparing Proportion to Meet Standard of CMP Group & Standards Group in Group 5

	CMP group	Standards group	Group 5
% that Met Standard	0.22	0.20	0.21
N	515	628	1143
σ^2	0.17	0.16	0.17
Result			
z	0.87		
z(α=0.01)	2.58		
p value	0.39		

Group 5 Median Comparison

A close visual inspection of the box plots of the CMP group and the standards group of Group 5 (see *Figure B5*) show that the CMP group and the standards group means are indeed close. The distance between the CMP mean and the CMP median is greater than that of the standards group. This at least raises the question, are the medians significantly apart? The CMP group shows a higher upper quartile and maximum, which is slightly higher than the standards group in this measure. The overall difference is not significant (see Table 24).

Table 24
State Grade 7 Assessment 2006: Using the Sign Test to Check for Statistical Differences in the Median in Group 5

MEDIAN (M)	624	
	# of data not equal to M	Proportion greater than M
CMP	498	0.53
Standards	602	0.51
Z	0.67	
$z(\alpha=0.01)$	2.58	
P	0.51	

Grade 7 Assessment 2006 - Group 6 Schools

Group 6 Mean Comparison

The comparison between the CMP group and the standards group within Group 6 reveal that null hypothesis is rejected. The CMP group mean is significantly below the standards group mean (see Table 23).

Table 25

NY State Grade 7 Assessment 2006: Comparing Means of CMP Group & Standards Group in Group 6

	Group 6	CMP group	Standards group
Mean (μ)	617.39	606.55	620.88
N	678	165	513
σ^2	1428.73	1245.63	1442.93

Result	
Z	-4.23
z(α=0.01)	-2.58
p value	0.00

Group 6 Comparison of Percentage of Students Meeting the Standard

There is a significant difference between the CMP group and the standards group in the proportion of students who met the standard. As shown in Table 26, the CMP group had 14 percentage points less than the standards group to score at level 3 or level 4.

Table 26

NY State Grade 7 Assessment 2006: Comparing Proportion to Meet Standard of CMP Group & Standards Group in Group 6

	CMP group	Standards group	Group 6
% that Met Standard	0.10	0.24	0.21
N	165	513	678
σ^2	0.09	0.18	0.16

Result	
Z	-4.04
z(α=0.01)	-2.58
p value	0.00

Group 6 Median Comparison

Examination based on sight appears to show the CMP group box plot and the standards group box plot (see Figure B5) reveals that the upper quartile of the CMP group is only slightly above the median of the standards group.

Also apparent in the box plots is that the distance between the medians is about the same as the difference in means. Based on the significant difference in the means, one would expect that the medians are also significantly different. The sign test verifies that the medians are in fact significantly different (see Table 27).

Table 27
State Grade 7 Assessment 2006: Using the Sign Test to Check for Statistical Differences in the Median in Group 6

MEDIAN (M)	620	
	# of data not equal to M	Proportion greater than M
CMP	155	0.39
Standards	490	0.56
z	-3.73	
z(α=0.01)	-2.58	
p	0.00	

Comparing 2005 to 2006 of the Grade 8 Assessment

Prior to 2006, the state assessment was given only at the eighth grade for middle school. The progress from one year to the next can be explored by comparing proportions of students to meet the standard in 2005 to the proportion of students to meet the standard in 2006. Comparisons will be made for each respective group of students from 2005 to 2006.

District Analysis

Overall, the Buffalo District eighth grade has a significant drop in percentage of students to meet the standard. The CMP group also has a significant decline in the proportion of students to meet the standard throughout the district from 2005 to 2006. The standards group on the other hand, while showing a decline in percent of students to meet the standard, does not have a significant decrease (See Table 28).

Group 5 Analysis

Neither the CMP group nor the standards group showed significant decline from 2005 to 2006. With a p value of .13, the CMP group fared well in Group 5 compared to their standards group counterparts who had a p value of .06. As one would expect, the drop for Group 5 as a whole was not significant (See Table 29).

Group 6 Analysis

Again, the CMP group experienced a statistically insignificant decrease in the proportion of students meeting the standard. The standards group, however, experienced a modest improvement in the percentage of students meeting the standard from 2005 to 2006. This increase is not statistically significant. Group 6 as a whole encountered a very modest drop (See Table 30).

Table 28[3].
NY State Grade 8 Assessment: Districtwide Comparison 2005 to 2006 via Proportion

	District	CMP group	Standards group
% that Met Standard	0.23	0.18	0.25
N	5792	1789	4003
σ^2	0.18	0.15	0.19
	Result		
z	-3.44	-3.26	-1.73
z(α=0.01)	-2.58	-2.58	-2.58
p value	0.00	0.00	0.08

Table 29[2].
NY State Grade 8 Assessment: Group 5 Comparison 2005 to 2006 via Proportion

	CMP group	Standards group	Group 5
% that Met Standard	0.19	0.21	0.20
N	892	1162	2054
σ^2	0.15	0.16	0.16
	Result		
z	-1.53	-1.85	-2.43
z(α=0.01)	-2.58	-2.58	-2.58
p value	0.13	0.06	0.02

Table 30[2].
NY State Grade 8 Assessment: Group 6 Comparison 2005 to 2006 via Proportion

	CMP group	Standards group	Group 6
% that Met Standard	0.05	0.22	0.19
N	275	1138	1413
σ^2	0.05	0.17	0.15
	Result		
z	-1.87	0.86	-0.17
z(α=0.01)	-2.58	2.58	-2.58
p value	0.06	0.39	0.86

[3] All values in Tables 28, 29, and 30 represent the combined groups for years 2005 and 2006. The variance of the combined groups is used to calculate the standard error of the difference.

CHAPTER 4

Conclusions and Limitations

Summary of Results

In order to determine if the CMP group performed better than the standards group on the NY State Assessment, students' scores from three different assessments were analyzed – Grade 8 2005, Grade 8 2006 and Grade 7 2006. For each assessment, three statistics were compared in order to test for differences – the mean, the proportion of students to meet the standard (score Level 3 or 4) and the median. All tests were done at the .01 level. These differences were examined for the entire Buffalo District.

In order to account for the diversity of students in a large city district, the state categorizes schools into groups of similar schools according primarily to the SES of the student population and secondarily to the level of English Language proficiency of the student population. Of these groups, schools falling into to the categories of Group 5 and Group 6 were compared within each of their respective groups.

Finally, the progress made from 2005 to 2006 by the eighth graders was measured by comparing the differences in percentage of students to meet the standard between the two successive years.

The null hypothesis for each comparison is that the difference between the two groups is zero.

Out of 27 comparisons between the CMP group and the standards group, only 3 z-scores (11%) are positive. The other 24 were negative. None were zero (See Table 31). The standards group measure of student performance is higher than the CMP group (not all of them significantly) for the vast majority of comparisons between the CMP and the standards groups.

The only group to have positive z-scores indicating that the CMP group did better than the standards group is the Grade 7 students of Group 5. All three measures – mean, proportion & median - showed a positive result. In none of these cases, however, was the difference considered significant. In fact the lowest p value of the three measures for this group was .39 for the difference in percentage of students to meet the standard (see Tables 22, 23 & 24 for p values).

Further inspection of Table 31 immediately brings to light that for Group 5, there were no significant differences between the CMP group and the standards group. At the same time, the opposite holds for Group 6, where all of the differences were quite significant except the differences in means on the Grade 8 2005 Assessment. The district results are not quite as homogenous as the two similar school groups.

Examining the district as a whole, the Grade 7 2006 and Grade 8 2005 assessments had similar results where only the proportion of students meeting the standard are significantly different between the CMP and standards groups. For the Grade 8 2006 Assessment, the CMP group was significantly below the standards group for means, medians and percentage of students to meet the standard.

Comparing the Grade 8 2005 column to the Grade 8 2006 column in Table 31 indicates if the CMP group was able to lessen the gap from one year to the next. Only in Group 5 was there any progress made in closing the gap denoted by the negative z-scores. This in no way indicates whether or not either group (CMP or standards) improved or declined from 2005 to 2006.

Table 31
The Test Statistic (z-score) from Each of CMP - Standard Comparisons

		Grade 8 2005	Grade 8 2006	Grade 7 2006
District	Mean	-1.90	-2.73	-1.84
	Proportion	-3.03	-5.36	-3.12
	Median	-1.22	-2.95	-0.67
Group 5	Mean	-1.93	-1.77	0.43
	Proportion	-0.86	-0.76	0.87
	Median	-1.62	-1.61	0.67
Group 6	Mean	-1.61	-4.20	-4.23
	Proportion	-3.66	-4.85	-4.04
	Median	-3.50	-5.13	-3.73

Note. The critical value for z at the 1% level is 2.58.

It is desirable to ascertain if there was any improvement or decline, significant or insignificant from one year to the next. Table 32 gives all the z-scores resulting from comparing the differences from 2005 to 2006.

The fact that there is only one positive z-score indicating an increase in the percentage of students to meet the standard from 2005 to 2006 is immediately evident. Group 6 standards group is the only group to show a positive gain in the percentage of students to meet the standard. Yet, even this gain is not significant - it could in fact be termed quite insignificant.

It is interesting to note that for Group 5 and for Group 6, none of the declines (CMP group, standards group or the group as a whole) were significant. At the same time, the district as a whole declined quite significantly. The decline for Group 5 as a whole was not enough to be considered significant at the .01 level, but with a p value of .02 it is close. The decline for Group 6 was smaller than both Group 5 and the district as a whole.

In comparing the CMP group to the standards group, the CMP group districtwide declined significantly while the standards group showed a moderately insignificant decline. In Group 5, both CMP group and standards group declined, but neither group declined significantly. The CMP group did not decline as much as the standards group. In Group 6, as previously mentioned, the standards group showed an insignificant increase while the CMP group showed an insignificant decrease in the percentage of students to meet the standard.

Table 32
The Test Statistic (z-score) from 2005 to 2006 Comparisons

Group	Whole Group	CMP group	Standards group
District	-3.44	-3.26	-1.73
Group 5	-2.43	-1.53	-1.85
Group 6	-0.17	-1.87	0.86

Conclusion

The research question is, "Do students taught using the CMP curriculum perform better than their counterparts taught based on the state standards on the NY State Math Assessments?" The CMP group fell below the standards group in 24 out of 27 comparisons. Of these 24 comparisons where the CMP group measured below the standards group, 13 comparisons showed significant differences. It is concluded based on the results presented herein that CMP students did not perform as well on the NY State Assessment as students taught based on the state standards.

Limitations with Suggestions for Further Research

The first limitation of this study is geographic. Data only from the city of Buffalo was used. It would be informative to perform this study in other large cities as well as other types of municipalities (suburban, rural, etc.) and in other counties across the state.

A second limitation is demographic. The city of Buffalo primarily consists of low SES and minority students. The results from this study do not generalize across the state, but they probably do generalize in large urban areas. It would be instructive to compare these results to that of other large urban cities in particular. Also, as the results showed a distinct difference in comparisons within Group 5 and within Group 6, it would be informative to explore the research question for students across the state within each of the state defined similar groups.

A third limitation is that this project in no way explored the extent to which CMP teachers followed the curriculum. In order to more thoroughly explore the effect of CMP on students' performance on the NY State Assessment, information should be gathered on the extent to which teachers follow the curriculum. Furthermore, it would be expedient to ascertain to what extent teachers are teaching in the spirit of the reform effort as intended by the designers of the CMP curriculum via observations of classroom lessons.

A fourth limitation is that no information was attained regarding the extent to which standards group teachers followed the UCSMP curriculum versus how much each of them supplemented with other curricular or self made materials. This too would help to make sure that the control group was in fact just that.

A fifth limitation resulted from complete overhaul of the state mathematics standards in 2005 as noted in the January 11, 2005 NY State Board of Regents monthly meeting (NYSED[c], 2005). In the March 15 monthly meeting, the Regents approved the new high school standards, which involved restructuring the state assessment vehicles. One of the results of this restructuring was that "the committee moved much of the algebra content from Math A into the 7th and 8th grade math courses" (NYSED[b], 2005). This restructuring probably caused the significant districtwide drop in percentage of students to meet the standard from the Grade 8 2005 Assessment to the Grade 8 2006 Assessment. A repeat of this study would prove enlightening in 2007 and 2008. This would allow for tracking the same students from sixth through eighth grades.

The final limitation focuses on alignment of the CMP curriculum with the state assessment. The CMP curriculum was not developed with the NY State Mathematics Assessment in mind. The CMP curriculum ensued from the NCTM's call to redirect the emphasis in mathematics education from teacher centered direct instruction consisting of rote memorization to student centered, problem-solving based, cooperative learning classrooms stressing mathematical conceptual comprehension (NCTM,1989). This reform effort required the designing of new curricula based on this new pedagogy. CMP is one such curriculum designed to meet this new standard of mathematics instruction set by NCTM in 1989. How well the CMP is aligned with the NY state standards and the assessments needs to be determined in order to provide some logical explanations for the results and to further inform future research design on this topic.

Crucial to the now decades old continuing effort to reform mathematics education into a meaningful, enriching and relevant educational experience is the implementation of curriculum based on problem solving and discover learning. Research along these lines is crucial in measuring the efficacy of curricula for the purpose of need for their continual improvement and in informing the design of the measuring tools such as state assessments in order to better align curriculum and assessment.

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APPENDIX A

Definition of State Performance Levels

Level 1: Not Meeting Learning Standards

Student performance does not demonstrate an understanding of the mathematics content expected at this grade level.

Level 2: Partially Meeting Learning Standards

Student performance demonstrates a partial understanding of the mathematics content expected at this grade level.

Level 3: Meeting Learning Standards

Student performance demonstrates an understanding of the mathematics content expected at this grade level.

Level 4: Meeting Learning Standards with Distinction

Student performance demonstrates a thorough understanding of the mathematics content expected at this grade level. (NYSED[d], 2006)

Table A1

Scale Score Ranges Associated with Each Performance Level 2006

Grade	Level 1	Level 2	Level 3	Level 4
7	500-610	611-649	650-692	693-800
8	480-615	616-649	650-700	701-775

Note: retrieved from the NYSED website, http://www.emsc.nysed.gov/irts/ela-math/math-06/Scale-Score-to-Performance-LevelMath.html, on March 18, 2007

APPENDIX B

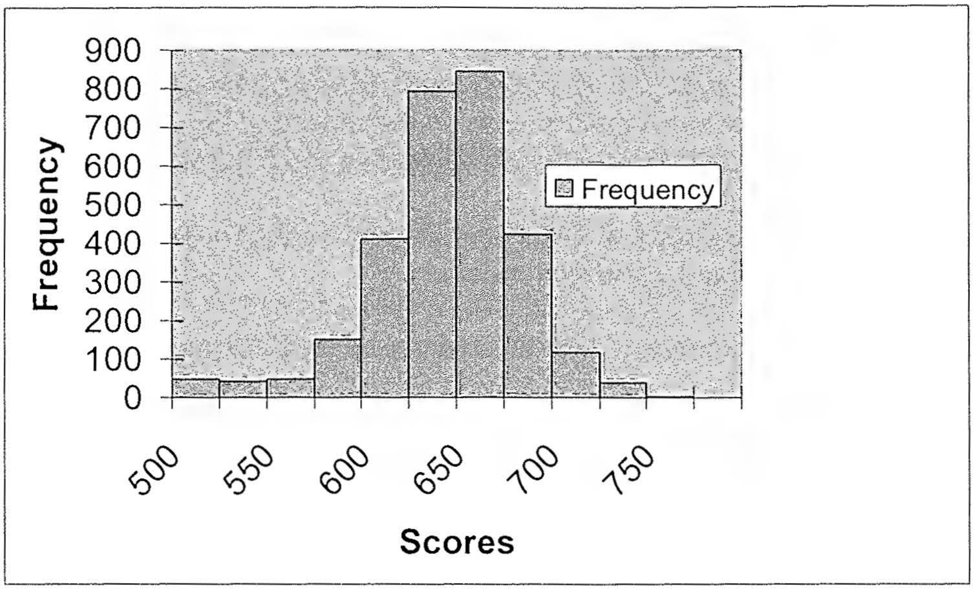


Figure B1

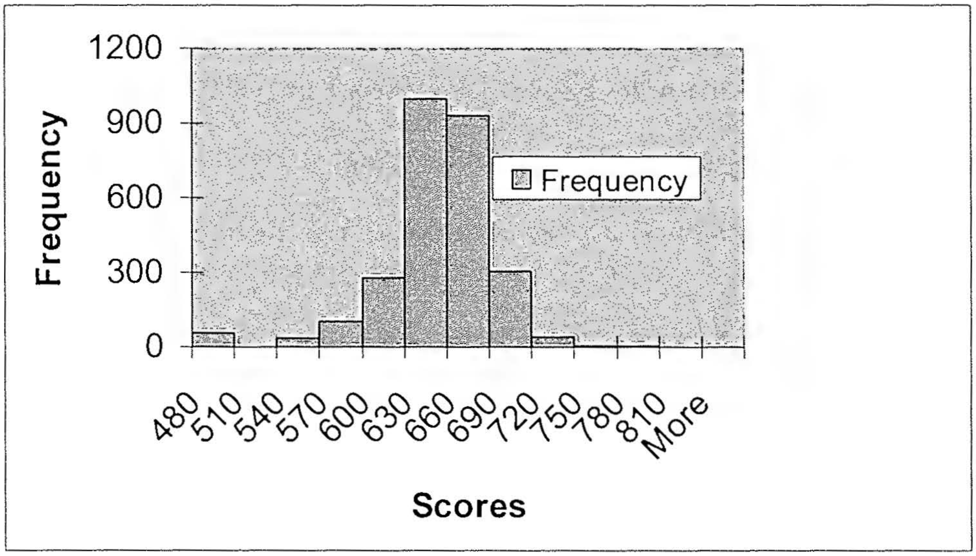


Figure B2

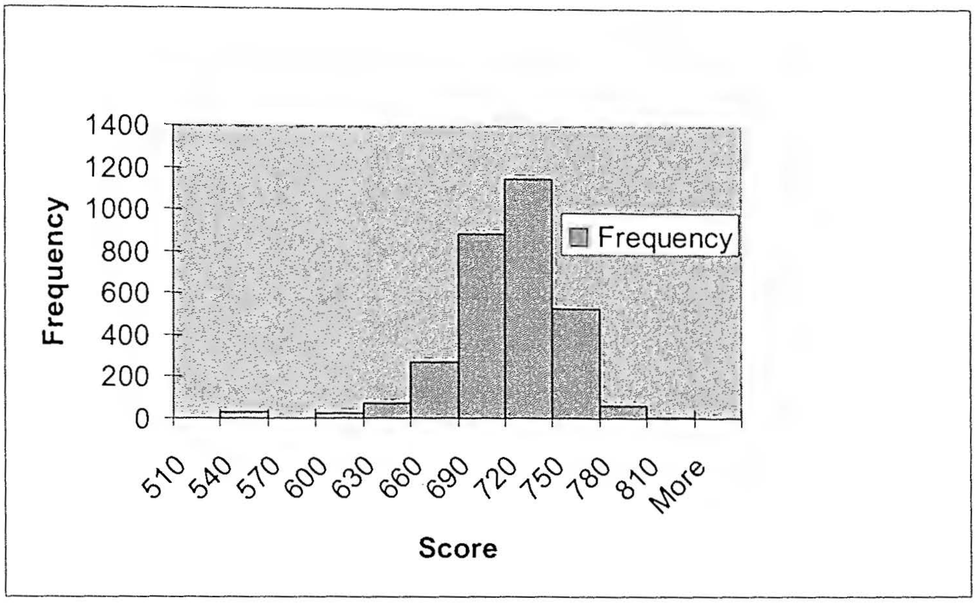


Figure B3

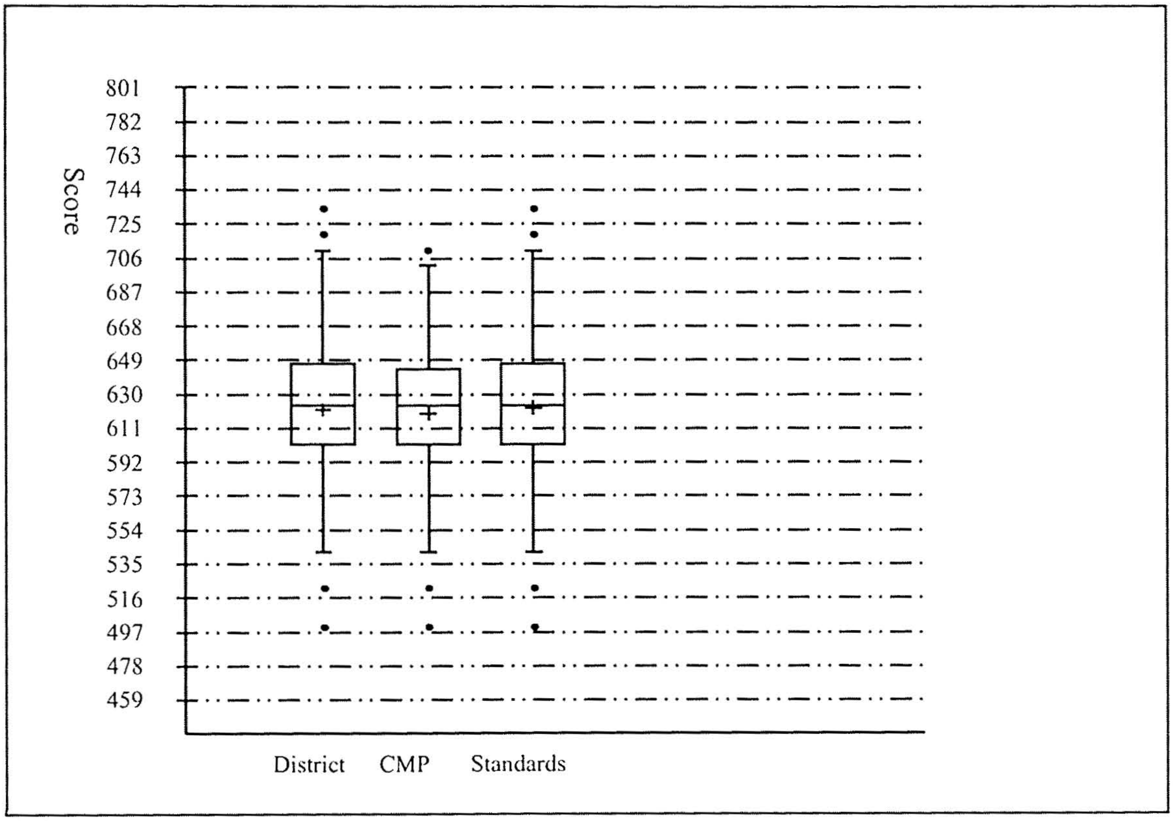


Figure B4.

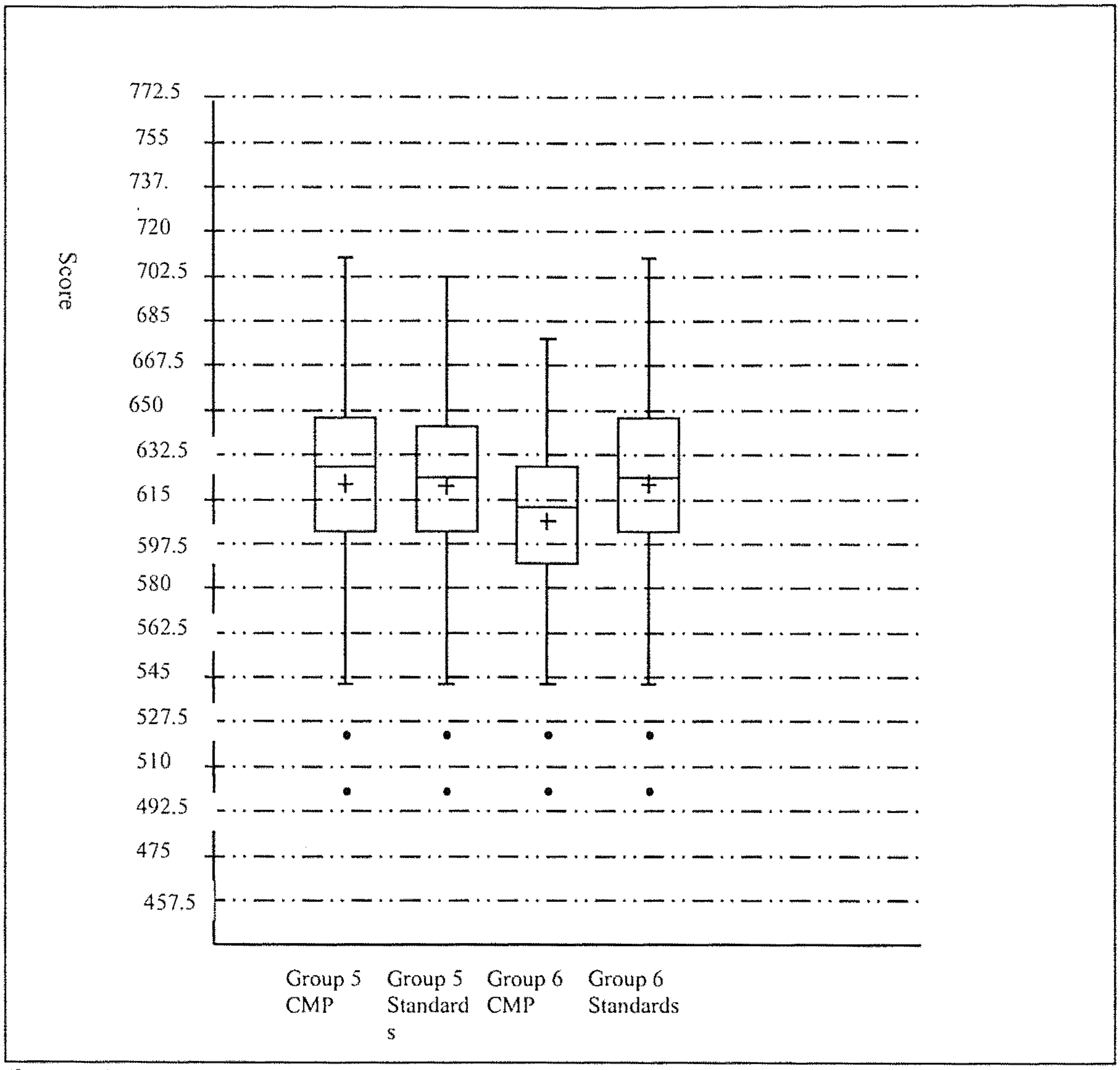

Score
772.5
755
737.
720
702.5
685
667.5
650
632.5
615
597.5
580
562.5
545
527.5
510
492.5
475
457.5
Group 5 CMP
Group 5 Standards
Group 6 CMP
Group 6 Standards

Figure B5

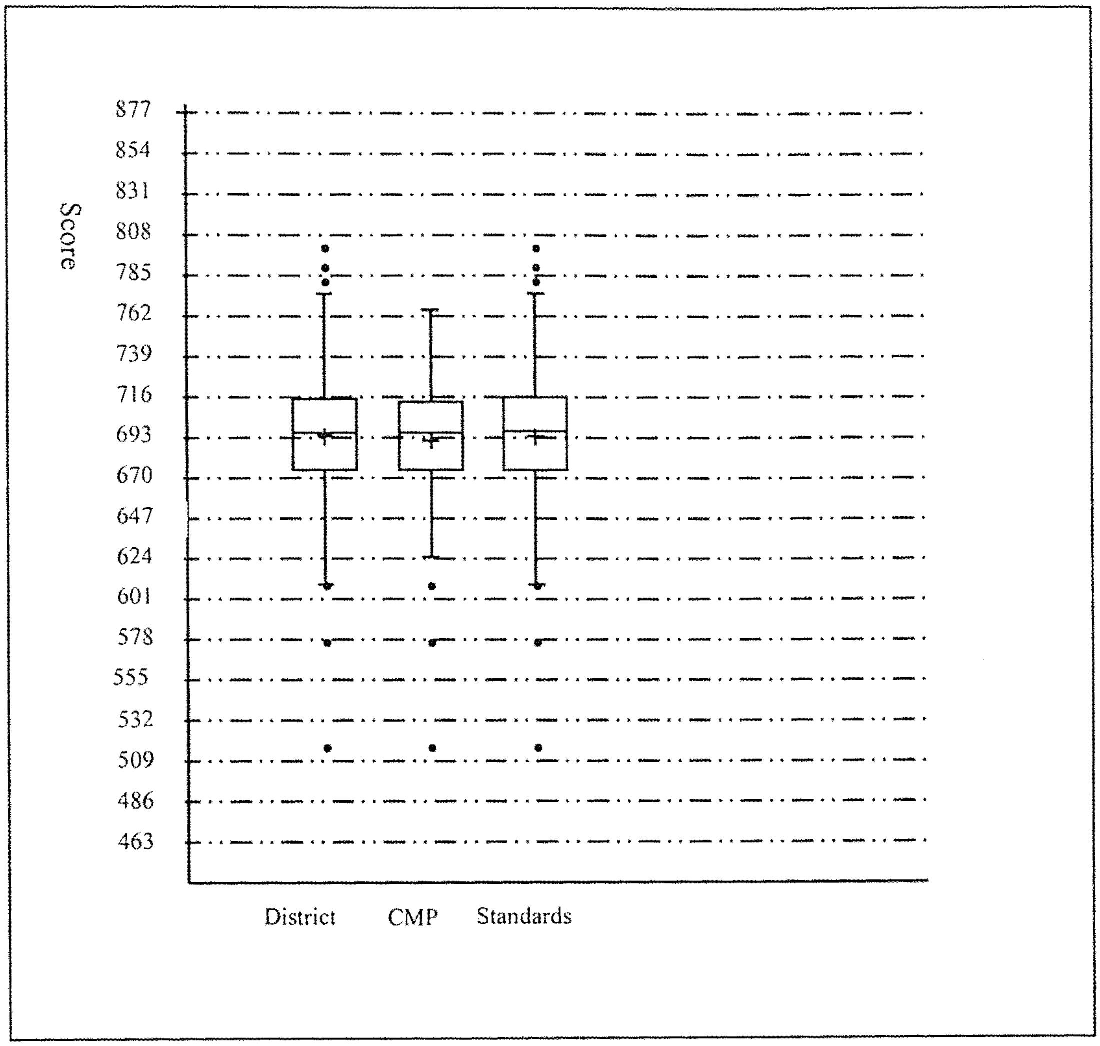
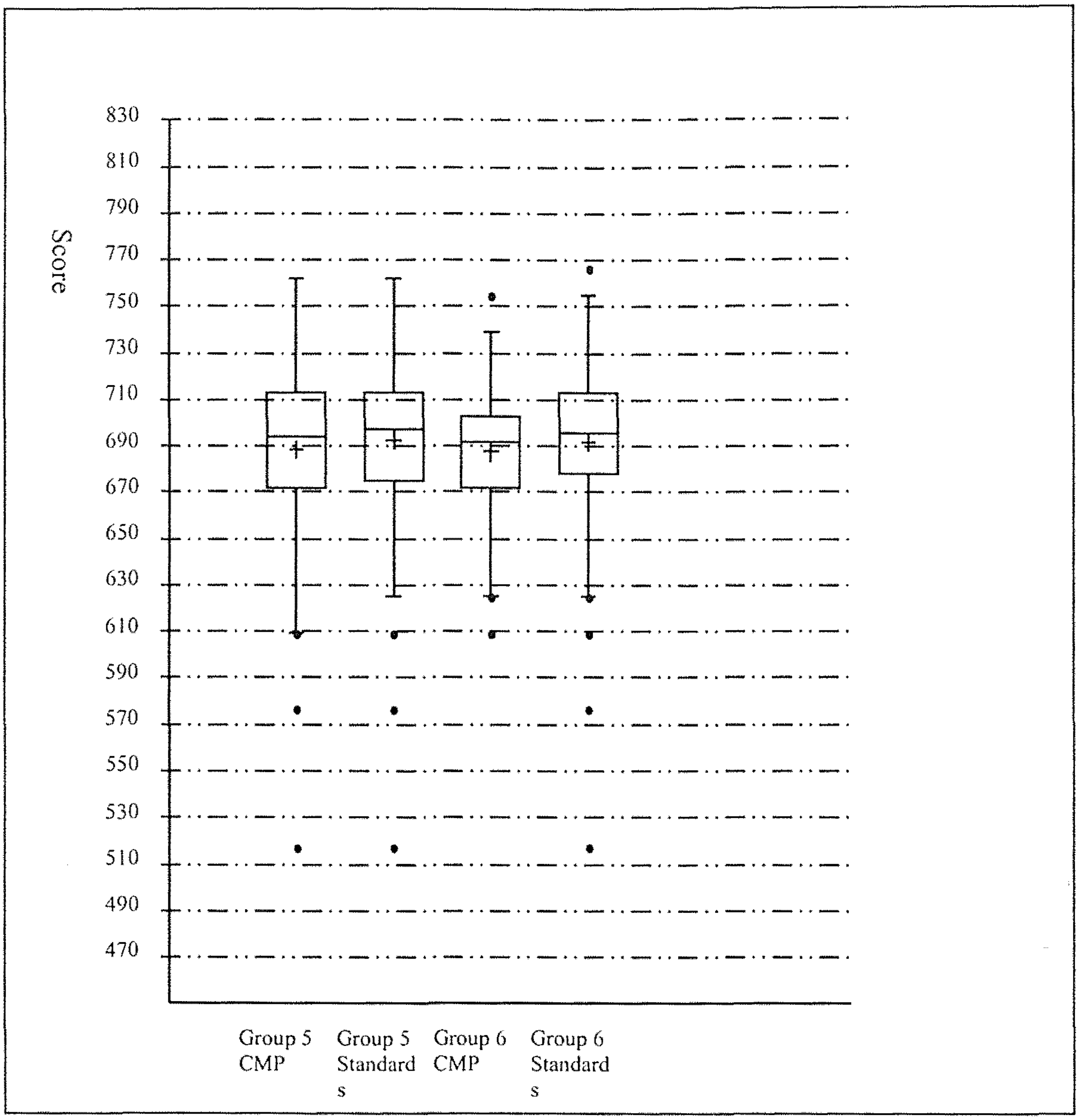

Score
877
854
831
808
785
762
739
716
693
670
647
624
601
578
555
532
509
486
463
District
CMP
Standards

Figure B6



Score
830
810
790
770
750
730
710
690
670
650
630
610
590
570
550
530
510
490
470
Group 5 CMP
Group 5 Standards
Group 6 CMP
Group 6 Standards

Figure B7

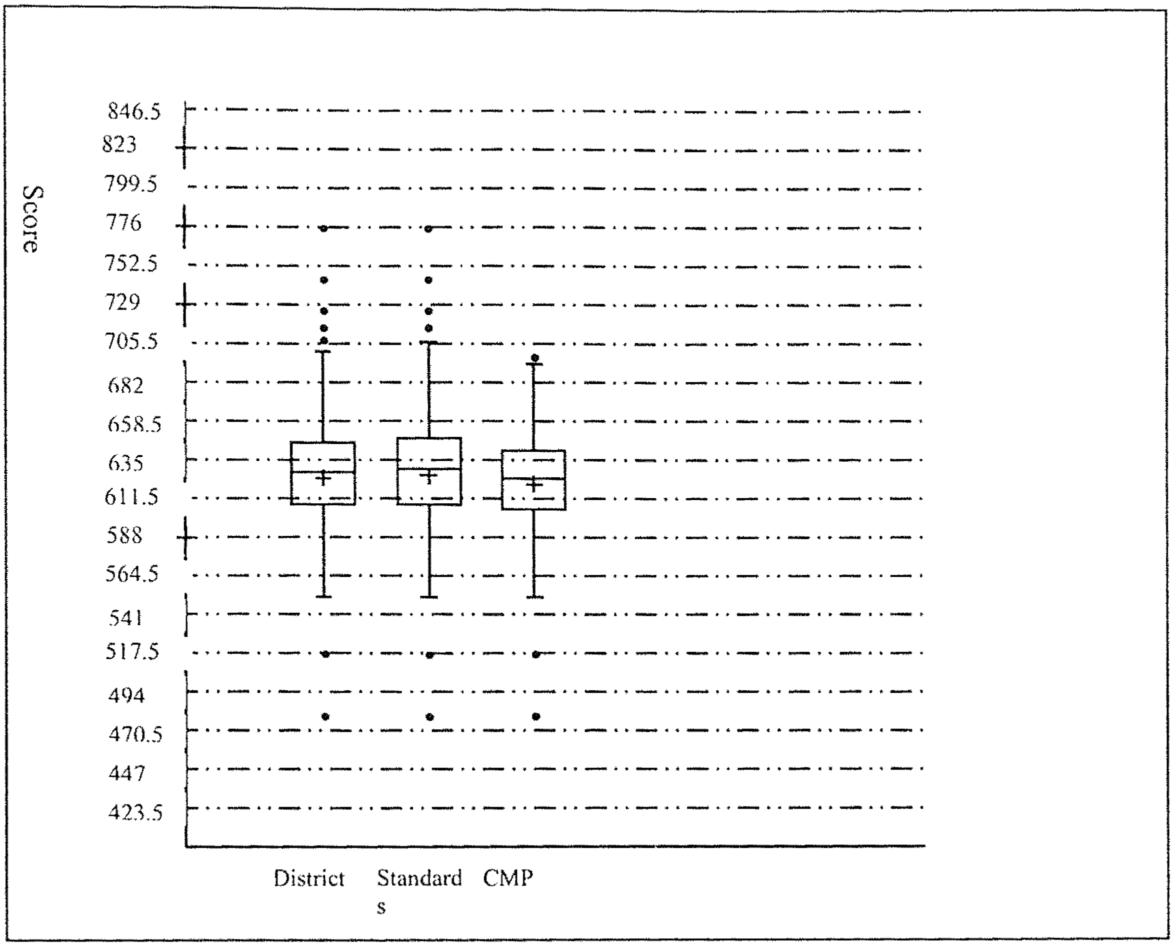

Score
846.5
823
799.5
776
752.5
729
705.5
682
658.5
635
611.5
588
564.5
541
517.5
494
470.5
447
423.5
District
Standard
s
CMP

Figure B8

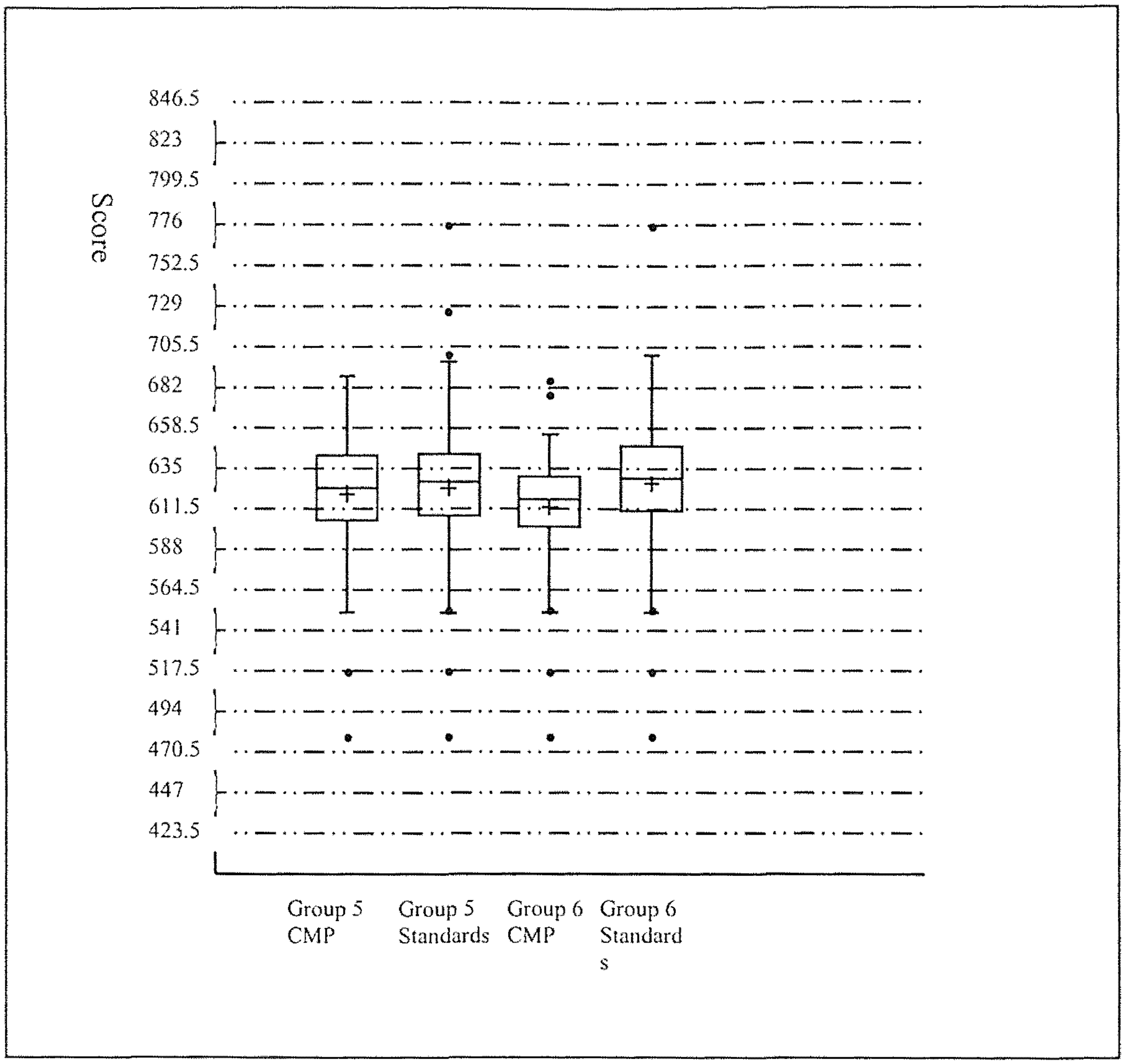

Score
846.5
823
799.5
776
752.5
729
705.5
682
658.5
635
611.5
588
564.5
541
517.5
494
470.5
447
423.5
Group 5 CMP
Group 5 Standards
Group 6 CMP
Group 6 Standards

Figure B9.

Figure Captions

Figure B1. Histogram of Grade 7 2006 NY State Assessment for all seventh graders in the city of Buffalo. N = 2924

Figure B2. Histogram of Grade 8 2006 NY State Assessment scores for all eighth graders in the city of Buffalo. N = 2,761.

Figure B3. Histogram of Grade 8 2005 NY State Assessment scores for all eighth graders in the city of Buffalo. N = 3,031.

Figure B4. Box and Whisker Plot of Grade 7 2006 NY State assessment for the district.

Figure B5. Box and Whisker Plot of Grade 7 2006 NY State assessment for the Groups 5 and 6

Figure B6. Box and Whisker Plot of Grade 8 2005 NY State assessment for the district.

Figure B7. Box and Whisker Plot of Grade 8 2005 NY State assessment for the Groups 5 and 6.

Figure B8. Box and Whisker Plot of Grade 8 2006 NY State assessment for the district.

Figure B9. Box and Whisker Plot of Grade 8 2006 NY State assessment for the Groups 5 and 6.

Appendix C

The z-score was calculated by dividing the difference of the statistic (mean or proportion) by the standard error of the differences.

z-score $$Z_{test} = \frac{\mu_{CMP} - \mu_{STANDARDS}}{s_{\mu_{CMP} - \mu_{S\tan dards}}}$$

OR

$$Z_{test} = \frac{p_{CMP} - p_{STANDARDS}}{s_{\mu_{CMP} - \mu_{S\tan dards}}}$$

P = proportion of students in group to meet the standard

Standard error $$s = \sqrt{\sigma^2 \left(\frac{1}{N_{CMP}} + \frac{1}{N_{STANDARS}}\right)}$$

Where σ^2 = Variance of the source population

and N_x = number of students in group x