The Challenge to America's Educational System

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Introduction

“A curriculum can be defined as the planned educational experiences offered by a school which can take place anywhere at anytime” (Todd, 1965). Keeping this definition in mind, the study of curriculum development and design seems as though it should be relatively straight forward and uncomplicated. However, upon closer examination, we discover a process that involves a countless number of individuals and special interest groups, each with their own agendas that complicate even the most simple of tasks. As time passes, interests change and technology advances. These also have their effect upon the various curriculums.

Historically, technological advancement provided an increase in the number of avenues open to educators, but it also required that curriculums be altered to keep up with those changes. Such alterations were designed to keep students current with the basic standards required for each of the subject fields. However, in light of the recent ***No Child Left Behind*** legislation signed into law by President George W. Bush in January of 2002, many school administrators have found themselves faced with the task of creating rigorous academic content standards that comply with the mandates set forth in the law. In addition, standardized tests aligned to those content standards and

at least three levels of performance have been defined and are used to hold the schools accountable. Schools that fail to meet any of these requirements or whose students fail to meet or exceed the established state levels of proficiency are subject to sanctions that will increase in severity for each year they fail to progress.

In effect, federally mandated testing has forced state and local administrations to change the curriculums in their schools to adhere to what is tested and ensure that students meet the competence levels required by the standardized tests. With NCLB, the impetus for change has shifted away from the social factors that have influenced the subjects of history and language, away from both the economic and technological forces that have influenced the fields of mathematics and science. With NCLB, the momentum has shifted towards the influence of politicians and policy makers in Washington. This paper will look at the trends in curriculum development and design, both historical and current, specifically in the areas of mathematics and science, and examine how these trends have been influenced by each of a variety of determining factors including, but not limited to NCLB.

Statement of the Problem

Proponents of NCLB argue that the Act upholds the principles of ***Brown vs. Board of Education***, the landmark Supreme Court decision that outlawed segregation in public schools and declared unconstitutional the doctrine of *separate but equal* "by creating an educational system that is more inclusive, responsive and fair."The No Child Left Behind Act of 2001 was President George W. Bush's reauthorization of the 1965 Elementary and Secondary Education Act. Enacted prior to 9/11, Lawrence Hardy calls it the "perfect post-9/11 initiative." Critics of NCLB have attacked the law for several reasons. They say that although the law professes to be based on scientific research, "no scientifically based research, or any research, supports the law's mandates" (Bracey). Also, the requirement that all students be proficient in reading, math, and science by 2014 is considered unrealistic by some and simply ridiculous by others. Some educators are critical of NCLB's reliance on punishment. Others argue that standardized testing is not an adequate measure of achievement in all cases. Whatever the argument, it would appear that the future of NCLB is not yet certain and whatever changes occur will certainly affect curricula in grades K-12. Short term data however has shown that a larger number of schools are making Adequate Yearly

Progress whereas critics have predicted that most schools will fail by 2014.

Science will not be tested until 2007, but the subject of science and science education is a topic on the minds of both educators and non-educators alike. Thomas L. Friedman, a columnist for the New York Times, criticized Congress in December 2004 for reducing the funding for the National Science Foundation for the year 2005. "Instead of doubling the NSF budget to support more science education and research at every level, this Congress decided to cut it... Could anything be more idiotic?" Friedman proposed a national science initiative aimed at exploring alternative fuels and energy conservation to make the United States self sufficient within ten years. However, in early December, a report released by the Program for International Student Assessment ranked American 15-year-old students 24th out of 29 nations in mathematics literacy. This is bleak news considering that some of the other nations are rapidly becoming America's chief technological competitors. One reason for America's poor performance noted by Steven Leinwand, principal research scientist at the American Institutes for Research, is that of the five top rated nations, "all five of these countries have a coherent K-12 national mathematics curriculum, the United States stumbles along with the 50 state frameworks

based more on whim and past practice than research."

Fewer American students are pursuing careers in the sciences as well. According the National Science Teachers Association, the United States now ranks 17th among the nations surveyed in the proportion of 18-24 year-olds earning degrees in the natural sciences and engineering. In 1975, America ranked 3rd. Many believe that the American public education system remains the nation's biggest disadvantage. In many school systems for example, science remains secondary in importance to subjects such as reading, writing and mathematics. Further, a large number of teachers have little or no background in the physical sciences other than what training they received in high school. The numbers of such inexperienced teachers increases in minority or high-poverty areas. If the United States is to maintain its standing in the global economy, it is imperative that it be able to compete in an ever increasing technological society both economically and educationally. To do so, America must improve its methods for preparing students in mathematics and the sciences to meet the demand for highly skilled workers.

Review of the Literature

Prior to the 1950's, mathematics education focused primarily on the student's mastery of basic computational skills. This did not however, suit the nation’s need for theoretical mathematicians and scientists. By the 1960's, a trend towards mathematics as a discipline began to emerge. The “new math” stressed general concepts, principles, and laws that would be useful in problem solving. However, just as the old math was criticized for being too simplistic, the new math was criticized for being too abstract and having little practical relevance. The current trend is to incorporate both traditional and modern mathematics in today’s schools. The older more basic mathematical skills are taught to the slower students or those that are not planning to attend college. The more advanced students, those that are primarily college-bound are still given instruction in algebra, geometry, and other pre and college level courses.

It has been suggested that future trends in mathematics instruction follow one of three new directions:

- Integrate mathematics with other subject matter stressing the importance of mathematical skills in all subjects.

- Introduce technology into the classroom. Computers and calculators, so much a part of society today, should be introduced into the classroom as early as possible.
- Include the community in the planning and implementation of new curriculums. Both parents, used as tutors or teachers' aides and members of local industry, as lecturers or to provide work opportunities supplement the educational experience and at the same time, reduce costs.

Disagreement persists on the best way to teach mathematics. Some stress computational skills over concepts while others believe that mathematics should be taught in relation to real world experiences or occupations. One thing that seems apparent is that any immediate solution requires a balanced curriculum. No single curriculum is suitable for all children and as such, content should be broadened. Metrics, symmetry, shapes, measurement, and graphing should be explored and important mathematical concepts should be considered. Basic mathematical skills are not of great importance in a highly technological society, but conceptual courses such as algebra, geometry and pre-calculus are not suitable for everyone. At the

college level, calculus at the freshman level is being challenged because technology has changed the needs of students. Some colleges are experimenting with courses in discrete mathematics.

The National Council of Teachers of Mathematics (NCTM) recommends standards for the mathematics curriculum in grades pre-K to 12, standards for mathematics teachers and assessment standards for evaluating the progress of students. The NCTM also stresses the interdependence of three factors:

- Techniques are needed to help students focus on specific elements and solve problems on their own.
- A variety of ways to solve problems should be explored.
- Students should be given the opportunity to relate real-life events to mathematical models by estimating, applying these estimated abilities in other situations, and developing criteria for comparison, noting regularities of coordinate systems in the real world and imposing order on a real situation and then summarizing in mathematical form.

NCTM documents attribute much of the disparity in student proficiency to cultural and gender differences. The *Principles and Standards for School Mathematics* (NCTM, 2000) highlighted equity by making it the first principle for school mathematics reform. PSSM acknowledged the negative impact of low expectations, inequitable access to quality mathematics, and inequitable allocation of material and human resources. PSSM stops short however at addressing equity in the larger social context or offering suggestions for establishing an equitable foundation for mathematics education.

All branches of scientific endeavor depend upon the laws of mathematics and their underlying principles and as such, science in the early 1960's was shaped by the same forces that influenced mathematics, specifically the proposition to teach science as a discipline and a movement towards specialization. Later, as with mathematics, the discipline approach to science education was criticized for spending too much time on theory and not enough on practical application. Prior emphasis, in the scientific community, on research concerning space exploration and national defense had distracted attention away from societal issues. The average student was unable to recognize the role of science in common affairs. As a result, a trend to humanize science emerged in the 1970's.

Science education gave way to pressure for higher test scores in mathematics and reading skills during the mid to late 1970's. Enrollment in high school science classes declined and teachers turned towards textbooks as the primary method of science instruction. A crisis in science curriculums by the mid 1980's prompted the U.S. Government Printing Office to make the following announcement:

- A mismatch exists between the current science curriculum and that which students want and need.
- Science is viewed as content to be mastered. Teachers only goal is to prepare students for the next academic level.
- Science curriculums were primarily textbook based and involved very little direct experience.
- There was no development of the science curriculum. Textbooks dictated the entire educational experience.
- The existing science program generated little interest in science or science literacy. Courses were taught by textbooks that were themselves inadequate.

Goals of future science curriculums will be to provide students with basic problem solving skills they will need. Instead of teaching single answers to direct questions, students will be given a number of different alternatives that can be ranked in terms of desirability. The consensus of recommendations favors more inquiry in the science classroom. One obstacle to that methodology is the economic considerations. A second is teacher familiarity and confidence in the various methods available and the subject matter. NCLB addresses both of these:

- Under the Act, all teachers are required to meet certain standards by the end of the 2005-06 school year. These standards include a bachelor’s degree, state certification and to have proven knowledge of the subjects he or she teaches.
- The federal education program, commonly referred to as the “Title I” program, provides supplemental financial support for those students who qualify for free or reduced price lunches in school. Under the 2005 federal budget, the request for Title I funding increases $1 billion to $13.3 billion. This is President Bush’s third consecutive request for a $1 billion increase in funding for disadvantaged

students.

- The budget also provides $681 million for English language acquisition to help those students who are learning the English language.
- Students who attend Title I schools that do not meet adequate yearly progress standards for two years in a row have the option of transferring to a higher performing public or charter school within the same school district. The President’s 2005 budget sets aside $504 million to help expand choices for parents and children.
- Accountability is one of the keystones of NCLB. $410 million is set aside for the development and implementation of new means of assessment to help ensure that both parents and school officials are receiving accurate information regarding the performance of students and the individual school systems.
- President Bush has requested $1.4 billion to support reading programs.
- NCLB requires that students with disabilities be included in state and district assessment programs. The President has requested a $1 billion increase to $11.1 billion for the Special Education Grants to

States Program.

With respect to Mathematics and the Sciences, the 1990's saw an unprecedented level of support for reform in the fields of mathematics and science education in the United States. Project 2061, established by the American Association for the Advancement of Science (AAAS) in 1985, and inspired by the belief that literacy in science, mathematics, and technology is an essential requirement for all students, regardless of their educational or career aspirations. Today, AAAS continues to shape the course of math and science curriculums across the country. Its first publication, ***Science for All Americans*** (1989), provided ways to achieve that proficiency and established what all students should know and be able to do in those fields upon graduation from high school. Laying the groundwork for the movement to reform science and mathematics education in the 90's, ***Science for All Americans*** was just the beginning. The project continued to develop tools that educators could use to help their students gain proficiency. ***Benchmarks for Science Literacy*** (1993) was intended to help educators design a K-12 curriculum, one that made sense and addressed the science and mathematical literacy goals expressed in *Science for All Americans*. This effort has become the foundation from which many of today's state and national

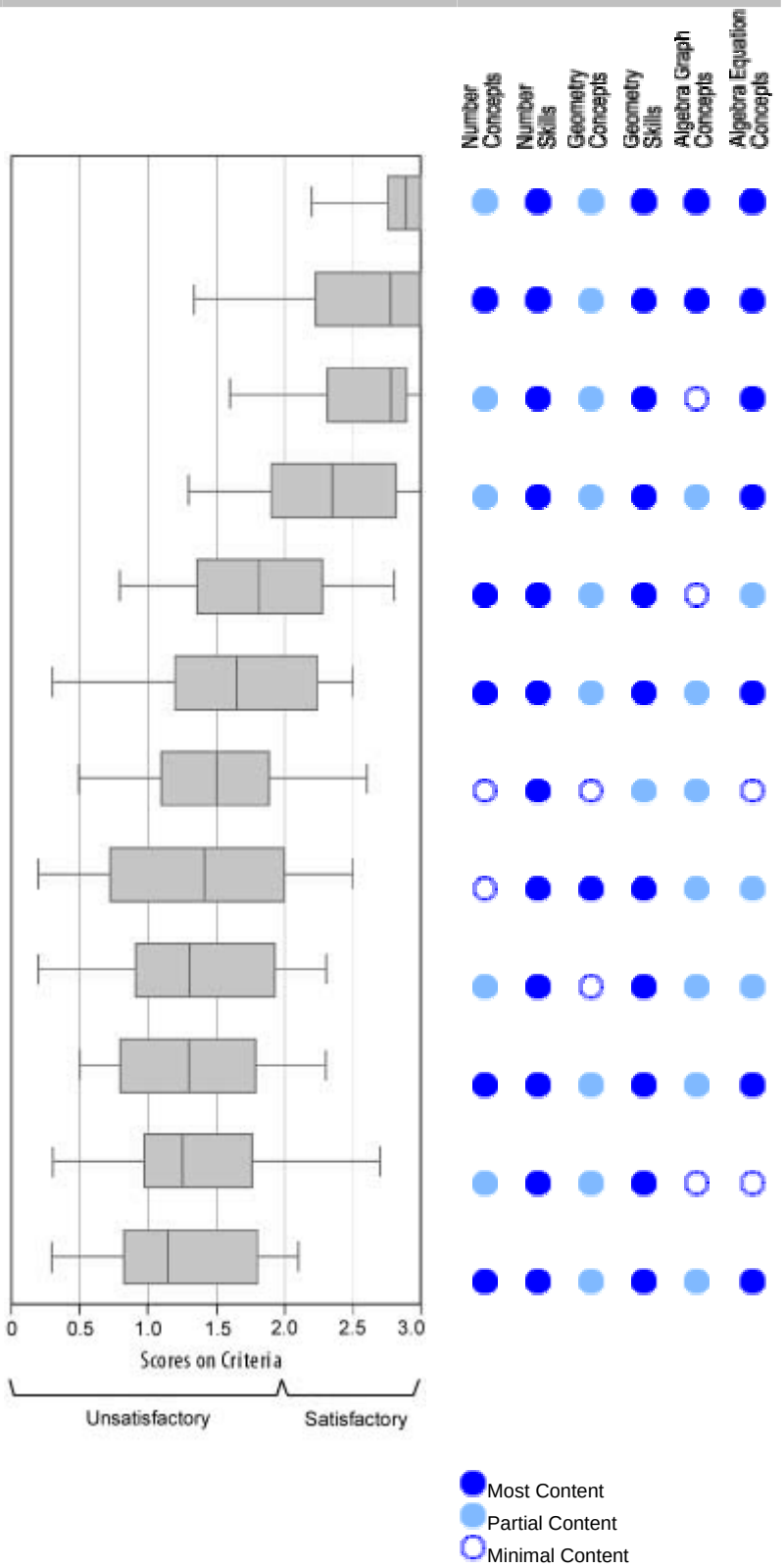
standards documents in science education are drawn. However, the links between important concepts in science and mathematics, both within and between grade ranges, were not expressly defined in *Benchmarks.* To help educators gain insight into the connections among benchmark ideas, Project 2061 and the National Science Teachers Association co-published the ***Atlas of Science Literacy*** (2001), a collection of linked maps that show how students might increase their proficiency and understanding toward specific science and mathematical literacy goals.

Project 2061 believes that curricular materials are an important part of improving science and mathematics education. However, they say many of those resources fail to successfully teach the most important ideas. Therefore, Project 2061 is working with educators, curriculum developers, and publishers to help develop instructional materials that will help all students achieve literacy in science and mathematics. One such way they do this is through the examination and evaluation of available teaching resources. In late 1999, Project 2061 published its ***Middle Grades Mathematics Textbooks: A Benchmarks-based Evaluation***. This was an evaluation of many of the resources that were being discussed among educators at the time (Cowles). It was thorough in describing the criteria and processes used in the evaluations and the results. This is

important because Mathematics curricula tend to be textbook based. If a textbook doesn’t cover the concepts required at the grade level for which it is used then either the teacher will have to supplement the text with other material or skip the material omitted by the text. Either scenario is not in the best interest of the students.

The chart on the following page is Project 2061’s summary of the textbooks evaluated. The chart on page 12 compares 12 of the textbooks evaluated and shows how well each scored on its depth of coverage and the quality of its instructional support across all six benchmarks (Same has been reprinted from Project 2061’s web site).

Textbook Series	Ranking by Quality of Instruction in Student and Teacher Editions	Selected Benchmarks



Connected Mathematics.
Dale Seymour Publications, 1998

Mathematics in Context.
Encyclopedia Britannica Educational Corporation, 1998

MathScape.
Creative Publications, 1998

Middle Grades Math Thematics.
McDougal Littell, 1999

Mathematics Plus.
Harcourt Brace & Company, 1994

Middle School Math.
ScottForesman-Addison Wesley, 1998

Math Advantage.
Harcourt Brace & Company, 1996

Heath Passport
McDougal Littell, 1996

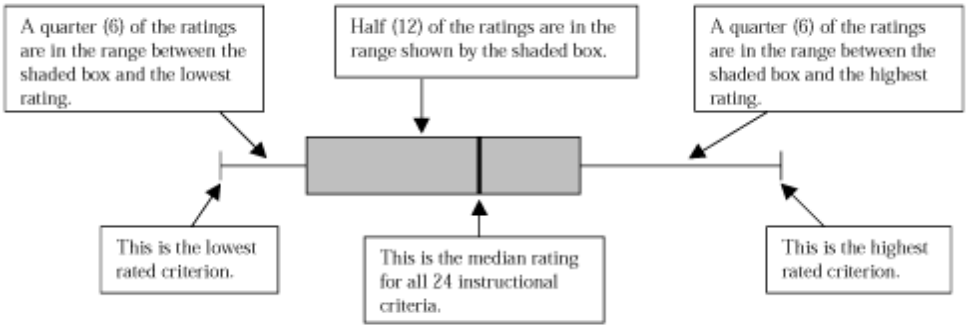
Heath Mathematics Connections.
D.C. Heath and Company, 1996

Transition Mathematics.
ScottForesman, 1995

Mathematics: Applications and Connections.
Glencoe/McGraw-Hill, 1998

Middle Grades Math.
Prentice Hall, 1997

The chart compares 12 of the textbooks that were evaluated and shows how well each scored on its depth of coverage and the quality of its instructional support across all six benchmarks. The data represent both the range and variation of scores across the instructional criteria. The three top-rated textbook series had a median rating of more than 2.5 on a scale of 0-3 points for all of the 24 instructional criteria for all six benchmarks. To show the range of scores given to each book across the 24 criteria for instructional quality, the summary chart indicates the median and also the highest and lowest criterion scores for each textbook. The diagram below explains how to interpret the quality of instructional support data shown in the chart.



Good News

- There are a few excellent middle-grades mathematics textbook series.
- The top two series contain both in-depth mathematics content and excellent instructional support.
- Most of the textbooks do a satisfactory job on number and geometry skills.
- A majority of textbooks do a reasonable job in the key instructional areas of engaging students and helping them develop and use mathematical ideas.

Bad News

- There are no popular commercial textbooks among the best rated.

- Most of the textbooks are inconsistent and often weak in their coverage of conceptual benchmarks in mathematics.
- Most of the textbooks are weak in their instructional support for students and teachers.
- Many textbooks provide little development in sophistication of mathematical ideas from grades 6 to 8.
- A majority of textbooks are particularly unsatisfactory in providing a purpose for learning mathematics, taking account of student ideas, and promoting student thinking.

It is difficult to foresee where organizations like AAAS will and Project 2061 will fit in with NCLB and what impact will they have. There is great concern among many educators that the standardized tests used to measure the achievement of standards established by NCLB fail to accurately measure the important ideas specified in those standards. Without an accurate assessment procedure, there will be no confidence in the results of those assessments, and penalties may be unfairly imposed.

Researchers at Project 2061, with support from the National Science Foundation (Bricker), are studying the

question of alignment of the standardized tests with established standards. They are focusing on whether the tests being used to measure achievement are truly aligned with the standards and it is hoped that their research will produce a clearer definition of alignment. The researchers are also developing a procedure for assessment analysis that can be used to determine the relationship between tests administered in grades K-12 in science and mathematics and national, state, and local standards. This research will be beneficial to commercial developers and publishers of textbooks and testing materials, those entities that are responsible for administering large-scale testing programs and classroom teachers who make up their own quizzes and tests. The research will also help to change educators' views on what to expect of the various testing instruments and show them how to make better choices from what is available.

The testing mandated by No Child Left Behind will have important consequences for students and teachers. In addition, the testing will continue to drive the curriculum, what gets tested is typically what gets taught. New and innovative approaches are crucial and research by organizations such as AAAS and Project 2061 will ensure that assessing student achievement is as accurate and fair as possible.

A second approach to science education was the ***Project Scope, Sequence, and Coordination of Secondary School Science*** by the National Science Teachers Association. This was an effort to replace the then current method of teaching Science in a fixed sequence in favor of a more integrated approach. William Aldrich, the project's founder writes:

> The "Project on Scope, Sequence, and Coordination of Secondary School Science" is an effort to restructure science teaching primarily at the secondary school level. The project calls for elimination of the tracking of students, recommends that all students study science every year for six years, and advocates the study of science as carefully sequenced, well-coordinated instruction in physics, chemistry, biology, and earth and space science. As opposed to the traditional curriculum in which science is taught in year-long and separate disciplines, referred to as the "layer-cake approach,"

The coordination of scientific concepts is based on the assumption that the separate disciplines, earth and space science, biology, chemistry, and physics all share certain commonalities. By integrating their study, students are expected to gain an awareness of the interdependence of the sciences and better understand the various concepts when examined in the context of more than one discipline (Bybee).

There are other efforts whose goals are to improve math and science programs in the United States. Some of these include the ***National Center for Improving Science***

Education whose frameworks for curriculum, assessment and staff development have greatly enhanced the development of local school science programs. The ***National Science Education Standards Project*** provides qualitative criteria and framework on which to judge local school science programs. The ***National Center for Improving Science Education*** has published reports on middle-level education (Bybee) and secondary education (Champagne, Loucks-Horsley, Kuerbis, & Raizen) addressing pressing issues in the field of science education. These reports became were instrumental in the development of the National Science Standards and Project 2061's Benchmarks.

Conclusion

As mentioned, the 1990's saw a great deal of movement towards reform in the fields of mathematics and science education in the United States. Many educators, though still cautious, were quietly optimistic that the future would hold great promise for improving the standards of math and scientific literacy for all Americans. How the No Child Left Behind legislation will affect this reform movement remains to be seen. The law itself comes up for renewal in 2007 and many educators are hoping for substantial changes in the law before then. Research into standardized testing and how such tests are aligned to established educational goals by groups like Project 2061 hold promise that NCLB can be administered fairly to all students. John D. McNeil (1996) concluded that "most subjects are influenced by the same social, economic, political, and technological forces." In light of NCLB, it would seem that some have become more influenced than others.

With NCLB, political concerns have become predominant in determining the direction that schools are taking and "teaching to the test" has become a real factor in the amount of attention that some subjects receive. However, NCLB may act to unify standards at least at the state level where before there was a lack of continuity. Educators face

a serious challenge in establishing a curriculum that will serve the majority of students and provide access to courses only that up to now have been available to only a few. Many feel that excellence in mathematics and the sciences is absolutely necessary in for global economic leadership and homeland security in the 21st century. Proponents of No Child Left Behind hope that the law can accomplish this.

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