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Introduction

The State of Mathematics

In 1992, the National Assessment of Educational Progress (NAEP) presented a devastating report to the nation. Over 250,000 fourth-, eighth- and twelfth-grade students in 10,000 schools nationwide were tested in mathematics proficiency. While the results showed that the students had made signi-ficant gains in mathematics proficiency since a study two years prior, only 25 percent or fewer students were deemed as being proficient in mathematics. One-third of the students tested did not even reach the lowest level of performance.

The NAEP published another report in 1996 finding that students at all grade levels showed an increase in scores on the 1996 test, which emphasized reasoning and communication within the mathematical standards identified as priorities by the National Council of Teachers of Mathematics (NCTM). The report indicated that 64 percent of fourth-grade students performed at or above the basic level, 62 percent of eighth-grade students achieved that same level, and 69 percent of the twelfth-grade test takers were able to score at or above the basic level.

Although this report seemed to contain better findings than the 1992 report, the results showed that over 30 percent of the students tested were not able to achieve even a basic level of performance, which means they were unable to achieve "partial mastery of prerequisite knowledge and skills that are fundamental for proficient work at each grade" (NAEP 1996, 8). These results show that educators need to find instructional methods that are catalysts for breakthrough performance and in-depth mathematical understanding for all students.

In today's classroom, mathematics teachers need to teach mathematics differently from the way they were taught mathematics. The world has changed in many ways in recent years. The use and availability of computers and computer technology has multiplied, the Internet has become a common research and communication tool, and videos and video games have become popularized. As a result, students have grown accustomed to various forms of brain stimulation and have come to welcome such forms of stimulation. Teachers lecturing while students take notes and complete routine problems from a textbook does not produce mathematics proficiency in all students. Students are not making the mathematical gains they deserve by working in isolation to complete worksheets or watching the teacher complete problems on the board; these practices do not reach all students (Black 1994). As stated by O'Brien, students need to be active thinkers and not simply memorize the thinking of others (1999). Mathematics needs to make sense to students, and the best way for this to occur is through hands-on learning. Practices must change and new strategies must be employed to help today's students to be successful in mathematics.

Many changes have occurred in the years following the 1996 NAEP study. Suggestions for new educational practices and techniques have flourished. Research shows that the classroom teacher and the strategies employed can and do impact the learner. New strategies (such as actively involving students through the use of performance tasks and problems that provide real-world applications) help students gain a deeper understanding of concepts involved and allow them to be better able to transfer that knowledge to new situations. Metacognitive strategies or reflective pieces written by students are strategies that assist students in developing a new level of understanding because students learn to evaluate their thinking and the processes they use to arrive at solutions. Assessment results can be used to positively drive instruction, and gains in student achievement can be made when students take an active role in the learning process. However, in order to help students be successful, teachers must be willing to adjust, adapt, try new things, and teach in ways that they probably were not taught. Teachers need to step outside of their comfort zones to seek practices that will impact their students.

For educators, increasing student achievement must be a primary goal. Creating a nation of thinkers and active problem solvers who can use their skills in ways that demonstrate true understanding is crucial for student success outside the classroom. Relating schoolwork and textbooks to real-world situations helps students see a purpose for their education. Active engagement in the learning process helps students make the mathematical connections necessary for increased learning and understanding. Rubrics are a necessary tool for promoting student achievement because they provide students with a clear road map that shows how to achieve success by allowing learners to assess their work against criteria for various levels of performance.

About This Book

This book offers methods, techniques, and tasks that can be used to engage learners in the hands-on learning of mathematics. This book establishes the importance of using standards and benchmarks as educational targets to help students understand expected outcomes, and it stresses the importance of rubric development and the assessment process. The performance tasks actively engage the learners while allowing them to have fun in the process.

Each chapter concentrates on a different aspect of rubrics and the assessment process. Strategies and suggestions are based on the research and opinions of top educators and organizations.

The first section of every chapter lays the foundation for suggested practices. The second section, called the Rubric/Mathematics Application, suggests a performance task that relates to the information covered in the first section. A complete explanation of the application is provided, as well as the resources (e.g., task explanations, suggested procedures, rubrics, graphic organizers, charts, and assessments) necessary to implement the task in a classroom. An overview page (see Figure Intro.1) is included in each of the rubric/mathematics applications. This page encapsulates all the important information needed to carry out the performance task. The steps to each task are accompanied by thumbnail versions of the figures that make up the data charts, reflection pages, assessments, and rubrics for the task.

All the performance tasks in this book are based on the National Council of Teachers of Mathematics *Principles and Standards for School Mathematics* (2000). Standards are the backbone of mathematics education and are currently the basis of almost all mathematics education programs in the United States. (More information regarding mathematics standards and their connection to rubrics is discussed in chapter 2.) The various principles and standards each application focuses on are listed in the overview page. The mathematical application in each chapter is designed to allow students to demonstrate their level of understanding of the mathematics standards embedded in the application. Each application states a problem or task, which is to be solved using mathematical skill, reasoning, and communication. The application also includes suggested procedures. These can be used to give direction for students who are not as familiar with performance tasks. (Performance tasks are opportunities for students to apply what they have learned in a real-life application.) For tasks with several steps or for more complex tasks, a task explanation and suggested procedures page is provided to be handed out to students. Each chapter offers Internet resource links that can be used to promote technology research in the classroom, and figures are included in each application that can be copied for classroom

RUBRIC/MATHEMATICS APPLICATIONS OVERVIEW
Page Explanation

STANDARDS Each project is linked to the NCTM Standards.

MATHEMATICS CONCEPTS The concepts related to the performance are listed.

GRADE LEVELS Suggested grade levels are stated, although they can be extended in both directions.

RELATED CURRICULAR AREAS Any curricular areas the project relates to in addition to mathematics are listed.

MATERIALS NEEDED This section lists any necessary supplies. It also states if computers are needed.

TASK The problem is a situation presented to students that sets the stage for a math connection related to the real world.

SUGGESTED STUDENT PROCEDURES The procedures outline what students need to do to complete the task.

TEACHER RESOURCES This is a list of the resource pages included in the chapter. The list indicates the pages that can be used with students.

INTERNET RESOURCES Each Rubric/Mathematics Application includes several Web sites that are excellent resources for math teachers and students.

Figure Intro.1

use. Each application also contains information about how long it will generally take to complete. (Though provided as a number of 45-minute class periods, this time estimation may vary according to the level of the students, if calculators and/or computers are used, and depending on whether teachers incorporate the task extensions.)

All of the mathematics applications in this book have been used with students and have produced outstanding results. Students who need to be challenged have found that the applications allowed them to grow and extend their capabilities, and students who find mathematics difficult have successfully completed the applications and developed a deeper understanding of mathematical concepts and their use. Extensions and simplifications are provided so each application can be differentiated for individual classrooms, students, and grade levels. In this way, low achievers, as well as gifted students, are able to achieve beneficial results. Expansions are also offered that

help extend the performance task into other curricular areas, such as language arts, art, and social studies. Such expansions are important as they incorporate an integrated, multiple intelligences (Gardner 1983) approach to learning. Technology is incorporated throughout the book in many uses; as a reference tool (to locate answers), as a construction tool (to build charts, graphs, or graphic organizers), and as a research tool (to find data).

Teachers can make a difference in the achievement level of their students by providing them with experiences that have an impact on their learning and performance. Students who become engaged in learning through active involvement develop an in-depth understanding of mathematics, how it relates to them, and how it influences the world. The strategies and applications provided throughout this book can help teachers assist students in this process.