Problem Solving Strategies

RATIONALE:

Being able to identify problem-solving strategies is an important skill in any situation. Hypothesizing and estimating solutions are good techniques, and trial and error may be acceptable in some situations, but logical, reasonable strategies will serve the student best. There are a number of problem solving strategies that have been developed. It is important for students to learn these techniques so he/she can employ them and solve problems better and easier. Just as problems in the real world are not constrained, so too the problem solver is not limited to using only one technique. Some problems challenge us to apply more than one technique to solve them. There is no need to reinvent the wheel when proven techniques can be learned first. It is very beneficial for students to appreciate at a young age that there is "more than one way to skin a cat" and some problems are not solvable with the information and power available to us.

CONCEPT DEVELOPMENT:

Some practice in problem-solving of any kind will be useful. All students will have vast informal experience at this. Even the youngest students will have practiced formal problem solving of several kinds in school (working backwards, following directions, using an equation and possibly others), through solving arithmetic problems.

SOME PROBLEM SOLVING METHODS

- Eliminating Unessential Elements
- Determining Insufficient Data
- Guess and Check
- Working Backwards
- Following Directions
- Employing an Equation/Math Expression
- Estimating
- Using Manipulatives
- Drawing a Diagram
- Making a Model
- Looking for Patterns
- Inductive and Deductive Reasoning
- Making a Table/Graph
- Using a Simulation
- Making a Venn Diagram
- Eliminating Possibilities
- Checking for Reasonableness
- Bracketing Limits

ACTIVITY 1:

Equipment	
Technique	Eliminating Unessential Elements
Level	Elementary/ Intermediate/Advanced

The teacher should devise some problems containing information that has no bearing on the real problem. The problems should correspond in complexity with the level of the student for whom they are developed. Before one can solve any problem, the problem must first be defined. Knowing what is irrelevant so it can be discarded allows one to simplify situations and focus on the real issues. This is an important skill for problem solving of all types.

The students should be instructed to read the problem developed by the teacher, and draw a line through those elements that have no bearing on the real problem. Then they should rewrite and rephrase the problem so it is as simple as possible and easy to understand.

An elementary example follows:

The Problem:

How far away from his home is John allowed to ride his bicycle?

The Facts:

John, who is 7 years old, lives on Elm street. His mother said he can only ride his bike three blocks away and no farther. His sister is 9. Her name is Ellen. She can ride her bike farther. This is not fair, because John's dog always goes with him for company. John's dog is named Blackie. John thinks Blackie does not especially like Ellen, because Blackie growls at her. After talking to his father about bike riding, John asked his mother again to let him ride his bike farther, but she said "No." John's father said he could ride 4 blocks away, if it was OK with his mother.

ACTIVITY 2:

Equipment	
Technique	**Determining Insufficient Data**
Level	**Elementary**

For this technique, the teacher should present the students with facts and then ask questions, some of which are beyond the scope of the facts. The students should identify those problems for which there is insufficient data to solve.

The following are elementary examples of problems based on the previous story for which there is insufficient data to solve:

- Why doesn't Blackie like Ellen?
- Why is John's sister allowed to ride her bike farther than John?
- Why does John's father think 4 blocks is OK, but his mother says only 3?
- What time was it when John spoke with his father?

... and one problem for which there is sufficient data to solve:

- How much younger is John than his sister?

ACTIVITY 3:

Equipment	Tempest
Technique	Bracketing Limits
Level	Elementary

Using Tempest, the teacher should use different colored ping pong balls (or draw numbers or shapes on white ones, anything so the balls are distinguishable from each other). Two students should work at the console simultaneously, but independently from one another. Each student should each be given a written set of instructions, indicating which balls he/she is to place in his/her scoring tube. The teacher should include some balls which are beyond the reach of each student's robot to reach. The students should be instructed to note next to each ball on the list, whether they placed it in the scoring tube or not. If not, they are to tell why not. It is suggested that the students be told that the teacher would like them to capture all the balls and that they are to work alone. Allow the fact that the problem is beyond the limits of the robot to emerge. A discussion of limits may follow when all students have had a turn.

ACTIVITY 4:

Equipment	RoboArm
Technique	Bracketing Limits, Employing an Equation or Math Expression, and Drawing a Diagram
Level	Intermediate

The following is an example of a "compound" problem for intermediate students:

Mrs. Brown is the grandmother of Tommy. She is old, but she is not the oldest living person in the world. The oldest person in the world is about 120 years old. Mrs. Brown is not even 100 yet. Her daughter is Tommy's mother. Tommy is 10 and his mother is 28 years older than Tommy. His grandmother is more than 20 years older than Tommy's mother. Between what ages must Tommy's grandmother be? (The answer is between 59 and 99. Students may argue for 58, and that's an OK answer, too!)

ACTIVITY 5:

Equipment	RoboArm
Technique	Bracketing Limits
Level	Advanced

The teacher should hang a wire or string from the ceiling of the classroom with a hook on the end. From it the teacher should suspend something (a cube, box, anything actually) to represent a generator. The "generator" should be within RoboArm's reach in 2 dimensions, but outside its work envelope in the third. In the RoboArm Operators' Manual are diagrams showing RoboArm's work envelope — from the side view and from the top. The teacher should refer to this diagram to position RoboArm as indicated.

> *Note:* It's easier to affix the wire conveniently, and then to move RoboArm under it until RoboArm is positioned correctly.

The teacher should make string and yardsticks or 12 inch rulers available to the students. The teacher should copy the RoboArm work envelope diagrams from the Operators Manual and give a copy to each student or student pair. The teacher may wish to explain the work envelope diagrams to the students prior to their beginning this Activity.

The students should be told the following scenario: They are on the space station Mir. At this time, they have enough electricity stored in a battery for a week, if they use only the minimum. It is dark and miserably hot in there using only the minimum. Not having to conserve their supply so drastically would certainly be good! The generator they need to remedy the situation has been sent to them. It is outside their spacecraft. They must pick it up and bring it in using their robotic arm, RoboArm. However, it is not in a great position, which creates a problem: if they try to bring it in and are unsuccessful, they will use up 95% of their existing power. They will die before Earth can help them with another generator. Should they attempt it or not?