GROUP LEARNING

(modified from "HANDS-ON MATH PROJECTS with REAL-LIFE APPLICATIONS" by Gary Robert Muschla and Judith A. Muschla)

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 an important 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. As fundamental skills are taught, practiced, and mastered, they are incorporated in problems that arise out of real-life situations. Students thus utilize the skills they are learning in meaningful ways.

YOUR ROLE

Your role changes when your students work on math projects. Along your traditional responsibilities of introducing concepts, demonstrating skills via 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 Group Work."

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PROBLEM-SOLVING STRATEGIES

Most of the math projects your students will be doing will require the use of computation, 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 that can be used all the time. You should familiarize your students with various strategies they can use 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's 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.

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 that might have been 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 discussions or presentations, 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 lack of confidence. Many students doubt 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-Iearning a musical instrument, excelling at gymnastics, or playing chess-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 your students should strive to acquire throughout the year.

MANAGING GROUP WORK IN YOUR MATH CLASS

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. Everybody has a part to play, a role to fill. Everyone can be a contributor to and a sharer in success.

A successful math class, where group work is an important part of the course of study, is the result of effective planning and management. As students work on group projects, they will be engaged in various tasks: they will need to consider different strategies, gather and analyze information, confer with each other, manipulate models, perform calculations, and test possible solutions. All this requires an environment that promotes vigorous inquiry, encourages students to assume the responsibility for their learning, and supports both individual and group activities.

We suggest you take part of the class period to introduce and begin the activity. Have students read and restate the activity, distribute any materials students might need, and give students time to plan, brainstorm potential strategies, and get started.

CREATING AND MAINTAINING A POSITIVE ENVIRONMENT

Problem-solving thrives in an environment in which people work on problems that have valid applications to life, feel free to risk making mistakes, and are encouraged to share their ideas. The best problem-solving occurs in classes where students enjoy the freedom to pursue learning in their own way. The tone you set in your classroom, your expectations, and the procedures you maintain are the foundation for such an environment.

Since students usually rise, or fall, to a teacher's expectations, always discuss your goals for the class with your students at the beginning of the year. Share with them how you intend to conduct the class, how the class will be organized, and what will be covered. Note what you expect from them.

For students to work efficiently in groups, they need a classroom that is logistically comfortable for problem-solving. Tables are ideal; however, if you don't have tables, you can push desks together. Either way, you should provide enough room among teams so that they can function as single entities without distractions from other groups. Along with enough space among groups, there should be enough work area for students to discuss possible strategies with each other, confer about data, manipulate and examine models, and work on calculations.

Support problem-solving in whatever ways you can. Bulletin boards, corridor display cases, media center exhibits, and math fairs are just some ways you can draw attention to your program. Always look for ways to highlight lists of problem-solving strategies, interesting articles about math, and the work of your students.

While there is much you can do to promote success in your classes, students, too, must strive to make the class beneficial. This is particularly true during group activities. Your students must be willing to accept more responsibility than is demanded by the traditional class. During group activities, they must remain focused on the tasks. Group work is not a time to talk about who might be named homecoming king or queen. Distributing copies of "The Responsibilities of the Math Student" to your students is an excellent way to share basic expectations for student behavior.

Unquestionably, student learning flourishes in the "right environment." One of your most important tasks as a teacher is to create a classroom filled with enthusiasm, the spirit of inquiry, and the desire to learn. The best classes are founded on the spirit of cooperation and energetic intellectual pursuit, in which it is believed that math can be learned (and enjoyed!) by everyone. For a summary of characteristics of math classes that have a positive atmosphere, see "The Right Environment."

TEACHING SUGGESTIONS

While every teacher has his or her individual techniques and methods, we've found the following plan is helpful in group work and problem-solving. It can be broken down into three parts: (1) Introduction, (2) Work Time, and (3) Wrapping Up.

Introduction

Begin a an activity by presenting the situation and problems to be solved. Having a student paraphrase the project and what needs to be solved can be helpful in clarifying what everyone is to do.

Once students understand the activity, distribute copies of student guide sheets and discuss the information presented there. Data sheets and additional materials, if any, should also be distributed. Having everything they need to begin helps students to see the full scope of the activity.

Work Time

As students work in teams, your task is to circulate around the room, offering help, encouragement, or simply observing. This is also a time to monitor and model student behavior.

Pay close attention that a team doesn't range off the topic. If you see this happening, you might point out their mistake, or nudge them in the right direction. However, avoid giving answers to any problems. If students feel you will provide answers, they will be less inclined to do the hard thinking that will result in finding answers themselves. To encourage students to find their own answers, some teachers insist that they (the teachers) may be asked a question only after the question has been presented to the team and no one else is able to answer it.

As you observe students, you may find that a group has trouble starting. Sometimes this is caused by students not being able to focus the problem. Have, students restate the problem and break it down into parts, concentrating their efforts to identify the most important facts. Groups may also have trouble finding viable strategies that will lead to solutions. In this case, suggest that teams brainstorm various strategies and examine each one to see if it leads to a, possible solution.

As you move around the room, be aware of the interactions of the members of each group. You'll likely see that some groups work well together with everyone sharing ideas, others are dominated by one or two members, and some are just unmotivated. When a team is working well, leave it alone. Merely offering a comment might disrupt its momentum. Remember, an activity is a time for students to discover solutions. If, however, a group is not working well, you should sit in on it and model appropriate behavior. Make sure everyone is participating, and encourage team members to help one another. If necessary, for a time, assume the role of team leader to get things going, then gradually fade into the background as students begin to assume ownership of the activity. In some groups you may need to remind students of the proper procedures and behavior often, especially during the first few weeks of class.

Wrapping Up

Sharing is essential to the successful culmination of a math project. Discussing methods and results helps students to realize that some problems have multiple solutions, which may be discovered through various strategies. This is an important lesson of authentic problem-solving. In the real world, many problems have several solutions and can be solved in many ways. For more information on sharing, see the section "The Importance of Sharing" presented later.

INDIVIDUAL AND TEAM CONFERENCES

As students work on activities, you will monitor the progress of the teams. In many cases, groups will have questions, or you will need to discuss procedures, rules, or behavior. You will undoubtedly be conducting conferences with individuals or the entire group.

A conference doesn't have to be long; in fact, it may last only a minute or two. In most cases it will be conducted at the student's work area. The purpose of any conference is to help students better understand the activity they are working on, as well as help them to improve their understanding of mathematics. Often you may find that students need you only to answer a simple question. In such instances, provide guidance and let them get back to work. However, if an individual or team seems stuck, use this as your starting point for the conference.

Focus any conference on a particular problem or skill. If you try to do too much, you'll only confuse students, or provide them with too much information. Either way, you'll end their efforts to solve the problem. During the conference be sure to keep your tone positive and offer specifics. You may need to point a group in the direction for finding more information, offer encouragement to the group that is about to give up, or assure a group that its efforts are worthwhile.

When you give praise, it should be genuine, because students can tell when it's not. Always avoid negative or sarcastic remarks, for these will only discourage students. The conference should be a time of help and support.

THE VALUE OF COOPERATIVE PROBLEM-SOLVING

In many jobs people work in teams, and the experience your students gain now working together on math projects will serve them not only in your class but in the future as well. Teamwork fosters inquiry and discussion, and students often learn more when working together than they do trying to solve a complicated problem alone. Cooperative learning also provides students with the opportunity to acquire valuable social skills.

When students work in groups, they are more likely to take an active role. It is easier to get involved because the group provides support to individuals. Seeing other team members struggling with the same problems helps students feel less intimidated about offering their thoughts, and many students who wouldn't risk sharing ideas with the whole class usually will share with their group. Furthermore, when they offer suggestions toward the solution of a problem, they receive immediate feedback. This sharing frequently results in a free-wheeling give-and-take of mathematics that is as stimulating as it is useful.

As a group works on a math project, it becomes involved in various activities. Group members need to discuss and assign tasks, reflect on how to approach the problem, test strategies, gather and analyze data, reach solutions, and determine how to justify and share results. Teamwork helps build student confidence, promotes critical thinking, and results in a sense of ownership of the problem.

ORGANIZING YOUR GROUPS

Random groups tend to make the best math teams, although you should reserve the right to make

adjustments. Groups of four to six generally work well for complex projects. With less than four, it's sometimes hard to generate enough ideas, especially if one of the students is absent or is shy or quiet.

You should also change your groups periodically. Rearranging groups allows students to interact with various personalities and see different viewpoints. In the real world, individuals are often required to work with people of varying outlooks and abilities. When making new teams, you can easily switch two members from each of the existing teams. Switching only one member keeps too much of the original team together.

After you have arranged your groups, explain to your students the purpose of working together. Suggest that a group may work most efficiently when tasks are divided. You may also suggest that students assume various roles that will help define responsibilities. For example, one student might serve as team leader. Her purpose is to keep the group on task and guide it toward the solution of the problem. Another might be the recorder, whose responsibility includes writing down the team's ideas, strategies, and conclusions.

Unless your students have worked in teams before, they will probably need training in the procedures of teamwork. You should focus much of your attention on team interaction during the first project. You'll likely need to model behavior and remind students of procedures often, especially in the beginning of the year. Sit in on the various groups and show them how to act and behave. Acquiring the skills necessary for effective group work may take students a few weeks, and distributing copies of "Rules for Working in Groups" can be helpful in discussing expected behavior.

THE IMPORTANCE OF SHARING

Sharing is crucial to projects and problem-solving. Becoming aware of other strategies and solutions can broaden students' understanding of math. Sharing may take the form of an oral presentation or discussion, or be a written log or report.

At the end of a project, you should provide time for groups to share their methods and findings. For oral sharing, the student designated as presenter shares the team's results with the class. Encourage students to discuss successful strategies, as well as earlier strategies that they attempted but that didn't work. It's possible that other teams tried the same strategies, but got different results or experienced different problems. The more math is discussed, the more opportunities students have to gain new insights.

After the presentation, encourage questions from the class. Don't permit questions during sharing, because the presenter might become distracted and may not cover all of the essential points. During questioning, other members of the team may help the presenter, but only one student should speak at a time. This is also the time for members of other teams to offer comments or observations. Emphasize that any discussion should be positive, and don't allow sarcastic or negative statements.

Sometimes you will find that presenters may need help to cover all the issues. Guide students to report the strategies they used, their methods, procedures, and solutions. If a student becomes blocked, a helpful question from you can get him or her started again. Consider asking questions like the following:

How did you divide tasks in your group?

What was your initial plan?

What strategies did you consider?

What problems, or obstacles, did you run into?

What kinds of data did you need to gather?

How do you know your solution is valid?

Are there other possible solutions? if yes, what made you select one over the others?

At the end of sharing, summarize the activity and the results obtained by the various groups. Highlight any unusual strategies or problems encountered, and be sure to discuss how the mathematics employed applies to life.

WRITING IN MATH CLASS

During the last few years, the benefits of writing in math class have become well documented. Writing provides students with a method through which they can examine and share their thoughts about mathematics in a formalized manner. Through writing students can connect concepts they've already learned with new ideas, summarize their understanding of math for themselves, and communicate their thoughts to others. Few will dispute that only when we truly understand something can we explain it and put it clearly into words.

Many types of writing can be done in math class. Some of the most common include:

- Writing about specific problems
- Formal papers
- Biographies of famous mathematicians
- Maintaining a math portfolio

Whenever your students write in math class, encourage them to share their thoughts and information about mathematical concepts, methods, and applications. Avoid allowing students to write about math in ways that show little thought, purpose, or insight. Students should select meaningful topics on which they can share information and their ideas.

In recent years, an extensive amount of research has been done on how people write. It has been found that authors write according to a process that has been aptly named the Writing Process. It's likely that the English teachers in your school are familiar with it. You might consult with your students' English teacher, and if he or she suggests that students use the Writing Process, you should too. You may wish to distribute copies of "The Writing Process," and discuss its stages with your students.

USING CALCULATORS

Skill in using technology is a necessity for many jobs, and will only become more important in the future. Technology should be considered a tool that enables students to focus their efforts on the higher-level skills of problem-solving. If students are more concerned about performing basic calculations with pencil and paper, they will be less concerned with exploring possible solutions to a problem. Rather, they will be more interested in simply "getting the job done," and will be glad to be finished with the tedious task of computation. Imagine a carpenter using only a handsaw instead of a power saw in the building of a house. (Craftsmanship has its limits.)

A FINAL WORD

A math class in which students are actively engaged in working on projects appears, on the surface, to be quite different from a traditional math class. However, a close look shows these seemingly different models have much in common. In both, students are learning math, discipline is necessary, and motivation is crucial. In the traditional math class, however, students sometimes fail to recognize the far-reaching importance mathematics has in our lives. They don't realize that math is just about everywhere. Math activities demonstrate to students that it is. Math projects not only show the connections of math to other subjects, but also offer students the chance to incorporate various skills, strategies, and methods in finding

solutions to meaningful problems.

ASSESSMENT

As the objectives and methods of math teaching change, forms of assessment must change, too. It is through assessment that we, as teachers, can validate the effectiveness of our instruction and evaluate our students' understanding of mathematics. Assessment should always be viewed as an essential part of the learning process, and should involve both you and your students.

You may choose from a variety of tools when assessing your students' work on projects, including: observation logs, checklists, and point systems. Because these assessment methods are flexible, you can tailor them to meet your needs. Combining the assessments of activities with the tests and quizzes of the general curriculum can give you a detailed profile of your students' overall achievement in your class.

OBSERVATION LOGS

As you move around the classroom during project work, you may observe students working individually or in groups. Writing down your observations will provide you with a permanent record of their progress. To reduce your workload to a manageable level, plan to observe only five to ten students per day in each class. Attach individual log sheets to a clipboard and carry it with you around the room, focusing your attention on the students you wish to observe that day.

When completing the logs, you may record items that indicate mathematical thinking, understanding of concepts, insights, or reflections. You might also note behavior. Selecting two or three skills or behaviors to concentrate on reduces the chances you'll feel overwhelmed with things to look for. It's helpful to develop your own system of shorthand using abbreviations, codes, and phrases. For example:

Identify names with initials. "John" becomes "J."

Abbreviate frequently used words. "Excellent" is "ex", "good" is "g," "fair" is I," "well" is "w," "strategy" is "strat," "work" is "wk," "process" is "proc," "question" is "quest," "group" is "gp," "illustrate" is "il," "problem" is "prob."

Use phrases whenever possible. Here's a sample entry on an individual log: "Wked w with gp. Offered sketch to il prob."

Conferences provide a fine opportunity to gain an understanding of your students' growth in mathematics. Simply talking to students about the project they are working on can give you insight to their thoughts and feelings about math.

While you can learn much about your students when they ask you questions, you can also pose specific questions to your students that will help show their understanding of math. Such questions may focus on comprehension of problems, formulation of strategies, procedures, calculations, justification of solutions, relationships between ideas, or group cooperation. Having a list of questions prepared ahead of time can help you zero in on points you wish to address. Since many of the students in a class frequently share the same problems and concerns, asking a few students the same questions will often provide information about the class's general thinking. See "Possible Assessment Questions" for a list of questions that you can ask during observations and conferences.

CHECKLISTS

Checklists are another useful tool for observation. Unlike an observation log in which you write notes detailing the progress of students, a checklist is an assortment of predetermined skills and behaviors. As you observe one of the skills or behaviors on your list for a particular student, you simply check it off. As with the observation log, it's more practical to select five to ten students per day in each class on whom

to focus your attention. While a checklist may include numerous skills, you may decide to concentrate on only a few, selecting those that apply best to particular projects.

A sample "Skills Checklist" is included for your use. You may utilize it in its current form or as a reference for designing your own. The checklist presented here is set up for five days. It also provides space for comments should you wish to record something in more detail.

POINT SYSTEMS FOR PROJECT ASSESSMENT

Some teachers prefer, and many schools require, numerical scores or grades for the work students do. Since most projects are long-term, complex activities, it's not easy, or usually fair, to give students a grade based simply on completion. A system where points are assigned to specific parts of the project is an alternative.

While you can break down point totals to fit your personal grading criteria, the point system that is included in this section-see "Grading Projects via a Point System"-works well for most projects. It is based on a total of 100 points, which can be easily translated to percentages.

Many math teachers feel uncomfortable evaluating the writing of their students. However, with the growing realization that writing should be an integral part of a math curriculum, and that it often has a major role in math projects, more and more math teachers will be reading and commenting on the writing of their students. When your students write about mathematics, they share with you much of their understanding of and attitudes toward math.

When you do grade the writing of your students, select a few points or criteria to focus on. This will make it easier to keep your objectivity. Also, rather than taking a pile of papers home each night to read, take only a workable number. If you try to do too much, you'll become frustrated and probably lose perspective. Concentrate your evaluative efforts on content. Since writers enjoy responses from readers, offer comments to your students, addressing mathematical ideas and issues. Keep your comments upbeat and positive. When criticism is necessary, be sure it contains suggestions for improvement. For more information about grading writing, see "Suggestions for Grading Writing in Math Class."

SELF-ASSESSMENT

A successful math class in which learning is vigorously pursued is a place of continuous assessment on the parts of both teachers and students. While virtually all students expect their learning to be evaluated by their teachers, few have ever been asked to assess themselves. Self-assessment is perhaps the most valuable of any form of evaluation.

Encourage your students to assess themselves. A good place to record thoughts about personal growth in math is in math journals. At the end of a project, ask your students to write a journal entry about the project. Suggest that they include the strategies they used, problems they encountered, and what they learned from the activity.

If you prefer, you may distribute copies of the "Student Self-Assessment." Having students answer these questions will help them to evaluate their own work and learning.

While we, as teachers, continuously evaluate the efforts of our students, it's helpful for us to step back occasionally and assess ourselves. This is particularly true for teachers who are implementing projects for the first time. At the very least, you should assess yourself by considering what went well and what you would do differently next time. Asking yourself the questions contained in the "Teacher Self-Assessment" can be most helpful.

Assessment clearly is an essential part of the program of any classroom. It should be continuous and effective, its overall purpose to promote and assist learning.

The Teacher's Role During Group Work

Since discovery is such 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 multi-step, 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 those seemingly "impossible" projects.
- 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 steppingstones to finding solutions, and to learning.
- Answering questions.
- Helping students to sort through their thoughts as they consider problemsolving 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.

Problem-Solving Strategies

There are many ways to solve multi-step problems. If you believe 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 you understand the problem. This may involve rereading it several times or discussing it with your group.
- Be sure you understand the question and what answers you are seeking. Look for "hidden" questions.
- Find the important information the problem provides, and eliminate information that is not essential. (Sometimes problems contain facts that you don't need.)
- Supply any missing information. You may need to do research, collect, and analyze data.
- Make sure 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 doesn't, try another.
- Write a list, organizing your facts and information. Sometimes this can show relationships that otherwise might be overlooked.
- 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 aren't possible. Don't waste time pursuing them,
- Sketch or draw a model to help you visualize the problem.
- Break down the problem into manageable steps, making it simpler. Solve a subproblem that leads to the solution of a bigger problem.
- Look at the problem from different angles.
- Estimate. Rounding numbers off can make it easier to find a solution. Using whole numbers rather than fractions may help you to see operations more clearly.
- Act out the problem.
- Keep notes of your attempted solutions. This will reduce the chances that you'll repeat steps that don't move you forward.
- Review your notes and attempts at solutions periodically. By rechecking what you've done, you might see something you overlooked.
- Don't give up. The persistent problem-solver finds solutions.

WHEN YOU BELIEVE YOU HAVE FOUND THE ANSWER:

- Double-check your work.
- Be certain you used all the important information.
- Recheck your calculations.
- Be sure 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 or too much information. Such problems will require students to supply or eliminate data.
- Give problems that tie in to other subjects.
- Encourage students to keep logs or notes of their efforts at solving difficult problems.
- 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.

What It Takes to Become a Top Problem-Solver

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

GOOD PROBLEM-SOLVERS ARE:

- Confident 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 upon other experiences in the solving of problems.
- Able to use logic and common sense.

The Responsibilities of the Math Student

A successful math class results from several people working together to learn math. Accepting the following responsibilities is the first step to making your class worthwhile.

- Each day report to class on time and ready to work.
- Remember to bring your text, notebooks, pencils, calculators, and other materials to class.
- Pay attention in class; ask questions when you don't understand something.
- Work hard. *Everyone can learn math*. Finish your classwork and homework.
- Work cooperatively with other students in groups. Share your ideas and be willing to listen to the ideas of others.
- Try various strategies in solving problems.
- Remember that solving complicated, multi-step problems takes time. Be persistent.
- Follow the classroom rules and procedures.
- Behave properly.
- Recognize the importance of math in your life.

The Right Environment

The following characteristics are found in math classes described as having a positive atmosphere.

- The goals of the class are high enough so that students have to work hard, but not so high that they feel frustrated with math and its applications.
- The classroom is built on openness, fresh ideas, and sharing.
- It is believed that everyone-regardless of gender and ethnicity-can learn math.
- Students' work is prominently displayed.
- The classroom is designed to support inquiry and problem-solving.
- The classroom is bright and cheerful.
- The classroom adheres to orderly procedures. Students maintain appropriate behavior and follow the classroom rules.
- Goals and objectives are clear to students.
- Classroom rules are fair and consistent.
- The grading system is reasonable and equitable.
- The teacher interacts with students, and is a guide, nurturer, cheerleader, and provider of information.
- Teachers model problem-solving behavior and share with students their own enthusiasm for finding solutions.
- Math is connected to real-life problems and situations.
- Cooperation is encouraged.
- Enough time is provided for problem-solving.
- Students are encouraged to consider and explain their reasoning during problem-solving.
- Students are encouraged to use various strategies in solving problems. They come to recognize that the same problem may have many solutions.
- Sharing is encouraged, especially how students worked Out solutions to problems.
- Calculators and computers are used whenever technology is appropriate.
- Math is related to other subjects as much as possible.
- Manipulative materials are used whenever possible to show students relationships.
- Students learn the value of mathematics in their lives.
- Students and teachers become partners in learning mathematics.

Rules for Working in Groups

The effectiveness of a group depends on the ability of its members to work together. Keeping the following suggestions in mind can help you and your group work more efficiently.

Each member of the group:

- is responsible for his or her own behavior.
- Should work with other group members.
- Should help other members.
- Should share his or her ideas.
- Should carefully consider his or her ideas before speaking.
- Should give the floor to others after speaking.
- Should listen carefully and politely when others are speaking.
- Should ask questions when he or she doesn't understand something.
- Should strive to keep the discussion on the project, and keep comments constructive.
- Should keep his or her emotions in check. When disagreements arise, they should be discussed calmly.
- Should carry out his or her role in the group the best he or she can.

The Writing Process

When you are writing articles in math, it will be helpful to follow the stages of the Wilting Process. You've probably learned about this in your English classes. Writing can be broken down into various stages, or steps. Authors go through these steps when they write, moving back and forth through the various stages as necessary. Understanding this process can help you with your writing. Following are the stages of the Writing Process.

STAGE 1: PREWRITING

- Thinking of a purpose
- Generating ideas
- Brainstorming
- Researching and gathering facts
- Analyzing ideas
- Organizing ideas
- Focusing ideas

STAGE 2: DRAFTING

- Writing
- Rearranging information and ideas as needed
- Expanding ideas

STAGE 3: REVISING

- Rewriting
- Rethinking, rearranging, deleting, adding
- Clarifying ideas
- Checking ideas
- Conducting more research
- Redrafting

STAGE 4: EDITING

- Proofreading
- Making any final corrections

STAGE 5: PUBLISHING OR SHARING

- Sharing your written work with others
- Producing copies of your work
- Displaying your work

Possible Assessment Questions

Asking students questions about their work can provide you with valuable insight about their progress. The following questions are just some you may decide to use.

- What is this problem asking? How would you explain it to a friend?
- What must you find before you can come up with a solution?
- How are the facts of this problem connected? How does one fact relate to another?
- Is there any information in this problem that you don't need? What is it and why isn't it needed?
- is there any information missing in this problem that is necessary to solving it? How would you go about finding it?
- What strategies might you try to solve this problem? Which do you think is the best one? Why?
- Can the information or facts presented in this problem be arranged in a pattern? In what way? How might that pattern help you solve the problem?
- Would drawing or sketching help you to solve the problem? If yes, how?
- How might you share your understanding of the problem with your group?
- How might your group divide tasks in solving this problem?
- How might your group work more effectively?
- What is the best solution to the problem?
- How can you justify your solution?

SKILLS CHECKLIST

Name _____ Section _____

Project _____

E=Exceptional S=Satisfactory N=Needs Improvement

Skill				Date			
Defines problem							
Identifies useful strategies							
Implements strategies							
Eliminates unnecessary data							
Collects needed data							
Organizes data							
Analyzes and interprets data							
Finds relationships							
Uses models							
Tests strategies							
Demonstrates solutions							
Explains results orally							
Explains results in writing							
Uses logic in arguments							
Makes estimates							
Makes accurate calculations							
Uses technology							
Cooperates with group							
Supports group members							
Shares ideas with others							
Listens to others' ideas							
Remains on task							
Is persistent							
Demonstrates creativity							
Shows enthusiasm							
Tries new ideas							
Takes risks							
Is confident							
Comments:							

STUDENT SELF-ASSESSMENT

Name _____ Date _____ Section _____

Project _____

To evaluate your work and what you've learned during this project, answer the following questions.

1. What did I like about this project? _____

_____

2. What didn't I like about it? _____

_____

3. What strategies did I use to solve the problem? _____

_____

_____

4. Could I have used other strategies? If yes, which ones? _____

_____

_____

5. Did I justify my solution sufficiently? Could I have provided more proof How?

_____

_____

_____

6. What did I learn during this project? _____

_____

_____

Teacher Self-Assessment

Honest answers to the following questions can help ensure that your next project will be even more successful.

- Did I present the project clearly? If not, how might I make it more clear?
- Did the students understand what they were supposed to do? How might I help them understand better?
- Did I arrange the classroom appropriately? What could I change?
- Were the students organized in effective groups? Whom would I change?
- Did I monitor students effectively? Do I know what each student learned?
- Did I ask appropriate questions that provided guidance without "giving away" answers? What was my best question? What was my least effective?
- Did I provide enough time for sharing and discussion upon conclusion? If not, how might I arrange more time in my schedule?
- What would I do differently to improve this project?