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# Flowcharting: A Method of Problem Solving

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by Sheryl A. DeCaprio

## *Purpose*

This unit is designed for use with seventh and eighth grade students as a supplemental activity and as an aid to develop problem solving techniques. This unit would be most beneficial if introduced in the beginning of the school year so that students may develop an understanding of the vocabulary and processes involved, then students may be encouraged to use this alternative method of problem solving throughout the school year.

The attractiveness of computers, computer languages, and computer games is evident, creating in this attractiveness a powerful and motivational learning tool. We have all seen our students on Saturday afternoons, pouring quarters into Space invaders machines or playing with electronic games. We cannot ignore the fact that computers are increasingly becoming part of our daily lives, and particularly,our students lives. Our students will undoubtedly be dealing with and operating computers in any career they choose. An early introduction of the student to computers and its use in problem solving will ensure, for the student, a certain degree of literacy and, proficiency in the usage of computers. We must help them relinquish their misconceptions that math and computers are beyond common knowledge and interesting to only a few crazed mathematicians while helping them develop a healthy attitude towards problem solving. All students would benefit from an introduction into the world of computers.

## *Computer Thinking and Flowcharting*

Computers and computer programming has become an integral part of today's society. The usage of computers appears in the educational and business as well as the scientific fields. Computer usage is a powerful resource and one that will grow and eventually become an integral part of all our lives. With the emergence of computers as an important learning tool, we as educators must also prepare our students for the future. Computer literacy is needed by all students. Computer literacy implies a working knowledge of a math language, the language of programming, and an idea of what computers can and cannot do.

Programming languages are available in many shapes and sizes. Some are science oriented, some business oriented, and some developed for a particular computer system. They all share one similarity, they all are

languages based in logic. A computer is simply a logic machine that performs computations and calculations at an incredible speed. What those of us not associated with computers do not realize is that these units are quite moronic and are only as efficient and effective as the person instructing or programming the machine.

Our students will enter an adult working world and will be faced with computers. They will need to understand and use this facility. Introducing the usage of computers, basic programming skills, and encouraging our children to think logically about solving problems will help them immensely when they enter the job market. The purpose of this unit is to act as an introduction to the thinking world of computers, to help students develop a math language and an alternative methodology that will enable them to solve all problems. This unit is directed specifically to those who still have difficulty deciphering and solving single and double-step word problems.

Most middle school students try to solve a word problem or any mutli-step task by trying to take intuitive leaps at the answer. This method has only two possibilities for solution. The answer is either right or wrong and efforts to solve the problem end. Students have attacked the whole without ever contemplating alternative ways of dealing with the problem. Our students would best solve problems if they critically read each problem and determined what information is given, what kind of answer should be returned, and what steps or calculations are needed to obtain this answer. This need not be so difficult to achieve. The introduction of computers, how computers work, and flowcharting will help students develop ways to handle these problems. Methods must be developed to help students relate the immediate problem to ones they have previously solved. Our students can solve these problems if we can explain how to break large difficult problems into small manageable ones. Again, a step by step procedure to solve tasks. Many of our students believe or have been told that they're just "not good in math". Ideally, with computers as a motivational tool, these students will also be able to achieve success in school mathematics.

The key to developing a child's ability to think logically is to have him talk through or explain how he goes about solving a problem. This method of "talking through" the problem will force them to verbalize an explanation of a problem he may *think* he understands. A child who can explain how to solve a problem, whether it be a mathematical problem or some other task, truly understands the process involved and is not dependent upon rote memorization of a skill. How many students can actually explain how to subtract two numbers when regrouping is involved? Our goal is to help students sit back and think about what must be done before attempting to solve a problem. An efficient and powerful method to use is that of flowcharting a problem. Flowcharts are used in programming to diagram the path in which information is processed through a computer to obtain the desired results. The flowchart will be a general outline of how to solve a problem or perform a task. The chart will not only enable the creator of the chart to solve the problem but other students may follow that procedure as well. Below is an explanation of the symbols used in flowcharting.

## *Flowcharting*

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There flowcharting that help build a method to solve a problem. They are as follows:

I.

*(figure available in print form)*
*START/STOP* : The oval represents the beginning or the end of the chart.

II.

*(figure available in print form)*
*INPUT* : This diagram represents a punch card, a common method of inputting data, and contains any *given* information.

III.

*(figure available in print form)*
*OPERATIONS* : The rectangle contains any of the operations or tasks to be performed on the data.

IV.

*(figure available in print form)*
*DECISIONS:* The diamond will contain yes or no decisions that allow the chart to branch to operations. It is used in more complex charting.

V.

*(figure available in print form)*
*OUTPUT* : The figure represents a torn piece of print out paper and contains the answers or end results of the flowcharted process.

Students will use the above symbols to diagram the process they will develop to perform a particular task. Placing the necessary operations in the appropriate symbols will direct children to think of problem solving as a process involving a logical sequence of steps, each step dependent upon the successful completion of the previous step.

## *Example of Usage of Flowcharts*

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Before students use charting for mathematical problem solving, they can attempt flowcharting problems like the one below. These will help the children “back- up” and think about what they have to do before actually solving the problem. *Remember* , the computer or the flowchart will only perform the tasks you instruct it to perform so each programmer must know what they will do before actually solving the problem.

***PROBLEM* : *FLOWCHART* the process of *FEEDING WILD BEARS.***

*(figure available in print form)*
The preceding chart lists a possible sequence of steps used to feed a wild bear. Students , when diagramming a non-mathematical problem such as this one will learn that the *order* in which a task is completed is very important for a successful finished product. Students will realize that many steps they would normally take for granted, for example “getting the bear food”, is important for the successful completion of the task (one would not want to accidentally awaken the bear without the insurance of bear food’). When programming computers, it is the “obvious” steps that we tend to forget about and so do not receive the desired results. Students, when charting similar familiar tasks, will learn to be very explicit in their directions. This explicit recitation of steps will help the student develop the directional thinking patterns that are so necessary in problem solving.

Students may be asked to design flowcharts of activities they enjoy such as buying a can of soda from a machine, making a peanut butter and jelly sandwich, performing a simple dance step, etc.. The lesson for the students to learn is that end results do not simply appear out of thin air. A sequential process must be followed for a task to be completed. Students will also discover by observing their classmates' charts that some tasks may be approached and solved in many different ways and yet each will obtain the desired results. Too often students view mathematics and any field associated with it, as inflexible and learnable only through memorization. This is a grave injustice to the children and to the field of mathematics. In effect, working of computers and flowcharting will help students assimilate their previously learned skills in computation with an enjoyable, highly motivating lesson about problem solving

The student should be encouraged to draw flowcharts that their classmates may also follow. This will emphasize the need for clear, concise instructions in a sequential order. I find that most children are impressed that their flowcharts) or the order in which they decide to solve a problem, are never necessarily wrong, but usually fixable. It is important for students to realize that an intelligent attempt at finding the answer to a problem is just as important as obtaining the correct answers. We, as educators, can unconsciously place entirely too much emphasis on right and wrong rather that on the thinking process involved. Students will benefit from this "ungraded" thinking process and in the long run, will develop a new thinking pattern for solving problems.

## *Application to Mathematical Word Problems*

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Students should eventually feel comfortable about designing flowcharts to complete tasks outside the realm of mathematics as they know it. Practice in this exercise will direct students to pay attention to the details and the order of events. Students can now apply this logical thinking process to solve the word problem that appear in math class. Below are three examples for flowcharting lessons. One for adding decimal numbers, one for finding Least Common Multiple, and one for finding area of a geometric figure. Students may develop general flowcharts to save and use again for similar problems or may write a chart to describe the solution to a specific problem. The choice is their own, although a collection of flowcharts describing basic mathematical operations and formulas can be used throughout the year and would be a tremendous resource for each student.

### *A. Addition of Decimals*

Write a flowchart to describe the process of solving the following word problem. Find the given information, decide what must be done and how to accomplish the task.

> Raul went to the grocery store and bought a loaf of bread for 69¢, a gallon of milk for $1.14, and a dozen of eggs for 97¢. He paid for the groceries with a ten dollar bill. What was his change?

Students must determine that this is a two part problem. First an addition problem to determine the total cost of the groceries and secondly, a subtraction problem to determine his change from the ten dollar bill. A possible flowchart of the problem is diagrammed in Figure I.

Although this may seem involved it is important for students to understand the process through which the numbers are placed as well as the computational skills needed to carry out the operation. The decision box may be omitted in this chart as it serves only to introduce and additional dimension to the problem, one of

sufficient information.

*FIGURE* I Flowchart the addition of decimals.

*(figure available in print form)*

### *B. Least Common Multiple*

Write a flowchart to describe the process to find the Least Common Multiple of two numbers.
*(figure available in print form)*
In each case the task at hand is divided into smaller manageable steps that can be easily performed. Students now have a general method for finding Least Common Multiples. A flow diagram can be referred to whenever the students must solve a similar problem.

### *C. Flowchart a formula for a geometric figure.*

Flowchart the following word problem:

> Roberta wants to grow spaghetti in her back yard. She has cleared a rectangular patch of land with a width of one inch and a length of sixty inches. How much fertilizer does she need to cover the area of her garden.

Students must recognize that:

1) it is an area problem

2) the dimensions are given

3) the formula for area of a rectangle is length x width

*(figure available in print form)*
Again, students have a general chart how to find area of any rectangular figure. Students should be encouraged to keep a notebook of charts explaining how to perform certain tasks. The use of general flowcharting techniques, especially those used to find area and perimeter, also help students adapt to the concepts of using variables and formulas, an important concept for children to grasp and necessary for math literacy.

A child who is able to develop a process for solving problems will achieve success in school and develop a healthier attitude towards learning. Flowcharting gives the children a direction and a method to decipher and decode the problems they, at one time, would not attempt. Practice and reinforcement of these skills will enable our students to solve any problem, and build their confidence in their own problem solving skills. To “think like a computer” that is to approach a task in a logical, sequential order, is to reorganize their thinking patterns and achieve success in developing problem solving techniques.

## *LESSON PLAN SUGGESTIONS*

I. Write a flowchart to explain how one buys a can of soda from a soda machine.
II. Place students in pairs and have one student instruct the other as to how to make a can of frozen orange juice. The “computer” child must only perform the tasks the “programming “ child gives. Have students discuss where problems occurred and how they “de-bugged” or corrected-their difficulties.
III. Have students “talk-out” the process of adding numbers together. Include in the discussion why regrouping is necessary.
IV. Play Computer Class. Assign groups of children to be INPUT DATA teams, OPERATIONS teams, DECISION teams, and OUTPUT teams. Each group has a set task to perform based on instructions given to them by another team. Watch how the transference of information is accomplished. Have students discuss the information processing involved.

## Teacher Bibliography


Alcock, Donald. *Illustrating BASIC: A Simple Programming Language* .. Cambridge University Press, Cambridge, 1977. Simple explanations of programming in the BASIC language. Clear enough for the general reader.

Davidson, Charles H., Koenig, Eldo C.. *Computers: Introduction to Computers and Applied Computing Concepts* . John Wiley and sons, Inc. ,New York, 1967. Introduction to how and why computers work. Good, if not dated, explanations. Somewhat technical.

Hatfield, Larry L. . .”A Case and Techniques for Computers: Using Computers in Middle School Mathematics.” Arithmetic Teacher, Vol.26, No.6 (feb 1979) An excellent article introducing the possibilities of computer usage in middle school classrooms.

Klienberg, Harry. *How You Can Learn to Live With Computers* . J.B..Lippincott Company, Philadelphia, 1977. An amusing book describing computer technology and its’ basic usages in laymen terms. Good for those who have no experience with computers.

Papert, Seymout. *Mindstorm: Children, Computers and Powerful Ideas* . Basic Books, Inc., Publishers/New York,1980. Extremely interesting concepts are explored concerning learning, computers as a form of learning, and development of learning skills in all children. Fascinating theories with interesting implications for education and mathematics in the future.

Piper, Roger. *The Story of Computers* . Harcourt, Brace, and World, Inc., New York, 1964. Comprehensive study of computers, their history and its applications to possible careers. Informative.

Schneider, Ben Ross Jr.. Travels in Computerland. Addison-Wesley Publishing Company, Inc., Reading, Mass., 1974. A humanist’s impression of the potential for good and evil of computers in our society based on the authors’ experience. Fun reading.

Skypek, Dora Helen. “Teaching Mathematics: Implications form a theory for Teaching Language Arts.” Arithmetic Teacher, Vol.28,No.7 (March 1981) Interesting study showing parallel concerns for the teaching of language arts and its applications to teaching mathematics as a language.

Whiteside, Thomas. *Computer Capers* . Thomas Y. Crowell Company, New York, 1978. Tales of electronic thievery, and white collar crime.

Wiebe, James H. “BASIC Programming for Gifted Elementary Students.” Arithmetic Teacher, Vol.28, No.7 (March 1981) Report on the study of a group of children introduced to programming in BASIC during a summer school session.