

Part One

Implementing Projects in the Math Class

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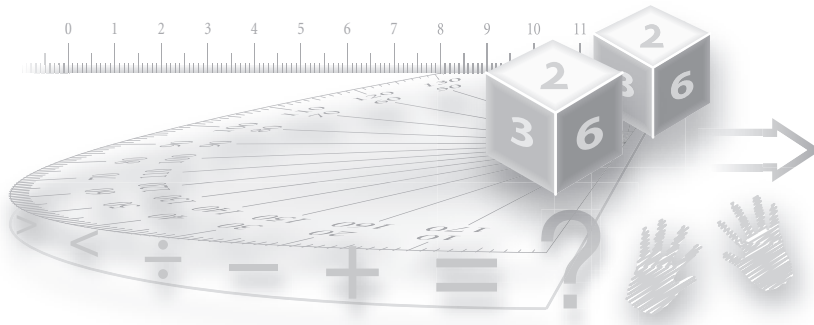
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Chapter One

Overview of projects in the math class

In a well-run math class, computation, problem solving, and critical thinking are all taught. Instead of learning skills in isolation, students learn math in context where they can see how it is applied in real situations. In this way they come to recognize the importance of math in their own lives. The connection between math and the real world is a strong one. This is especially true of math classes in which projects are a significant part of the curriculum.

Filled with activity and enthusiasm, a successful project-oriented math class is a center of individual learning, collaboration, cooperation, and sharing. Students work alone, together, and with the teacher. Along with learning fundamental math skills, students learn to think logically, analyze data, make decisions, and solve multifaceted problems that arise out of real-life situations. Students thus use the skills they are learning in meaningful ways.

Your Role

Your role changes when your students work on math projects. Along with your traditional responsibilities of introducing concepts, demonstrating skills with example problems, and grading the work

of your students, you will become a facilitator and promoter. The horizons of your teaching will expand. More of your time will be spent working directly with individuals and groups. As students work on solving problems, you will circulate around the room, offering advice and suggestions, asking questions that lead to insights or direction, and giving encouragement and praise. Sometimes you may simply monitor a group's efforts or model appropriate behavior. Occasionally you may need to pull a group back on task. (See "The Teacher's Role During Math Projects.")

There are many ways you can incorporate projects into your curriculum. While following your text, you can easily provide regular project activities. You may build time for projects into your schedule, for example, a day or two each week, or do units on projects a few times a year. Some teachers introduce a multistep project and then give students time to work on it at the end of class over the next few days. No matter how you provide the time, you should be consistent. Students not only need sufficient time for working on projects, they need to know when they will be working on them. This information enables students to come to class prepared and ready to work.

Supporting the Standards of the National Council of Teachers of Mathematics

The projects in this book support the Standards of the National Council of Teachers of Mathematics (NCTM), with specific emphasis on the following:

- The Problem-Solving Standard
- The Communication Standard
- The Connections Standard
- The Representation Standard

Problem solving is an essential part of learning mathematics. At its most basic, it requires students to find a solution to a problem without initially knowing what methods or procedures to use. As they seek a solution to the problem, students must draw on their own knowledge, experience, and skills. They may be required to assume various tasks, including conducting research, analyzing and organizing data, and drawing conclusions. In their efforts to discover answers, they reinforce previously learned skills, acquire new skills, and gain a greater understanding of mathematics. By presenting students with a variety of practical, engaging problems to solve, the projects contained in this book support the Problem-Solving Standard and foster the learning of valuable problem-solving skills.

The projects also support the Communication Standard. Because effective communication depends on clear thought and expression, communication encourages students to think critically, formulate their ideas, and express those



The Teacher's Role During Math Projects

Since discovery is an important part of any project, you must encourage your students to assume much of the responsibility for their learning and progress. Your role changes. Along with your traditional duties, you will be spending some of your class time doing many of the following:

- Presenting multistep, critical thinking projects based on real-life situations
- Organizing and monitoring groups so that members work effectively together
- Modeling appropriate behavior and problem-solving skills
- Demonstrating to students what it is to be an enthusiastic problem solver by showing them how you are willing to tackle projects that at first may seem impossible
- Brainstorming with groups
- Guiding students in their research efforts
- Showing students that process is crucial to finding solutions
- Offering suggestions to solve problems
- Offering encouragement and applauding efforts
- Explaining that mistakes are merely stepping-stones to finding solutions and to learning
- Answering questions
- Helping students sort through their thoughts as they consider problem-solving strategies
- Showing students that various strategies may be used to solve the same problem
- Providing sufficient time for working on projects
- Monitoring student behavior and ensuring that classroom procedures are followed
- Keeping students on task
- Evaluating and assessing student progress
- Providing time for sharing results

ideas with mathematical precision. Communication gives students the opportunity to state their ideas, listen to the ideas of others, and compare them to their own, furthering their understanding of math. An important part of every project of this book is sharing results through formal and informal presentations.

Along with the Standards for Problem Solving and Communication, working on math projects supports the Connections Standard. Although students are often taught mathematical skills in isolation or in packets of information, mathematics is a broad, complex subject in which ideas are interconnected, extending throughout the field of math and to other disciplines. As they work on projects, students will find relationships among ideas that will broaden their understanding of problems and solutions, thereby gaining an appreciation of the scope of mathematics and how math is interwoven through all parts of society.

The projects of this book also support the Representation Standard. Mathematical ideas are represented with notations, symbols, and figures. Typical examples of representations include numbers, expressions, diagrams, and graphs. There are many more, of course. As students work on projects, they will express mathematical ideas as representations, which then become tools to explore, model, and develop mathematical concepts. An understanding of mathematical representations will serve students well in their continued study of math.

Perhaps one of the greatest benefits of using math projects in the classroom is how students must draw on numerous skills as they work toward solutions. When students work on math projects, they expand their view of math to real-life situations and develop skills that stretch well beyond the traditional curriculum. Such results support the Standards of the NCTM and enrich the mathematical experiences of students.

Strategies for Problem Solving

The math projects your students will be doing will require computation, analysis, problem-solving and critical thinking skills, and decision making. Since the type and nature of problems vary, there can be no set plan or step-by-step process they can use all the time. You should familiarize your students with various strategies that they can draw on as needed. Emphasize that strategies are methods or procedures that can be used alone or with other strategies. If a student should ask what strategy is best for solving a particular problem, a good answer is, "The one that works best for you." You will likely find that different students will use different strategies to solve the same problem.

While some students may be quite adept at problem solving, many will need guidance, and you may wish to distribute copies of "Problem-Solving Strategies." It is a guide that can help students get started in solving problems and keep them moving along.

There is also much you can do in regular lessons to help students acquire sound problem-solving skills that will be useful to them throughout their lives. See "Helping Students Develop Problem-Solving Skills" for a list of suggestions.

Problem-Solving Strategies

There are many ways to solve multistep problems. If you believe that there can be only one or two, you limit your options and reduce your chances of finding a solution. Following are some suggestions and strategies.

Before you begin seeking the solution:

- Make sure that you understand the problem. This may require rereading it several times.
- Be sure you understand the question and what answers you are seeking.
- Look for "hidden" questions.
- Find the important information that the problem provides, and eliminate information that is not essential. (Sometimes problems contain facts that you do not need.)
- Supply any missing information. You may need to research and analyze data.
- Make sure that you understand any special facts, data, or units of measurement.

As you seek a solution, consider all of these strategies:

- Look for patterns, relationships, connections, sequences, or causes and effects.
- Use guess and check (also called trial and error). Choose a place to start, try a solution, and see if it works. If it does not, try another.
- Organize your facts and information in a list. Sometimes this exercise can show relationships that you might otherwise overlook.
- Construct a table or chart. This is another way of identifying relationships.
- Think logically. Look for sequence and order.
- Rely on common sense. Some answers simply are not possible. Do not waste time pursuing them.
- Sketch or draw a model to help you visualize the problem.
- Simplify the problem by breaking it down into manageable steps. Solve a sub-problem that leads to the solution of a bigger problem.
- Look at the problem from different angles.
- Estimate. Rounding numbers can make it easier to find a solution. Using whole numbers rather than fractions may help you to see operations more clearly.
- Act the problem out.
- Keep notes of your attempted solutions. This will reduce the chances that you will repeat steps that do not move you forward.
- Periodically review your notes and attempts at solutions. By rechecking what you have done, you might see something you overlooked.
- Do not give up. The persistent problem solver finds solutions.

When you believe you have found the answer:

- Double-check your work.
- Be certain that you used all necessary information.
- Recheck your calculations.
- Be sure that your answer is logical.



Helping Students Develop Problem-Solving Skills

You can help your students learn critical thinking and problem-solving skills by doing the following:

- Present students with real-life problems to which they can relate.
- Offer problems that have multiple solutions and can be solved through several strategies.
- Encourage your students to try various strategies in solving problems.
- Organize students into cooperative teams.
- Encourage students to brainstorm for ideas that might lead to solutions.
- Give problems that have missing information *and* too much information. Such problems require students to supply and eliminate data.
- Give problems that tie in to other subjects.
- Encourage students to keep logs or notes of their efforts at solving difficult problems.
- Encourage students not to give up; persistence is a major factor in successful problem solving.
- Require students to write explanations of how they solved problems.
- Remind students to always check answers for logic and accuracy.
- Encourage discussion and the sharing of solutions.

A vital part of any project is the sharing of solutions and results at the end of the activity. When results are shared, students have the opportunity to hear other viewpoints, learn about other methods used to solve problems, and realize that others may have experienced some of the same stumbling blocks they did. Not only does this help reduce an individual's feelings that he or she is the only one having trouble, it also helps build a sense of class community and problem-solving camaraderie.

Sharing may be oral through presentations using technology such as interactive whiteboards or Microsoft PowerPoint, or written in the form of logs or reports. Thus, speaking and writing become essential components of your math class.

Perhaps the biggest factor that holds many students back from becoming good problem solvers is a lack of confidence. Many students doubt that they can solve complex problems and give up with little effort. Explain to your students that problem-solving skills come with practice. Just like anything else—learning to play a musical instrument, excelling at gymnastics, playing computer games—the more they work at solving problems, the better they will become. Distribute copies of "What It Takes to Become a Top Problem Solver" to highlight some of the characteristics that successful problem solvers share. The list can serve as a guide, detailing traits and attitudes that your students should strive to acquire throughout the year.

Creating Your Own Projects

While this book provides projects that require various steps and strategies, you may eventually wish to create projects of your own, designed specifically for your students. Material for math projects is all around you. As you develop projects, keep in mind the following points, which will help ensure that your projects are stimulating and exciting to your students:

- Base your projects on real-life situations that are meaningful to your students.
- Design projects that capture the interest of your students.
- Make sure that your students possess the mathematical skills to solve the problems they will encounter in your projects.
- Develop projects that require analysis, critical thinking, and decision making.
- Create projects that require students to formulate a plan to find a solution.

For suggestions where you can find material from which to create projects for your students, see "Sources for Developing Math Projects."

What It Takes to Become a Top Problem Solver

Top problem solvers share many of the same traits. You can become a successful problem solver. All it takes is practice. The more problems you solve, the more skilled you will become. Try to make the following traits part of your personality.

Good problem solvers are:

- Confident that they can solve just about any problem.
- Persistent in solving problems.
- Willing to try different strategies to solve problems.
- Able to find important information and eliminate unimportant facts.
- Able to recognize patterns, relationships, and connections.
- Able to look at a problem from various viewpoints.
- Open to new ideas.
- Willing to make notes to keep track of their attempts at solutions.
- Able to draw on other experiences in the solving of problems.
- Able to use logic and common sense.



Sources for Developing Math Projects

Good material for creating your own math projects is all around you. The following sources are particularly useful.

- Your math text likely contains sections such as “Challenges” that offer interesting facts or situations that you can easily turn into fine projects. Some texts have sections of data banks that provide information that can serve as the basis for projects.
- The Internet offers vast information on countless topics. Information can be easily found by conducting a simple search by topic.
- National and local newspapers contain an assortment of valuable information. Charts and tables can be especially helpful.
- Regional and national magazines are good sources of information for projects.
- Almanacs and other reference books can provide unusual and interesting data on countless topics.
- Major events at school can be your springboard for creating projects. Use field day, homecoming, the Valentine’s Day dance, or the prom to capture the interest of your students.
- Books of math puzzles and games frequently offer a wealth of ideas for projects.
- Consult with your colleagues and develop projects that include two or more subject areas. Science and social studies in particular share many topics with mathematics.

Conclusion

Without question, math projects offer many benefits to students. Perhaps most important, when students work on authentic problems, they see how the math skills they are learning may be applied to the real world. Math projects open the door to bringing other subjects and disciplines into the math class, and students quickly recognize that math is interwoven through many parts of their lives. Math projects also give students the opportunity to work together cooperatively, share their experiences, and celebrate the solving of problems that might be overwhelming for one person to manage. Furthermore, when students collaborate on a project, students of all abilities have the chance to contribute to the solution. Everyone has a part to play; everyone has a role to fill; everyone can be a contributor to and a sharer in success.