

WHY ARE SCHOOL DISTRICTS ABANDONING THE CORE-PLUS
MATHEMATICS CURRICULUM?

by

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STATEMENT BY AUTHOR

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In this paper, the author establishes that high schools are abandoning the Core-Plus Mathematics curriculum and determines the need for curricular reform and the motivation to develop such standards-based programs. She discovers that although Core-Plus is a nationally recognized, exemplary mathematics curriculum, school districts are deciding to discontinue the curricular option of Core-Plus. The author reviewed literature and interviewed teachers from schools that have recently decided to abandon Core-Plus in attempt to determine factors leading to these decisions. This paper discusses those interviews, provides suggestions for the future adoption of Core-Plus, and concludes with recommendations that further study be done on factors leading to decisions to abandon Core-Plus, in order to facilitate further recommendations for the future adoption of Core-Plus.

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Chapter 1: Introduction

Over the past 45 years, there has been much reform in mathematics education. Different standards-based curricula have been developed to meet these needs in mathematics education reform. School districts that had initially adopted the standards-based Core-Plus curriculum are now dropping this program. The purpose of this paper is to explore reasons for abandoning Core-Plus.

The author is a high school mathematics teacher. She has been teaching for four years from both a traditional curriculum and a reform curriculum, specifically, Core-Plus.

At one high school in central Minnesota, the author taught lower-quartile mathematics students using Core-Plus and second-quartile mathematics students using a traditional Geometry curriculum. In another central Minnesota high school, she taught using Core-Plus with all but the accelerated mathematics students.

The author observed attitudes of students toward mathematics, their ability to do mathematics, and their willingness to work collaboratively changed during their time in the author's Core-Plus classroom. Their attitudes became more positive regarding the class, mathematics in general, and their ability to do mathematics. They liked being challenged and they liked solving problems. These students were continuously engaged on a daily basis. Working with each other and communicating mathematics became the norm in their classroom. The students became a community in which active collaboration was a means of solving challenging mathematics problems. The community, or classroom environment, promoted the learning of mathematics for all students.

Over the past two years, both of these high schools went through curriculum review and dropped Core-Plus as a curricular option, leaving only traditional curricula for their students.

From her experience as a teacher, the author is very concerned about the choices that these districts are making for their mathematics curricula and the effect this will have on their students. Student achievement at the high school level is an important issue; high school students are not performing well in mathematics. According to the National Assessment of Educational Progress (NAEP, 2005), in 2003 “the percentage of fourth-graders performing at or above *Basic*, at or above *Proficient*, and at *Advanced* was all higher in 2003 than in all previous assessment years since 1990.”

It was also reported that “the percentages of eighth-graders performing at or above *Basic* and at or above *Proficient* were both higher in 2003 than in all previous assessment years since 1990. The percentage of eighth-graders performing at *Advanced* was higher in 2003 than in 1990” (NAEP, 2005). Where reports should have been on the website regarding twelfth-graders’ performance, there were none. Among students in grade 12, performance scores were so poor that NAEP neglected to report the results (Sowder, 2005). High school students are not performing well in mathematics.

Research Questions

1. Where did Core-Plus come from? Why was it developed? What is it? How does it differ? Is it a high-quality curriculum?
2. Why are school districts that chose Core-Plus changing to more traditional curricula?

Limitations

1. Other reform, or standards-based curricula have been written in the last fifteen years. This paper will focus on the Core-Plus curriculum.
2. The author will interview teachers of four school districts that have dropped Core-Plus.
3. More time and money is needed to identify school districts that have dropped Core-Plus; contacting and interviewing more teachers at more school districts that have dropped Core-Plus would provide more information leading to better and more definitive conclusions.
4. Out-state schools and communities will be compared to a metro school and community even though they have significant demographic differences.

Definitions of Terms

AAAS: The American Association for the Advancement of Science (AAAS) is an international non-profit organization dedicated to advancing science around the world by serving as an educator, leader, spokesperson and professional association. In addition to organizing membership activities, AAAS publishes the journal *Science*, as well as many scientific newsletters, books and reports, and spearheads programs that raise the bar of understanding for science worldwide (AAAS, 2005).

ACT: The American College Test (ACT) is a college entrance exam.

CMIC: The Contemporary Mathematics in Context (CMIC) is also known as Core-Plus Mathematics Project (CPMP).

ENC: The Eisenhower National Clearinghouse for Mathematics and Science Education (ENC), established in 1992, is located at The Ohio State University. It is funded through

a contract with the U.S. Department of Education. The mission of ENC is to identify effective curriculum resources, create high-quality professional development materials, and disseminate useful information and products to improve K-12 mathematics and science teaching and learning. ENC was originally created to collect all types of teaching materials for K-12 math and science educators and to identify and disseminate information about federally funded programs. ENC acquires and catalogs mathematics and science curriculum resources, creating the most comprehensive collection in the nation. ENC provides the best selection of math and science education resources on the internet. ENC supports teachers' professional development in math, science, and the effective use of technology. ENC serves all K-12 educators, parents, and students with free products and services (ENC, 2005).

Exemplary program: An exemplary program (curricula) must be highly rated on quality, usefulness to others, and educational significance and must provide convincing evidence of effectiveness in multiple sites with multiple populations. The Expert Panel and other teachers, researchers, and practitioners, evaluated and judged such programs (ENC, 2005).

The Expert Panel: The Expert Panel was formed by the Office of Educational Research and Improvement (OERI), as requested by Congress in 1994. The Expert Panel included educators, scientists, mathematicians, and policymakers, each of whom have vast experience with mathematics education and science education.

MCAs: The Minnesota Comprehensive Assessments (MCAs) are standardized exams. The MCAs assess reading, writing and mathematics to help schools and districts measure student progress toward the state's academic standards. In the spring of 2005 the MCAs

were given in grades 3, 5, 7, 10, and 11. In 2006, when the tests will be aligned with the new academic standards, the MCAs get a new name, MCA II, and will be given in grades 3-8, 10, and 11. In 2008 the new science MCA IIs will be operational in grades 5, 8 and the high school. (MDE, 2005)

NAEP: National Assessment of Educational Progress (NAEP) assesses samples of students in grades 4, 8, and 12 in various academic subjects. Results of the assessments are reported for the nation and states in terms of the Governing Board's achievement levels: basic, proficient, and advanced. NAEP is also known as "The Nation's Report Card".

NCTM: The National Council of Teachers of Mathematics (NCTM) is a public voice of mathematics educators, providing vision, leadership, and professional development to support teachers in ensuring mathematics learning of the highest quality for all students.

NSF: The National Science Foundation (NSF) is an independent federal agency created by Congress in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense..." With an annual budget of approximately \$5.5 billion, NSF is the funding source for approximately 20 percent of all federally supported basic research conducted by America's colleges and universities. In many fields such as mathematics, computer science and the social sciences, NSF is the major source of federal backing.

OERI: On March 31, 1994, President Clinton signed Public Law 103-227, which includes Title IX, the Educational Research, Development, Dissemination, and Improvement Act of 1994 (the Act). The Act restructured the Office of Educational Research and Improvement (OERI) and provided it with a broad mandate to conduct an

array of research, development, dissemination, and improvement activities aimed at strengthening the education of all students.

Please note: OERI is no longer a working component of the Department of Education. On November 5, 2002, President Bush signed into law the Education Sciences Reform Act, which produced a new organization, the Institute of Education Sciences (IES) (UDE, 2005).

Profiles of Learning: The Profiles of Learning were state-originated standards for high school students to attain and achieve in Minnesota.

Promising program: A promising program (curricula) must be rated high in terms of quality, usefulness for others to implement, and educational significance, in addition to providing preliminary evidence of effectiveness in one or more sites. The Expert Panel and other teachers, researchers, and practitioners, evaluate and judge such programs (ENC, 2005).

Reform curricula: Standards-based curricula and reform curricula are used interchangeably. Please see standards-based curricula.

SAT: The scholastic aptitude test (SAT) is a college admissions exam.

Standards-based curricula: Standards-based curricula and reform curricula are used interchangeably. Standards-based mathematics programs (curricula) are those with the following characteristics:

- Comprehensive. They are based on the broad content of the national (NCTM) standards at each grade level: Number and Operations, Algebra, Geometry, Measurement, and Data Analysis and Probability. They also incorporate the

important processes of mathematics: Problem Solving, Reasoning and Proof, Communication, Connections, and Representation.

- Coherent. They are woven together as a whole, with ideas connecting to each other. They are not repetitive, and the sequence from one grade to the next gives students the preparation they need for the next learning step.
- Depth. Important and pivotal “big ideas” are developed in increasing depth as students mature.
- Sense-making. They have a goal of guiding students to learn mathematics with understanding, enabling them to remember the ideas, rather than viewing mathematics as a set of unrelated symbols, rules, formulas and definitions.
- Engaging. They provide challenge to all students intellectually and encourage active learning. This enables all students to both participate and grow in learning.
- Motivating. They teach mathematics through realistic situations and applications, giving both an understandable approach and a reason to learn the mathematics (MCTM Position Statement and Frequently Asked Questions, p.1, adapted from “Standards-Based Mathematics: A Phrase in Search of a Definition”, 2001).

Traditional curricula: Traditional mathematics curricula are based upon reform from the 1960s. Traditional curricula emphasize mathematics content and logical development of mathematical techniques. These curricula are characterized by a great deal of practice and few applications.

Chapter 2: Literature

Need for Mathematical Curricular Reform

It was noted in *A Nation At Risk* (NCEE, 1983), that our nation cannot afford to continue to overlook the need for change in mathematics education. If our nation wants to continue its global leadership role tomorrow, the way in which mathematics is taught in this country must change today. The United States risks losing a leading and secure position in the world in science, technology, democracy, society, economic security and military security. “What was unimaginable a generation ago has begun to occur – others are matching and surpassing our educational attainments” (NCEE, 1983, p.5).

“America’s position in the world may once have been reasonably secure with only a few exceptionally well-trained men and women. It is no longer” (NCEE, 1983, p.6). If our country continues to allow generations of students to go out into the population limited by lack of mathematical power, our society will not grow, but decay, according to *A Nation At Risk*. “International comparisons show that the mathematical achievement of American students falls far behind our major economic competitors” (COMAP, Inc., 2001, p.1). *A Nation At Risk* continues to describe how as this country’s population grows, the ratio of needed scientists and technology-savvy citizens to limited citizens will decline if we do not recognize and step up to the need for educational change and reform. This literature supports the notion that to keep our nation strong, we must minimize the division between the technologically skilled (mathematically powerful) and the technologically unskilled (mathematically weak). Mathematical education for all will help maintain a high ratio of technology-savvy citizens to limited citizens.

In 1989, *Everybody Counts* reported that mathematics is more diverse and important to society than before (NRC, 1989). Technology and its applications have grown, sparking a revolution in what mathematics is and how it plays a role in society. “[M]any of today’s students are not prepared for tomorrow’s jobs... Workers need to absorb new ideas, to adapt to change, to cope with ambiguity, to perceive patterns, and solve unconventional problems” (NRC, 1989, p. 1). These skills are now much more important than calculation skills. Machines, technology, are able to calculate, but determining the applications, reasonableness, and importance of these calculations is up to us.

United States high school students are not performing well in mathematics:

The Third International Mathematics and Science Study assessed the performance of students from 41 countries in 1995. U.S. fourth-graders scored above the international average in mathematics and science; eighth-graders scored slightly above the international average in science and slightly below the international average in mathematics. However, among 20 nations assessed in advanced mathematics and physics (students were not assessed from all countries for all grades), *none* scored significantly lower than the United States in advanced mathematics, and only *one* scored lower in physics. In a phrase, our mathematics and science students are not “world class” (NCMST, 2000, p.10-11).

Many informed Americans agree there is an unprecedented need to improve the way we teach and learn mathematics in our country.

Reform

In the past, mathematics education changed in response to previous factors. “During the first half of the twentieth century, mathematical growth was stimulated primarily by the power of abstraction and deduction...” (NRC, 1989, p.33-34). During World War II, applied mathematics was emphasized. Factories demanded skilled workers, with new skills. After World War II, the government invested money into education and research, inspired by Sputnik. The beginning of computers allowed mathematicians to explore patterns and test conjectures with ease. This put an emphasis on algorithms.

Computers, technology, and competition with other nations are now pushing the United States to change the mathematics learned in school. As indicated by *Everybody Counts*, no longer is learning abstraction, deduction, and algorithms enough (NRC, 1989). Conceptual understanding and applications are being demanded outside the classroom. It follows that to be competitive citizens and productive members of society, conceptual understanding and applications of abstraction and algorithms are what students need to learn. Research should be changing the way in which mathematics is learned, as supported by *Everybody Counts*.

Many would agree that it is desirable to produce life-long learners. It must be understood that there are more efficient ways needed for students to learn and more mathematics for them to learn now than ever before. Today’s students need to be prepared for *their* lifetimes and *their* futures. Their future is much different than their parents’ and their teachers’. “Today’s schools labor under the legacy of a structure designed for the industrial age, misapplied to educate children for the information age”

(NRC, 1989, p. 11). After high school, more students today are attending college and fewer students are going to factories than in the past, as said by *Everybody Counts*.

“Mathematics must become a pump rather than a filter in the pipeline of American Education” (NRC, 1989, p. 7). To get mathematics to be the pump it needs to be, many things must change, including attitudes, classrooms, and assessments, as *Everybody Counts* advises.

As *Everybody Counts* states, initially children like mathematics. Children are naturally curious and this lends to discovering patterns, and making and testing conjectures. However, this fondness of math does not last long. Children quickly learn from school and society that math is not fun, according to the literature. Math is not discovering patterns, or making and testing conjectures, but rather memorization and mimicry. “Their view of mathematics shifts gradually from enthusiasm to apprehension, from confidence to fear. Eventually, most students leave mathematics under duress, convinced that only geniuses can learn it. Later as parents, they pass this conviction on to their children. Some even become teachers and convey this attitude to their students” (NRC, 1989, p. 44).

“Only in mathematics is poor school performance socially acceptable” (NRC, 1989, p. 74). Unfortunately—for our nation’s sake—this acceptance and expectation to perform poorly in mathematics exists only in the United States. *Everybody Counts* also supports that changing this acceptance and the public attitude about mathematics can only happen if the way in which mathematics is taught and learned is changed. The way in which mathematics is practiced in the classroom must change.

Today's classrooms are described by the following observations. "Excessive emphasis on mechanics of mathematics not only inhibits learning, but also leads to widespread misconceptions among the public" (NRC, 1989, p. 44). Typically, classrooms in America rarely involve more than presentation, repetition and mimicry (NCMST, 2000). Classrooms like these today resemble the classrooms of when today's teachers were students.

Too few math teachers are prepared to teach the math their students need." (NRC, 1989, p.28) *Everybody Counts* indicates that teachers often teach as they were taught. Many of these teachers have never experienced learning mathematics meaningfully; this is all they know about teaching and learning mathematics. Many teachers only know mathematics as lecturing and listening, and they believe this to be an acceptable means for teaching and learning mathematics.

"There is no place in a proper curriculum for mindless mimicry in mathematics." (NRC, 1989, p.44) Repetition and mimicry may help students on a short-term basis; on standardized tests, however, students will not benefit long-term, according to *Everybody Counts*. They will not be well prepared to interpret, analyze, question, make conjectures, test conjectures, make decisions, and solve problems, consistent with *Everybody Counts*. To adequately prepare students to perform all these tasks that will be asked of them in their futures, these higher order thinking situations must be practiced in the classroom. "In reality, no one can *teach* mathematics. Effective teachers are those who can stimulate students to *learn* mathematics. Educational research offers compelling evidence that students learn mathematics well only when they *construct* their own mathematical understanding" (Everybody Counts, 1989, p.58).

Life is active; classrooms that are just as active far better prepare students for life, as suggested by *Everybody Counts*. Students need to be actively engaged in learning, i.e. discovery and investigating. Arranging and managing a classroom such as this is not easy. The text mentions that it initially requires more time and energy from the teachers and students, initially. Less teaching will result in higher achievement and better understanding.

An effective active classroom is actively monitored, as described by *Implementing the Core-Plus Mathematics Curriculum*. Not only does such a classroom require more time and energy during class than previously, but expectations need to be raised, as stated by *Everybody Counts*. Heightened expectations will help meet the need for equity in opportunity and the need for excellence in results, as defined in the Equity Standard of NCTM. However, raising expectations is not equivalent to raising graduation standards. “Raising standards for graduation often widens the gap between those who know mathematics and those who do not, since increased standards are rarely accompanied by program changes” (NRC, 1989, p.13). This maintains that classrooms need to change in addition to expectations.

Technology has, and will continue, to influence mathematics. The advancement of computers is due to applied mathematics, and in turn, the advancement of computers will promote further study of mathematics. As technological advances are made, schools need to reflect these advances by preparing students for the future, a world in which technological skills and understanding will separate the haves from the have-nots. Schools need to have students learn how to use calculators and computers as tools for learning and solving problems, in accordance with *Everybody Counts*.

Scientists, engineers, and mathematicians use computers as tools in assisting them with menial mathematics. This allows them to model and investigate problems and questions more quickly and deeply. Modeling and investigating problems and questions require interpretation needed for prediction and correction. Classrooms need to model this to adequately prepare students for their future. “Self-confidence built on success is the most important objective of the math curriculum” (NRC, 1989, p.45). Success begets success.

Self-confidence, in students along with a positive attitude about mathematics can make a difference for students continuing to study mathematics (ENC, 2005). However, success at mastering basic skills is not enough. In general, students need to be challenged with meaningful and worthwhile mathematical tasks, (NCTM, 1991).

There is a misconception that the purpose of a high school education is solely to prepare students for a post-secondary education. “All students need to leave secondary school well prepared mathematically for leading intelligent lives as productive citizens, since even many of those who go on to higher education will take little or no further mathematics” (NRC, 1989, p.49). Students leaving high school need to know mathematics to help them do more than survive. Students entering society should be able to contribute productively; they should be able to reason intelligently and make decisions regarding jobs, health, environment, loans, investments, children, etc. Students need mathematical power, skills, knowledge, understanding, and confidence to lead a meaningful and constructive life, which includes learning as needed. Students need to be life-long learners.

As specified by *Everybody Counts*, assessment must also change to reflect what students will be asked to do and practice in the classroom. Students should not be assessed exclusively on procedural mathematics without context. Students need to be given opportunities to show what they know and can do: analyze, apply, interpret, and predict. In-depth, contextual assessments must become the norm. To allow reform to be successful, many people must be involved.

“Effective reform requires strong leadership by teachers, parents, professionals, and politicians” (NRC, 1989, p.80). According to *Everybody Counts*, there are seven transitions that need to be realized for our nation’s reform of mathematical education.

1. The focus of school mathematics is shifting from a dualistic mission—minimal mathematics for the majority, advanced mathematics for a few—to a singular focus on a significant common core of mathematics for all students.
2. The teaching of mathematics is shifting from an authoritarian model based on “transmission of knowledge” to a student-centered practice featuring “stimulation of learning.”
3. Public attitudes about mathematics are shifting from indifference and hostility to recognition of the important role that mathematics plays in today’s society.
4. The teaching of mathematics is shifting from preoccupation with inculcating routine skills to developing broad-based mathematical power.

5. The teaching of mathematics is shifting from emphasis on tools for future courses to greater emphasis on topics that are relevant to students' present and future needs.
6. The teaching of mathematics is shifting from primary emphasis on paper-and-pencil calculations to full use of calculators and computers.
7. The public perception of mathematics is shifting from that of a fixed body of arbitrary rules to a vigorous active science of patterns.

Despite the visibly changing world around us and the common understanding that we must prepare for the future, change is resisted. “Both because it is so massive and because it is so unstructured, mathematics education in the United States resists change in spite of the many forces that are revolutionizing the nature and role of mathematics” (Everybody Counts, 1989, p.39). There are over twenty-five different U.S. organizations that support professional work in the mathematical sciences. There are over twenty-five U.S. publications dedicated to students and teachers of mathematics. With so many different mathematics associations, it is understandable that coming to agreement on mathematics reform is problematic.

“If such transitions are to become reality, all major components of mathematics education, curricula, teaching, teacher education, testing, textbooks, and software, must change significantly in some reasonably coordinated manner” (NRC, 1989, p.87). It comes down to this: “Our national goal must be to make U.S. mathematics education the best in the world” (NRC, 1989, p.88). The United States cannot afford to accept mediocrity if we are to continue our privileged way of life. As *Everybody Counts* states, three challenges need to be met to achieve this goal. Mathematics education must be for

all students. *All* students' mathematical achievement must improve drastically; improvement needs to happen on a national level. Curricula must be developed to meet current and future needs. Mathematics education reform is needed in the United States. The nation's future position as a world leader is at risk. Each student's future as a productive citizen is at risk. To effectively achieve mathematics education reform, many must be involved, including teachers, parents, professionals, and politicians. For successful reform, changing American attitudes, classrooms, and assessment is essential. To do all of this, common goals must be established, with means to reach these goals.

Standards and Curricula

In response to these challenges, the National Council of Teachers of Mathematics (NCTM) published *Curriculum and Evaluation Standards for School Mathematics* (1989), *Professional Standards for Teaching Mathematics* (1991), and, *Assessment Standards for School Mathematics* (1995). These documents represent a first attempt by a professional organization to develop and articulate explicit and extensive goals for teachers and policymakers, NCTM, 2000. These documents also provided a goal of what teaching and learning should look like, see *New Resources for School Mathematics* (COMAP, Inc., 2001).

Also, in response to these challenges, following NCTM's lead with its publications, the National Science Foundation (NSF) awarded grants for the necessary curricula to be developed and written. The NSF funded thirteen major projects to address the need for change in mathematics education. Three projects were aimed at elementary school mathematics education. Five projects were designed for middle school, and five were designed for high school.

All thirteen NSF funded projects were to design, develop, test, and implement innovative approaches to standards-based mathematics education (COMAP, Inc., 2001). Each of the projects were based on the NCTM *Standards* documents, modern research on teaching and learning mathematics, and mathematics believed to be useful in students' future endeavors.

The elementary school mathematics projects resulted in three curricula: *Everyday Mathematics* (University of Chicago School Mathematics Project [UCSMP]), *Investigations in Number, Data, and Space* (Education Research Collaborative at TERC, Cambridge, Massachusetts), and *Math Trailblazers* (Teaching Integrated Mathematics and Science [TIMS] Project, University of Illinois, Chicago, Illinois). These three curricula are different, but all share the same goals:

- Teaching basic arithmetic but also geometry, data analysis, measurement, probability, and concepts of algebra;
- Building on children's everyday experiences and common sense, using engaging and meaningful applications;
- Connecting topics within mathematics and integrating mathematics with other subjects while encouraging students to represent ideas and solve problems in many ways;
- Maintaining a balance among concepts, skills, and problem solving;
- Supporting a variety of instructional approaches;
- Providing resources to help teachers extend their understanding of mathematics and teaching. (COMAP, Inc., 2001, p.5)

The middle school mathematics projects resulted in five curricula. *Connected Mathematics* (Michigan State University), *Mathematics in Context* (University of Wisconsin), *Mathscape* (Education Development Center, Newton, Massachusetts), *MATHThematics* (University of Montana), and *Pathways to Algebra and Geometry* (Institute for Research on Learning, Palo Alto, California) are all engaging curricula developed to address the changes made during the middle school years.

“Each of the middle grades mathematics’ curricula is problems-centered; students build mathematical understanding and skill through the mathematical explorations required to solve carefully planned sets of engaging problems” (COMAP Inc., 2001, p.11). The mathematics exposed to students are important ideas for the middle grades not only in order to prepare them for studying important high school level mathematics, but also in order to sustain students’ interest in learning mathematics, as stated by the literature, *New Resources for School Mathematics*.

The five middle school projects share five goals:

- Addressing important mathematical content in algebra, geometry, measurement, probability and statistics, and number in ways that will promote understanding and ability to solve problems;
- Involving students in challenging and engaging activities that promote, support, and motivate student thinking at all levels of ability.
- Incorporating assessments of student learning that give teachers information useful to optimize instruction.
- Supporting teachers as they use learning activities that promote higher level thinking and involve challenging mathematical content.

- Using calculator and computer technology to deepen students' understanding of mathematical concepts (COMAP, Inc., 2001, p.11).

Five curricula have also been developed for the high school level. *Contemporary Mathematics in Context* (Western Michigan University), *Interactive Mathematics Program* (San Francisco State University), *Math Connections* (Hartford, Connecticut), *Mathematics: Modeling Our World* (Consortium for Mathematics and Its Applications), Lexington, Massachusetts, and *SIMMS Integrated Mathematics* (The University of Montana and Montana State University). These curricula were designed to improve students' achievement and address the changes that come with transitioning from middle school to high school. These five high school curricula also have common goals:

- Selecting traditional and contemporary mathematics objectives that are most important for students who will live and work in the 21st century.
- Emphasizing problem-solving and mathematical reasoning throughout the curriculum.
- Developing mathematical ideas in engaging contexts that reflect applications of the subject outside classroom work.
- Developing mathematical ideas across the high school years in ways that take advantage of the interconnections of various topics.
- Using technology to deepen understanding of mathematical concepts and procedures and to broaden the applicability of mathematical principles and methods" (COMAP, Inc., 2001, p.17).

The elementary, middle school, and high school curricula were each carefully constructed and carefully evaluated. The evaluation process included pilot testing,

revision, and extensive field testing. The evaluation results of student achievement for the three levels using the NSF curricula were similarly positive. In response to the need for mathematics education reform, NCTM published documents establishing goals for teachers, policymakers, and for what a classroom should look like. Also in response to need for reform, the National Science Foundation awarded grants for curricula to be written that would align with goals of NCTM. The way in which these curricula are used is important to reaching the goals of NCTM.

Implementation of Curricula

Since the publication of these thirteen NSF-funded curricula, many schools across the nation have adopted them. Students from urban, suburban, and rural backgrounds are learning with these new curricula. From these adoptions and implementations, effective strategies have been identified for implementing such curricula.

According to *New Resources for School Mathematics*, there are four key strategies: long-term implementation, professional development/support, stakeholder support, and implementation assistance. Not only mathematics teachers and administrators need to know and understand the differences between standards-based and traditional curricula, but so should community members, and parents, as mentioned in *New Resources for School Mathematics*. It may take some time to educate others about these new curricula. Teachers would participate in continuous, on-going professional development and support that would prepare them to continuously answer parent and administrative questions. By keeping updated on materials, articles, and research, teachers are able to share extremely supportive and encouraging information when communicating with parents and administrators.

As indicated by *New Resources for School Mathematics*, not all schools successfully using a standards-based curriculum had implemented it with a long-term plan, but schools that do choose to introduce their new curriculum over a few years improve the likelihood of a more successful implementation process. Schools that have used the long-term plan share certain important characteristics including:

- Before consideration of specific programs, teachers and key administrators understand the differences between standards-based and traditional programs.
- With district goals in mind, the schools plan for an in-depth curriculum selection process involving representation from parents, teachers, and administrators.
- The schools consider pilot-testing several programs to compare their effectiveness in classrooms.
- Though some districts have successfully introduced standards-based curricula to all schools and all grades simultaneously, others have found that the gradual introduction of a new program into several schools or grade levels per year has been more appropriate for them. This also builds a resource of experienced teachers.
- Schools plan for regular communication with parents about the curriculum change. (COMAP Inc., 2001, p.23)

Teachers using standards-based curricula for the first time need training prior to their first year to help prepare teachers as to how to begin their first year, and throughout the year, *New Resources for School Mathematics*. During that year, continued support is also crucial. Teachers are often teaching in a way they have never or hardly ever

experienced; reminders and support are important. *New Resources for School Mathematics* informs us that the needs of teachers change as they become more experienced with their curriculum. Teachers will become more confident and comfortable with their curriculum, but they still need professional development and support. Continued professional development and support is not merely a suggestion, as stated by *New Resources for School Mathematics*, it is essential to the successful, progressing implementation of the curriculum.

- Before using a program, teachers need to become familiar with its goals, philosophy, structure, and management.
- Teachers report that during the first year of teaching a standards-based program, regular support through in-class help or networking makes a positive difference.
- The professional development program should provide opportunities for teachers to extend their own mathematical knowledge and to further explore the instructional methods of the program.
- Many districts find that classroom teachers serving as teacher leaders are a vital and versatile resource for building and sustaining a sound professional development program.
- Principals should be included in parts of the professional development program so they can support and encourage teachers throughout the implementation process. (COMAP, Inc., 2001, p.23)

“The introduction of a standards-based mathematics program is likely to challenge parent and community beliefs about school mathematics and how it should be

taught and learned.” (COMAP Inc., 2001, p.23) It is important—even necessary—to communicate with parents and community members. It is important that this communication come from teachers and administrators intelligently and clearly. There are many ways this can be done.

- Make sure school board members have enough knowledge of the new program to ensure their commitment to its successful implementation.
- Invite parent input during the selection process.
- Hold parent nights during implementation. Especially effective are events in which parents do activities from the new program along with their children.
- Give parents enough information about the program so that they can help their children at home.
- Have information about the use and effectiveness of the program in other parts of the country available for interested parties. (COMAP, Inc., 2001, p.23-24)

Resources for curriculum implementation, professional development, and support, teacher materials, administrator materials, and parent materials are available from the National Science Foundation. The NSF also funds national Mathematics Curriculum Implementation Centers. These centers serve as resources as well as collecting and interpreting information about student learning and standards-based curricula. The elementary focused center is the ARC Center; the middle school level center is the Show-Me Center; the COMPASS Center is focused on high school curricula; and the fourth, K-12 Mathematics Curriculum Center covers curricula K-12.

Implementation is key to success with reform curricula. It is important for administrators and teachers to be knowledgeable about reform curricula in contrast to traditional curricula and to regularly communicate this knowledge with parents.

Mathematics teachers have different training and support needs as they gain experience with using reform curricula. Continued training and support is necessary for teachers.

Successful implementation will lead to gains in student achievement.

Student Achievement With Reform Curricula

Elementary students learning with a standards-based curriculum, as compared to elementary students learning with a traditional curriculum, usually performed at least as well with factual knowledge and computation and usually performed considerably better with geometry, problem solving, measurement, algebra, data analysis, and probability (COMAP Inc., 2001). These students developed a greater variety of problem solving strategies, and computational strategies, while remaining strong with mental arithmetic. Regarding state and national standards tests, “students demonstrate substantially greater achievement...” (COMAP Inc., 2001, p.9). Middle school students learning with a standards-based curriculum, as compared to middle school students learning with a traditional curriculum, look for and identify patterns and relationships more often. *New Resources for School Mathematics* reports that computational skills are developed at the same proficiency level or at a higher proficiency level. Regarding mathematical problem solving, these students “...consistently demonstrate superior performance...” (COMAP Inc., 2001, p.15). According to *New Resources for School Mathematics*, high school students learning with standards-based curricula, as compared to high school students learning with more traditional curricula, have comparable procedural skills and

performance on placement and college admission exams. These students have better attitudes about mathematics, and are better at conceptual understanding, problem solving, applying mathematics, and algebraic reasoning.

Students who used reform curricula usually performed as well as or better than students who used traditional curricula with facts and skills. Students who learned with reform curricula generally performed better with problem solving and conceptual skills. These students also generally had better attitudes about learning mathematics. Core-Plus will now be specifically considered.

The Reform Curriculum Core-Plus

The developers of the Contemporary Mathematics in Context (CMIC), or Core-Plus Mathematics Project (CPMP) out of Western Michigan University, realize the importance of communicating with parents. Just as parents can play a big part in their children's success in math class, they can play a big part in the curriculum's successful implementation (CMIC, 1998). Parents are not used to the standards-based path to college; they are not used to the technology-based work. It is crucial that parents understand CPMP; it is crucial for students' success and for the curriculum's success that there is communication with parents.

Parents need to be contacted and informed early in the process of adopting of Core-Plus. Parents need to be involved before their children begin to use it.

Implementing the Core-Plus Mathematics Curriculum suggests ways in which to maintain the constant line of communication between educators and parents (CMIC, 1998). "Math Nights" are organized, family events in which parents are provided with information regarding the need for change, and expectations of post-high school

institutions. Parents are given opportunities to review the text and ask questions. Other research and data may be provided. Another suggested form of communication is a parent news-letter. Keeping parents up to date on their children's studies and objectives is efficient. For CPMP to be successful in the classroom, parent communication is vital, but so is the way in which it is used in the classroom. The way in which a teacher is to use Core-Plus in the classroom is much different than the way most traditional curricula are used. Traditionally, a class resembles much of what it did generations ago. These classrooms often have students in individual desks, lined up in straight rows and six elements were present:

1. a review of previous material and homework
2. a problem illustration by the teacher
3. drill on low-level procedures that imitate those demonstrated by the teacher
4. supervised seat work by students, often in isolation
5. checking of seatwork problems
6. assignment of homework (NCMST, 2000, p.20)

In an ideal CPMP class, students are actively learning and teachers are actively teaching. Teachers are "...observing, listening to, questioning, facilitating student work, and orchestrating classroom discussion; and in managing the classroom" (CMIC, 1998, p.15). These classrooms most likely have students seated in groups at tables or in groups in desks clustered together. Teacher materials serve as a resource to support teachers in all of these tasks. Student materials serve as a resource in supporting their doing mathematics.

Since a CPMP class is so different than a traditional class and vastly different than most teachers experienced as students, maintaining an effective CPMP classroom can be overwhelming. It is recommended by *Implementing the Core-Plus Mathematics Curriculum* that teachers teaching mathematics with Core-Plus for the first time, collaborate with others that share a common planning time. According to *EDthoughts*, teachers who had perceived themselves to be successful in a traditional classroom will need reassurance of their efforts in a standards-based curriculum. (Sutton & Krueger, 2002). These teachers may not be used to skill development embedded in the text, and supplement it with more worksheets with which they are more comfortable. However, this is not aiding in student learning, but actually hindering student learning since coherence is emphasized in a standards-based curricula and worksheets generally focus on drill and practice of basic skills with minimal contextual understanding.

For Core-Plus, or any standards-based curricula, to reach its potential in helping students learn mathematics, it must be implemented as it was designed (as a 9-12 mathematics curriculum for all students). In *EDthoughts*, the essential characteristics of standards-based curricula are recalled, as defined in the *PSSM Curriculum Principle*: classroom discourse, presentation of mathematics skills in the context of problem solving, and application of learning to real situations.

Students are expected to be actively engaged in doing mathematics during class. For students to be actively engaged, they must be expected to do much more than drill and practice of low-level procedural problems. Their minds must be challenged. Students investigate mathematics through real-world, contextual problems. Through this investigation and discovery, students make sense of the mathematics within the problems,

enabling them to make sense out of and solve future problems, including actual problems they may encounter in life.

Students have a few different investigations for each lesson, and each lesson lasts for several days using a four-phase cycle to guide students through the discovery. The four phases include the *launch*, the *explore*, then *share and summarize*, and *apply*. Students are expected to be able to communicate with other students and the teacher during each of the four phases.

The *launch* of the lesson starts with a full-class discussion about questions from the “Think About” portion of the text. These questions get students thinking about a context and about anticipated problems. These questions are designed to set-up the problem and pique students’ interests. The *explore* part of the lesson allows students to investigate problems stemming from the launch. Students are “gathering data, looking for patterns, constructing models and meanings, and making and verifying conjectures” (CMIC, 1998, p.12). Students collaborate with other students in their small groups. The teacher roams around the room providing support and guidance, and answering questions. The teacher must also monitor collaborative group work and help maintain the functionality of the groups.

As the *explore* comes to an end, class transitions to the *share and summarize* portion that will provide closure and conclusion. Again, there is a full class discussion prompted by questions from the “checkpoint”. Small group conjectures and methods are to be shared, with a class summary to bring these conjectures and methods together. Here the teacher makes sure every student understands the main point of the lesson.

Students are then to complete a similar problem or problems to reinforce their understanding. The On Your Own and MORE problems are intended to help students strengthen the concept or method and are to be completed individually as homework is done in a traditional mathematics curriculum; however, the problems are non-routine in nature, unlike traditional programs.

Not only are the class structure and classrooms different, but assessment is also different when using CPMP. Determining what students know and what mathematics they can do is important. Core-Plus provides opportunities for the teacher to assess initial knowledge, monitor student progress, and evaluate student performance.

The *launch* allows the teacher to gauge students' pre-knowledge. Circulating among groups during the *explore* allows teachers to monitor student progress. Observing can provide information, but good questioning and listening are also quite valuable. The *share and summarize* gives an opportunity for students to show what they have understood from the *explore*. The On Your Own and MORE problems provide additional opportunity to evaluate individual progress. The lesson quizzes and unit exams, like the On Your Own and MORE problems, provide opportunities for students to apply mathematics and reflect upon the work and solutions with open-ended questions. There are in-class and take-home unit exams. There are also projects to be used for student assessment. Some students are required to journal as reflection and assessment. Some students put together a portfolio of their work as a long-term assessment.

For Core-Plus to be successful in the classroom, parent communication is important, and so is the way in which it is used in the classroom. Students are actively learning by collaborating and communicating with other students. Teachers are actively

monitoring students' and groups' progress. This type of a classroom is different than a traditional classroom. Is this kind of a classroom a high-quality classroom?

Is Core-Plus A High-Quality Curriculum?

An Expert Panel on Mathematics and Science was established to come up with a process for identifying exemplary and promising curricula, as published on the Eisenhower National Clearinghouse (ENC) for Mathematics and Science Education website, there are five exemplary mathematics curricula and five promising mathematics curricula. The Expert Panel and their process were intended to help parents, teachers, administrators, and policymakers make informed decisions regarding programs, textbooks, and curricula. “Moreover, what students are taught is largely determined by the programs, textbooks, and other curriculum materials schools choose” (ENC, 2005).

During the Expert Panel's first year in 1998, mathematics programs were reviewed. At that time, forty-three states had used recommendations from the national standards documents to come up with their own state standards. Due to such standards, curricula that easily incorporated these standards were desired. The Expert Panel then decided to measure mathematics curricula against the (NCTM) standards and the American Association for the Advancement of Science (AAAS) benchmarks.

Mathematics programs were encouraged to submit applications if they believed that their program or curricula would meet the review criteria. Nearly one-hundred teachers, researchers, and practitioners reviewed the sixty-one submitted mathematics programs. These teachers, researchers, and practitioners all were proficient in mathematics and were trained for three days in the review process. Two reviewers made up a field-based team. Each submitted program was initially reviewed by two field-based

teams. During this initial review process, the programs were evaluated as to their quality, usefulness to others, and educational significance. Highly rated programs from this round of review, moved on to a second round of review, conducted by program evaluation experts. These experts assessed evaluation data and examined the quality and claims of curriculum effectiveness by those submitting.

The entire Expert Panel reviewed each program. With its review, and the results from the other review teams, five programs were recommended as exemplary and five programs were recommended as promising to the Secretary of Education. The Secretary of Education designated the respective programs (curricula) as exemplary or promising in 1999.

Everyday Mathematics, MathLand, Middle-school Mathematics through Applications Project (MMAP), Number Power, and The University of Chicago School Mathematics Project (UCSMP) were each designated as promising mathematics programs. Everyday Mathematics, MathLand, and Number Power are programs for grades K-6. Middle-school Mathematics through Applications Project (MMAP) is designed for grades 6-8. The University of Chicago School Mathematics Project (UCSMP) secondary level materials are for grades 7-12; this program was first developed during 1983-1991, and revised during 1993-1998.

Cognitive Tutor™ Algebra, Connected Mathematics (CMP), The Interactive Mathematics Program (IMP), College Preparatory Mathematics (CPM), and Core-Plus Mathematics Project (CPMP) were each designated as exemplary mathematics programs. The Connected Mathematics Project (CMP) is for students in grades 6-8. Cognitive Tutor™ Algebra, from Carnegie Learning, also known as PACT Algebra or Pump

Algebra, is a first full year algebra course. It can be used in any of the grades 7-12 or by college undergraduates. The Interactive Mathematics Program (IMP), College Preparatory Mathematics (CPM), and Core-Plus Mathematics Project (CPMP), are all four-year secondary school mathematics programs designed for students in grades 9-12.

The program quality of Core-Plus was determined to be high. The learning goals throughout were found to be explicit and clear. Mathematics concepts and skills are developed by students making connections between mathematics and every-day, real-world situations. Students need to learn mathematics in order to solve the contextual problems. Reviewers noted that prepared students will succeed in this program, but more importantly, ill-prepared students should also find success. Classroom assessment is varied; there are more traditional types of assessment as well as alternative assessments. The assessments are teacher-friendly, providing fitting explanations.

CPMP provided solid evidence about students' improvement in understanding and developing mathematics, reasoning, and problem-solving skills. Among the evidence, it was noted that "On items taken from the 1990 or 1992 NAEP assessment of twelfth-grade students, *Core-Plus* Course 3 students scored higher than the NAEP samples in all content and process categories, particularly so on items in the content category of statistics and probability and on items in the process category of conceptual understanding" (ENC, 2005). (In twenty-three Core-Plus field test schools, 1,292 students took the NAEP-based test in May of 1997.)

In 1996-1997, many comparisons between ACT and SAT exam scores of Core-Plus students and traditional curricula students were made. "*Core-Plus* students

performed as well as, or better than (but not to a statistically significant degree), students in traditional curricula who had similar prior school achievement” (ENC, 2005).

“On a pre-post student belief survey about mathematics, *Core-Plus* Course 1 students demonstrated a statistically significant level of growth in confidence about their ability to solve mathematical problems and to reason mathematically, as compared to students in traditional mathematics courses” (ENC, 2005). Core-Plus students also had significantly more positive attitudes than their traditional counterparts. Core-Plus students were more interested in the mathematics they were studying; they were more positive towards the challenge of solving the mathematics and they were more positive about the reality of needing to learn the mathematics. Core-Plus students were significantly more positive about collaborative problem solving; these students saw collaboration as a tool and means for solving problems and learning mathematics. Core-Plus students had much better attitudes about communicating mathematics with their peers. Finally, Core-Plus students had statistically higher growth in their interest in mathematics, demonstrated by their interest to continue to take mathematics courses.

As noted, *Core-Plus* comes with a complete set of teacher materials to help in implementing and classroom use. However, considerable professional development is needed by high school teachers. For a teacher, it is not enough to know the mathematical content being taught. The teacher needs to know the whole program – where and when students will be exposed to what mathematics. Also, teachers need to know the purpose(s) and goals throughout the entire curriculum.

Is Core-Plus a high-quality curriculum? Experts say yes! Yet, school districts are dropping Core-Plus.

Chapter 3: Interviews

Teachers at four high schools that had abandoned Core-Plus were interviewed. Two of the teachers interviewed were previously known by the author. Two schools were known to have recently dropped Core-Plus, the two teachers were chosen randomly from these schools.

The interviews were open discussions in which the teachers were asked to talk about their school district's recent decision to drop Core-Plus as a curricular option for their students. Specific information was desired from these interviews, and as these teachers told their stories, they might have been prompted by a question to obtain the information. If the teacher shared the information without being questioned, the question was not asked.

Guidelines

The author used earlier information in the paper and personal experience to construct questions aiming at important factors in the success of Core-Plus. Core-The following guidelines were used by the interviewer to gather information:

1. Tell me about the initial adoption of this (dropped) curriculum.
 - a. Why did your district decide to adopt Core-Plus?
 - b. Was there opposition?
 - c. Was there support?
 - d. Why was change needed before Core-Plus?
2. Tell me about teacher training and professional development.
 - a. Did teachers get involved with training?
 - b. Did they continue to be involved with professional development?

3. Tell me about teachers and their involvement in the decision to change mathematics curricula.
4. Tell me about parents and the community and their involvement in the decision to change mathematics curricula.
5. Tell me about administration and their involvement in the decision to change mathematics curricula.
6. How was the final decision achieved?

The author was interested in obtaining quantitative data in order to compare student achievement throughout the duration of Core-Plus. The 11th grade MCA test scores would be valuable for this purpose; however the 11th grade MCA test has not been in existence for more than three years. Scores going back only three years would not be of use. Prior to the 11th grade MCA tests, different standardized tests were given. It is not reasonable to compare prior test scores to the recent MCA test scores.

School One

The first school considered is in central Minnesota. It is located in a rapidly growing resort community. According to the U.S. Census Bureau, the county has an estimated population of 55,099, with 97.6% identified as being white. Families and individuals below the poverty level make up roughly 16.5% of the county.

The high school serves 1,595 students in grades 10 through 12. Twenty-two percent of students qualifying for free and reduced price lunch. Special education services reach 11% of students, and 0% of students are limited English proficient. White students make up 97.05% of the student population, with 0.69% American Indian students, 0.88% Asian students, 0.69% Hispanic students, and 0.69% Black students.

Why did your district decide to adopt Core-Plus?

The interviewed teacher was employed at the district at the time of initial adoption. According to the teacher, it was because Core-Plus was best for kids. It had new content covering what they needed to know. It was a change in pedagogy, how kids learn best. The assessment was performance-based assessment. Core-Plus would allow students to learn through hands-on collaboration. Not everyone can learn alone (as with the previous traditional curriculum) and all kids would benefit from the change.

Was there opposition?

Some teachers in the mathematics department at the time were not as interested or as supportive in this decision as the interviewed teacher. Core-Plus was to be the only curriculum for the district. Administration wanted to have a “top-track” (traditional) for the “advanced” students; teachers were happy to get Core-Plus and they agreed to have a “top-track”. Ultimately, teachers feel that this was the beginning of the end and reinforced the misconception that Core-Plus is a remedial math program.

Was there support?

When informational parent sessions were given, parents were very supportive. A handful of informational parent sessions were given to parent groups such as the PTA (parent-teacher association) and the parent curriculum advisory group during the adoption/initial implementation process (the first few years). Administration was supportive at that time.

Why was change needed before Core-Plus?

The high school, with the previous curriculum, was only educating a small percent of students, it was desirable to reach all kids. The strands of Core-Plus aligned

with the Profiles of Learning. This curriculum provided hooks for getting challenging mathematics students involved. Learning mathematics was to be done in-context. The use of technology was unlike any other curriculum; students used graphing calculators as a tool.

Did the teachers get involved with training?

Since the initial adoption, several new mathematics teachers had been hired. The new hires have had little or no training. Those that did have some training, did a lot of “lip service:” they were not professional during training and during professional development; they did not sincerely partake in training/development.

Did they continue to be involved with professional development? No.

Tell me about teachers and their involvement in the decision to change mathematics curricula.

Several teachers did not feel that Core-Plus was a good curriculum. Evident by their great supplementation of worksheets when teaching Core-Plus, these teachers value students mastering skills and did not feel that Core-Plus emphasized mastering skills enough. These teachers were very outspoken among their students, parents, the community, district staff, and administration about their belief that Core-Plus was inadequate. These teachers pushed for the district to adopt a traditional curriculum in exchange for Core-Plus.

Tell me about parents and the community and their involvement in the decision to change mathematics curricula.

Parents apparently played a big role in the decision to abandon Core-Plus. The parents that were outspoken and played a part in this decision are the “elite” parents.

“Elite” parents are parents who believe they know what is best and part of what they “know” to be best is tracking students by ability, creating an advanced track in which (their) students can accelerate their courses. “Elite” parents push for tracking in other subjects including mathematics. The “elite” parents believe their children belong in advanced courses.

Parents had a negative impression about Core-Plus. They felt that it did not prepare students for college. The negativity from parents was not really addressed; in fact, many high school mathematics teachers felt the same way and were quite outspoken about it. Remaining consistently unprofessional, these math teachers were badmouthing the Core-Plus curriculum. Many other staff at the high school, among them, science teachers, were also badmouthing the curriculum.

Tell me about administration and their involvement in the decision to change mathematics curriculum.

Administrators had involvement in the decision to drop Core-Plus. The curriculum director’s supervisors directed the curriculum director to make the new curriculum more traditional to please parents, the “elite” parents. Also, to please the “elite” parents, a disproportionate number of advanced classes are being offered. More students are taking advanced classes than there are truly advanced students. In the interviewed teacher’s words, “Administrators are scared of parents.”

How was the final decision achieved?

Despite more kids in math classes, meeting more mathematics standards, and ACT math scores being the same or better every year, Core-Plus is being dropped. The

majority of mathematics teachers voted to drop Core-Plus and apparently, “majority rules”.

Some education was done with the grades 6-12 mathematics staff, now it has been wasted. This school district is going back to a 1970s style mathematics curriculum with no context, and 80+ naked number problems. This teacher believes it comes down to teachers being scared of the Core-Plus curriculum, and traditional is what is comfortable.

School Two

A second central Minnesota high school was examined. This community is also a growing resort community. Its county population is estimated to be 32,821. Community members identified as white make up approximately 98.5%, and approximately 14.1% are families or individuals below poverty level.

This high school serves 1,091 students in grades 10 through 12. Students qualifying for free and reduced price lunch are at 17%. Special education students reach 12%, and 0% of students are limited English proficient. White students make up 97.8% of the student population, with 0.18% American Indian students, 0.64% Asian students, 1.01% Hispanic students, and 0.37% Black students.

Why did your district decide to adopt Core-Plus?

This teacher was not in this district when Core-Plus was first adopted and was unable to comment about the initial adoption.

Was there opposition?

This teacher was not in this district when Core-Plus was first adopted. This teacher could not comment much about the initial implementation. However, Core-Plus was implemented as a remedial mathematics course. In this district, course 1 of Core-

Plus was taught at the tenth grade level, course 2 at the eleventh grade level and course 3 at the twelfth grade level. Taking course 4 was not a possibility for students in this district.

Was there support?

This teacher was not in this district when Core-Plus was first adopted and was unable to comment about the initial adoption.

Why was change needed before Core-Plus?

This teacher was not in this district when Core-Plus was first adopted and was unable to comment about the initial adoption.

Did teachers get involved with training? The interviewed teacher attended three days of training prior to the teacher's first year of teaching Core-Plus, followed by a one-day users' group meeting the next year. Other teachers also participated in a three-day training.

Did they continue to be involved with professional development?

Besides the one-day users' group meeting, involvement with professional development was not continued.

Tell me about teachers and their involvement in the decision to change mathematics curricula.

There was not a consensus to get rid of the curriculum, but no one pushed to keep it. No one was fighting to keep it.

Tell me about parents and the community and their involvement in the decision to change mathematics curricula.

This teacher did say that parents had commented on the reading (difficulty) and that was an issue. Parents were happy with the On Your Own problems being shorter than a traditional homework assignment.

Tell me about administration and their involvement in the decision to change math curricula.

This teacher did not comment on this beyond saying that the teacher believed the administration trusted the judgment of the mathematics department.

How was the final decision achieved?

The projects in Core-Plus were a positive. The reading level and lack of practice and skills, were both negatives. What it came down to was that to meet new state standards, students needed to start taking Core-Plus in ninth grade. The ninth grade teachers were not willing to teach course one and no one was fighting to keep it; it was a unanimous decision to no longer offer it as a curricular option.

School Three

Another high school considered is in a northern Minneapolis suburb. This high school belongs to one of the largest school districts in Minnesota. Its district has several elementary and middle schools and two high schools. The city in which this high school is located is also served by a second, smaller school district, which has one elementary school, one middle school, and one high school. This city has an estimated population of 22,206, roughly 88.6 % white, and roughly 8% families or individuals living below poverty level. The county of this high school has an estimated population of 511,035, with nearly 77.4% white, and close to 18% families or individuals below living below

poverty level. Both the city and county populations have remained relatively stable over the past 15 years.

This high school serves 1,549 students in grades 9 through 12. Sixteen percent of students qualifying for free and reduced price lunch are at 16%. Special education students reach 11%, and 1% of students are limited English proficient. White students make up 84.96% of the student population, with 1.48% American Indian students, 6.07% Asian students, 2.97% Hispanic students, and 4.52% Black students.

Why did your district decide to adopt Core-Plus?

The interviewed teacher recalled adopting Core-Plus approximately seven years ago. Core-Plus was “on the edge” of new curricula and there were teachers that were committed to the ideas of Core-Plus. When Core-Plus was first adopted, it was first implemented as the only curricular option for students at the high school.

Was there opposition?

After the first semester of implementation, a second, traditional, curricular option was being made available. Some students were also being bused to a sister high school for mathematics courses. These students were taking both the traditional mathematics option and the Core-Plus mathematics options. These two tracks were decided upon by the school board due to parental pressure.

Was there support?

All teachers were supportive, with one exception. This teacher did not have interest in teaching Core-Plus and did not teach it.

Why was change needed before Core-Plus?

The influential group of teachers believed it to be more beneficial to students.

Did teachers get involved with training?

The interviewed teacher attended a week-long training prior to teaching Core-Plus the first time. Other teachers attended similar training.

Did they continue to be involved with professional development?

The teacher had a mentor for that following year, as well as other follow ups. Other teachers continued similarly. For the newer teachers, funding was not available and they didn't get training. The interviewee believed more training would have been beneficial.

Tell me about teachers and their involvement in the decision to change mathematics curricula.

There was a mathematics curriculum committee made up of high school mathematics teachers.

Tell me about parents and the community and their involvement in the decision to change mathematics curricula.

There were some parents who wanted the Core-Plus curricular option to continue. Parents' involvement was not as big of a deal because they could choose for their children to not be in a Core-Plus class.

Tell me about administration and their involvement in the decision to change mathematics curriculum.

The principal trusts his teachers. A push came from the district office to get rid of Core-Plus.

How was the final decision achieved?

Factors influencing this decision include saving money, promoting collaboration among teachers, and less preps. The idea is that if more teachers are teaching more of the same courses, there will be more collaboration. Having two curricula for teachers to teach was a scheduling nightmare; this will help with that problem. The mathematics curriculum committee made the decision to drop Core-Plus and “blend” the best of both styles. There is also the idea that teachers who have taught integrated mathematics can bring ideas, methods, investigations, etc., to a traditional curriculum.

In addition, the interviewed teacher described that the parents and community had the perception that Core-Plus was a lower ability track. The percent of students in Core-Plus had been dropping ever since the offering of a second track. This perception and the actions of the school board in yielding to parents and offering two tracks was setting this curriculum up for failure. As this teacher said, “Core-Plus was doomed”.

School Four

The final high school is in southern Minnesota. This school district serves a typical, neighborly, small town. It is the economic center of the county. This town has an estimated population of 3,519 compared to an estimated population of 3,745 in 1990. This town has roughly 96.9% white citizens, and approximately 12.3% families or

individuals below poverty level. The county in which this final high school is located has an estimated population of 55,941 compared to a 1990 estimated population of 54,044. It is reported that the county's population includes nearly 95.0% whites and that 19.0% of families or individuals live below poverty level.

This high school serves 454 students in grades 9 through 12. Students qualifying for free and reduced price lunch are at 26%. Special education students reach 12%, and 2% of students are limited English proficient. White students make up 93.61% of the student population, with 0% American Indian students, 0.44% Asian students, 5.29% Hispanic students, and 0.66% Black students.

Why did your district decide to adopt Core-Plus?

The interviewed teacher could not answer this question.

Was there opposition?

The interviewed teacher could not answer this question, but did mention that for two or three years, the school had two tracks.

Was there support?

The interviewed teacher could not answer this question.

Why was change needed before Core-Plus?

The interviewed teacher could not answer this question.

Did teachers get involved with training?

The math teachers that taught Core-Plus had most of their training at White Bear Lake High School. One teacher had training for Core-Plus 4 somewhere else.

Did they continue to be involved with professional development?

The interviewed teacher was not able to comment on this beyond initial teacher training.

Tell me about teachers and their involvement in the decision to change mathematics curricula.

The teacher did not feel able to comment on this.

Tell me about parents and the community and their involvement in the decision to change mathematics curricula.

The parents and the community were very involved in changing the curriculum from Core-Plus back to traditional. We were on two tracks for two or three years and now after next school year, we will be teaching only traditional math.

Tell me about administration and their involvement in the decision to change mathematics curriculum. Because of the push from the community to teach traditional math, the administration made the decision to offer both (Core-Plus and traditional) tracks.

How was the final decision achieved?

Due to financial strain, the district felt it could only financially support one track, the traditional track. The entire process was very political.

Tables: Responses to Interview Questions

Table 1a: Why did your district decide to adopt Core-Plus?

School	Response
School One	The decision was made based upon what students needed to know, how students learn best, and aspects of the curriculum such its performance-based assessment, collaborative hands-on learning, and the fact that all participating students can do well.
School Two	This teacher could not comment.
School Three	The decision was made based “on the edge” of new curricula, the initial commitment of teachers to the ideas of Core-Plus, and the fact that Core-Plus was initially the only curricular option.
School Four	This teacher could not comment.

Table 1b: Was there opposition?

School	Response
School One	Some teachers were not supportive and the administration wanted a “top-track” for “advanced students.”
School Two	Core-Plus was implemented as a remedial mathematics course in such a way that Course 4 was not an option for students.

Table 1b. (continued).

School	Response
School Three	After one semester a second, traditional, curricular option was made available; this decision was made by the school board due to parental pressure.
School Four	This teacher could not comment.

Table 1c: Was there support?

School	Response
School One	Parents that participated in parent sessions were supportive, and administration was also supportive at the time.
School Two	This teacher could not comment
School Three	All teachers were supportive, with one exception.
School Four	This teacher could not comment.

Table 1d: Why was change needed before Core-Plus?

School	Response
School One	Previously only a small percent of students were being educated.

Table 1d. (continued)

School	Response
(School One)	Core-Plus was desirable for reaching all students, aligned with the Profiles of Learning, made use of technology, and provided hooks for involving challenging students and learning math in-context.
School Two	This teacher could not comment.
School Three	Teachers believed it to be more beneficial for students.
School Four	This teacher could not comment.

Table 2a: Did teachers get involved with training?

School	Response
School One	New hires had little or no training, while other teachers did not seriously take part in the training or development.
School Two	Teachers participated in a three-day training, while the interviewed teacher took part in a one-day users' group the next year.
School Three	Teachers attended a week-long training.
School Four	Teachers had most of their training at White Bear Lake.

Table 2b: Did they continue to be involved with professional development?

School	Response
School One	No.
School Two	Besides the one-day users' group meeting, no.
School Three	Teachers had a mentor for a year with other follow-ups. Funding was not available for newer teachers' to receive training.
School Four	No.

Table 3: Tell me about teachers and their involvement in the decision to change.

School	Response
School One	Several teachers did not feel that Core-Plus emphasized mastering skills enough. These teachers were outspoken among students, parents, district staff, and administration; they pushed for the adoption of a new curriculum.
School Two	Although there was not a consensus to get rid of Core-Plus, no one fought to keep it.
School Three	The mathematics curriculum committee was involved.
School Four	This teacher could not comment.

Table 4: Tell me about parents and the community and their involvement in the decision to change mathematics curricula.

School	Response
School One	“Elite” parents played a big role by pushing for tracking, having a negative impression of Core-Plus, and feeling it did not prepare students for college.
School Two	Parents commented on the difficulty of the reading, but were happy with the On Your Own problems being shorter than traditional assignments.
School Three	Some parents wanted Core-Plus to continue, but parents’ involvement was not as big of a deal because they could choose for their children not to be in Core-Plus.
School Four	They were very involved in changing the curriculum from Core-Plus back to something more traditional.

Table 5: Tell me about administration and the community and their involvement in the decision to change mathematics curricula.

School	Response
School One	“Administrators are scared of parents” The curriculum director was asked by supervisors to make the new curriculum tradition to please “elite” parents.

Table 5. (continued)

School	Response
School Two	Administrators trusted the judgment of the mathematics department.
School Three	The principal trusts his teachers. The push to get rid of Core-Plus came from the district office.
School Four	Because of the push from the community, administration decided to offer both Core-Plus and a traditional curriculum.

Table 6: How was the final decision achieved?

School	Response
School One	The majority of the teachers voted to drop Core-Plus.
School Two	Projects were positive, but the reading level and lack of skill practice were negative. Teachers were not willing to make the changes to meet new state standards and no one fought to keep it.
School Three	The decision to build collaboration between teachers and blend Core-Plus and the tradition curriculum was made to save money, create less prep-time, and make scheduling easier.
School Four	Due to financial strain, only one tradition track could be offered. The entire process was very political.

Chapter 4: Conclusions

In this paper a clear unprecedented need to improve the way we teach and learn mathematics in our country has been established. Recall that among 20 nations assessed in advanced mathematics and physics, *none* scored significantly lower than the United States in advanced mathematics, and only *one* scored lower in physics (NCMST, 2000, p.10-11) and “International comparisons show that the mathematical achievement of American students falls far behind our major economic competitors.” (COMAP Inc., 2001, p.1). As stated previously in this paper, the United States risks losing a leading and secure position in the world in science, technology, democracy, society, economic security and military security. If our nation wants to remain strong and continue its global leadership role tomorrow, the way in which mathematics is taught in this country must change today, specifically providing mathematical education for all in order to maintain a high ratio of technology-savvy citizens to limited citizens as supported by *Nation At Risk*.

As stated earlier, computers, technology, and competition with other nations are now pushing the United States to change the mathematics learned in school. To be competitive citizens and productive members of society, conceptual understanding and applications of abstraction and algorithms are what students need to learn; this is what is being demanded outside the classroom, as supported by *Everybody Counts*.

As mentioned in this paper, to get mathematics to be the pump, rather than filter, it needs to be, many things must change, including attitudes, classrooms, and assessments, as *Everybody Counts* advises. Apprehension and fear of mathematics will change as students’ self-confidence about mathematics builds. The way in which

mathematics is practiced in the classroom must change from presentation, repetition and mimicry (NCMST, 2000) to discovery, investigating, and engaging higher order thinking skills with worthwhile mathematical tasks for students to construct their own mathematical understanding, as suggested by *Everybody Counts*. As specified by this literature, assessment must also change to reflect what students will be asked to do and practice in the classroom. In-depth, contextual assessments that give students opportunities to analyze, apply, interpret and predict, must become the norm.

To effectively achieve mathematics education reform, many must be involved, including teachers, parents, professionals, and politicians. To do all of what is needed for successful mathematics education reform, common goals must be established, with means to reach these goals.

In response to the need for mathematics education reform, NCTM published documents establishing goals for teachers, policymakers, and for what a classroom should look like. Also in response to need for reform, the National Science Foundation awarded grants for elementary, middle school and high school curricula to be written that would align with goals of NCTM. All thirteen NSF funded projects were to design, develop, test, and implement innovative approaches to mathematics education based on NCTM *Standards* documents, modern research on teaching and learning mathematics, and mathematics believed to be useful in students' future endeavors.

According to *New Resources for School Mathematics*, there are four key strategies to implementation of reform curricula: long-term implementation, professional development/support, stakeholder support, and implementation assistance. It is important for administrators and teachers to be knowledgeable about reform curricula in contrast to

traditional curricula and to regularly communicate this knowledge with parents.

Mathematics teachers have different training and support needs as they gain experience with using reform curricula. Continued training and support is necessary for teachers.

Successful implementation will lead to gains in student achievement.

Students who used reform curricula usually performed as well as or better than students who used traditional curricula with facts and skills. Students who learned with reform curricula generally performed better with problem solving and conceptual skills. These students also generally had better attitudes about learning mathematics. Students using reform curricula evidently achieve more than students using traditional curricula.

One NSF funded high school programs is Core Plus and for it to be successful in the classroom, parent communication is important, and so is the way in which it is used in the classroom. Four phases of each lesson include the *launch*: questions to get students thinking and anticipating, the *explore*: students actively and collaboratively investigate mathematics, then *share and summarize*: students communicate what has been tried and discovered as a whole class and the *apply*: contextual problems similar to the investigations, OYOs and MOREs, for students to work on individually. As students are actively learning, teachers are actively monitoring students' and groups' progress. This type of a classroom is quite different than a traditional classroom, characterized by a review of previous material, a problem illustration by the teacher, drill on low-level procedures that imitate those demonstrated by the teacher, supervised seat work by students, often in isolation, checking of seatwork problems, and assignment of homework (NCMST, 2000, p.20).

Core-Plus has been determined to be a high-quality curriculum by the Expert Panel on Mathematics and Science, yet, school districts are dropping Core-Plus.

Review of Interview Responses

From the author's personal experience, the author anticipated finding certain consistencies among the information from the interviews. Several consistencies were found as anticipated, along with additional information:

Why did your district decide to adopt Core-Plus?

One district adopted Core-Plus because of the differences that would benefit *all* students. Another district adopted Core-Plus because it was “on the edge” of new curricula.

Was there opposition?

Schools reported to have some opposition from teachers or administrators. The author predicted that the curriculum would not have been implemented correctly. This was found to be true in each school district; specifically that Core-Plus was not a curriculum for all students. Unexpectedly, initial correct implementation was intended, as reported by two schools. The decision to change the way in which it was implemented—offering more than one curricular option to students—was ultimately dictated by administration, reportedly in response to parental pressure.

Was there support?

Schools reported that there was support from parents and teachers.

Why was change needed before Core-Plus?

From information earlier in this paper, the author expected to find that schools first adopted Core-Plus because it was better for all students. Information from interviews affirmed this expectation.

Did teachers get involved with training?

The author expected to find that teachers in the school districts had little or no Core-Plus training and professional development from her experience. From the interviews, it was confirmed that teachers had little or no training and professional development, however more teachers had more initial training than the author had expected. Also, from experience, the author believed that these teachers would have had no interest in participating in initial and/or continued training and professional development. Surprisingly, this did not seem to fit each case. Some teachers were not able to get training due to lack of district funding.

Did they continue to be involved with professional development?

From the interviews, more teachers had more initial training than the author had expected, but continued professional development was certainly lacking.

Tell me about teachers and their involvement in the decision to change mathematics curricula.

Some teachers were more involved than others with the decision to change mathematics curricula. Some teachers were outspoken about their beliefs that Core-Plus was lacking in skills practice and some teachers were ambivalent about the decision.

Tell me about parents and the community and their involvement in the decision to change mathematics curricula.

Parents were not quite as involved in the decision to drop Core-Plus in school districts that had used Core-Plus as a remedial course. Otherwise, parents played a big role in the decision to change curriculum.

Tell me about administration and their involvement in the decision to change mathematics curricula.

Some administration placed trust in their mathematics department, but it was found that at some level, administration made decisions to get rid of Core-Plus in response to parents and the community.

How was the final decision achieved?

Due to the author's experiences with teachers doubting the effectiveness of Core-Plus, the author predicted that the biggest proponent for the abandonment of Core-Plus would be due to mathematics teachers. The author found that at each school district there were teachers that didn't support Core-Plus, but they were not necessarily the main factor in changing from Core-Plus. A big push came from parents pressuring administration. Administration gave in either initially by offering more than one track – ultimately leading to its demise of Core-Plus – or, administration gave in later and instructed to get rid of it. From the author's experience and interviews, teachers that support Core-Plus can get worn down by administration, parents, and the frustration of trying to make it work without support, training, and correct implementation. The final decision to abandon Core-Plus seems to be achieved by a combination of pressures from unsupportive teachers, parents, and administration.

Suggestions

It is now understood by the author that the initial adoption process is just as important as the implementation. Before adopting a curriculum, get all stakeholders involved: teachers, parents, administrators, and outside knowledge and resources throughout the district. Parents need to feel that their opinions are valuable and respected without needing to be critically outspoken. Come to agreement about what is important in a mathematics curriculum and appropriate goals of the district. Ideally, this will be about what is best for *all* students—what will allow all students to learn important mathematics best and to prepare them for the future, i.e. appropriate use of technology.

Don't rush the adoption process. Be prepared to take more than one year, maybe two or three years. Keep the agreed goals in mind throughout; keep all students in mind throughout. Don't ignore or avoid issues because it may get heated. Have these conversations, and resolve them as best possible. This is where an outside resource would be quite beneficial. Additional non-biased knowledge can help direct decisions.

Even when all (teachers, parents, administrators, outside resources) are ideally involved in the adoption of Core-Plus, continued professional development for all is a must. New teachers and administrators are hired and different parents become involved over time. Teachers need to participate in regular training and support. They need to be reassured that teaching standards-based curricula is different, difficult at first, but it gets easier and can be more fulfilling. As teachers progress in teaching such curricula, their needs change. To meet the changing needs, teachers must continue participating in training, users' groups, on-line discussions, and collaboration. It is also vital to Core-

Plus that inappropriate use and implementation by teachers and the department are not to be tolerated.

Administrators should go through training as teachers do. They need to be as informed as teachers. Administrators need to be able to answer parents' questions immediately and knowledgably.

School districts need to be proactive regarding parent questions. Constant parent communication must be maintained. Teachers should share what is happening in their classrooms, what students are doing and learning. Parent nights should be a regular event. Teachers can send news-letters to parents and share student work and progress with local newspapers. School districts should also share state and national research findings with parents and the community. School districts should also keep and share their own records regarding their students and standardized test results.

These conclusions are based on research and interviews. It is clear that to make more solid conclusions, further investigation and study are necessary.

Professional Implications

The information I have gathered and learned from will be valuable to me in my future. Teaching Core-Plus in another school district is of interest to me and it is of no interest to me to see Core-Plus leave another one of my school districts. Before I decide to become part of a school district, I will definitely ask about its initial adoption, who was involved and how the was decision made. I will find out about the history of implementation in the district. I will also ask about administrators and parents, how involved they are, how knowledgeable they are, and how committed they are to this program.

Suppose I become part of a school district considering adoption of Core-Plus. What I have learned about the significance of initial adoption and implementation as well as open communication can be very important to the school district, to the on-going success of Core-Plus, and to the students' mathematics educations.

If I do not teach Core-Plus in a high school again, what I have learned will still be of great value to me. I have ambition to work with undergraduates pursuing mathematics teaching degrees. Sharing with them what I have learned can be just as valuable to them when searching for school districts as it was for me. I have aspiration to work with school districts in general during their curriculum review process and am confident that I have useful information to share with them. I also have aspiration to study more about what I have learned from this experience. I have accomplished and learned much throughout this process. There is much more to explore.

Appendix A:

Appendix B:

Appendix C:

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