Problem Solving in the Classroom

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In order to function adequately in society one must have some command of logic. Judging arguments for or against a topic requires some type of deductive reasoning. The argument may be in the form of a television commercial, a newspaper article covering a political candidate, or a discussion between two co-workers about the horrible calls made by yesterday's baseball umpire. Regardless of the setting, a competent citizen must be able to draw conclusions from a list of given or inferred facts. Small situations such as those stated above occur every day. The person who does not know how to effectively apply deductive reasoning to a problem is often lost in confusion.

Logical thought is a skill, and like any other skill it must be practiced before it is mastered. This practice can be initiated in the middle-to-upper elementary classroom. Logical problems needn't be scientific or intellectual in order to be effective. Simple everyday situations which employ deductive thought will do. Of course, to many mathematicians logic is a succession of

letters and equations which are utilized to prove a scientific or mathematical fact. Logic does not need to be this formal to be useful in the elementary classroom.

On the other hand, elementary school reasoning can be a basis for mathematical success. Many studies have shown that boys perform better than girls in math. "By the end of secondary school, young men are quite superior to young women in respect to mathematical ability" (Stanley et. al., 1977, p. 115). However, girls are the superior in verbal ability after age eleven (Stanley et. al., 1977, p. 116). If these two qualities are combined in the right doses, problems could be devised which rely on verbal abilities, yet which practice step-by-step reasoning which is often found in mathematical problems.

One possible combination is the logical puzzle. The puzzle rarely uses figures unless they are ages or salary figures which pertain to the problem's subject. The puzzle is usually written in sentence or paragraph form and includes a list of clues from which the correct answer is derived. This unit on logic problems for the classroom is presented in order to introduce children painlessly to deductive reasoning. If these problems are taught as a game and the children enjoy them, students will be more likely to pursue such thought processes on their own when the need arises.

Introduction to Problem Solving

In order to teach a class how to solve a problem creatively and well, the instructor first must be able to solve it. Even the simplest logic problem can be baffling if one does not know how to begin to complete it. As a guideline to problem solving Dewey's 1910 paradigm will be used. This will later be simplified and rephrased for use by the class under the heading Rules for Good Detectives. Dewey's steps to problem are as follows:

> "1. Felt need or difficulty observed.
> 2. Difficulty or problem situation located and problem defined (formulated).
> 3. One or more possible solutions suggested.
> 4. Consequences considered and evaluated.
> 5. Solution accepted at least tentatively."
>
> (Stanley et. al., 1977, p. 157).

These steps apply to each problem that will be used in this unit as well as any you might use on your own. If the same steps are applied every time to the puzzles they soon cease to be mysterious. Sometimes they cease even to be puzzles and turn into a simple game. To illustrate, let's use the first problem which will be presented to the class.

> Tom and Danny are twins.
> They both like ice cream.
> One likes chocolate best.
> The other likes vanilla.
> Which boy likes which ice cream?

Clues:

1. Neither boy ever eats the other's favorite flavor.
2. Danny likes the color of his ice cream to match the color of his cone.
3. Danny and Tom cannot buy brown cones.

By reading through the problem once the solution is clear to an adult. However, this sequencing of facts is not that obvious to a ten-year-old child. Using Dewey's model, the problem will be solved step by step. All clues are present. They simply need to be joined together so that they point to a solution.

First, a need or difficulty must be present. The need here is evident -- to solve the puzzle which has been presented. Next the problem must be defined. In logic problems this is usually stated in question format in the puzzle itself. The problem statement here is "Which boy likes which ice cream?"

Possible solutions must then be formulated. This is the most difficult part of the logic problem. In order to derive a solution the facts must be examined. Facts of this problem are:

1. One boy likes chocolate ice cream.
2. One boy likes vanilla ice cream.
3. Neither boy eats the other's flavor.
4. Danny likes the color of his ice cream to match the color of his cone.
5. Danny and Tom cannot buy brown cones.

The statement that Danny and Tom are twins is irrelevant to the problem. Their enjoyment of ice cream in general simply helps to structure the situation. It does not add anything to the solution.

Two of the five isolated facts on the previous page were taken from the introductory paragraph. This will often be the case, since some information is needed to create the problem in the first place. Facts which are given in the problem itself and in the following clues can be assimilated to determine the solution. With the addition of some basic guidelines any logic puzzle is solvable. 1. Assume that girls' names belong to girls and boys' names belong to boys, as in Thomas and Susan. Do not assume this to be true, however, with neutral names such as Corey, Kelly, or Terry. 2. Assume that situations in the problems are similar to everyday life unless otherwise stated. 3. Never jump to conclusions. If these general rules are incorporated with given clues, the problems will become much more simple.

Once the clues have been isolated the solver is on his way to a solution. Taking the first three given facts together, it is seen that each boy likes a flavor of ice cream and that neither flavor is alike. So far the problem has been easy. From this point deductive reasoning must be utilized.

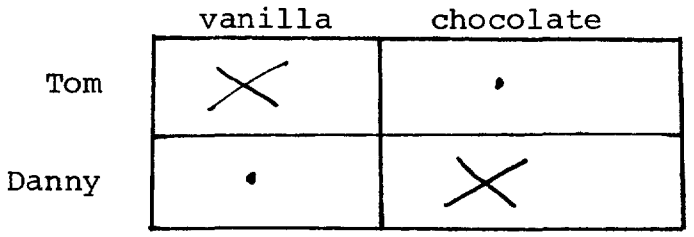
The last two clues in this puzzle give the solution. "Danny likes the color of his ice cream to match the color of his cone." This tells the student that Danny either eats vanilla ice cream on a white cone or chocolate ice cream on a brown cone. The next statement, "Danny and Tom cannot buy brown cones," cancels the option of chocolate ice cream on a brown cone. Brown cones are not available to the boys. Therefore, Danny must like vanilla ice cream which matches a vanilla-colored cone. If Danny likes vanilla then Tom must favor chocolate.

Possible solutions for this problem are that Danny likes vanilla ice cream or that he likes chocolate. If his preference to chocolate is accepted, the clues which have been given were not used. The clues make the chocolate ice cream option void. Since the clues have been written into the problem for the purpose of solving it, the chocolate ice cream is not a good choice for Danny. In coming to this conclusion sections four and five from Dewey's list have been combined. Possible solutions were suggested and the consequences to those solutions were evaluated. One solution follows the succession of clues; one does not.

The final step is to accept the solution to the problem, at least until something better comes along. Since everything fits together well the problem has been completed.

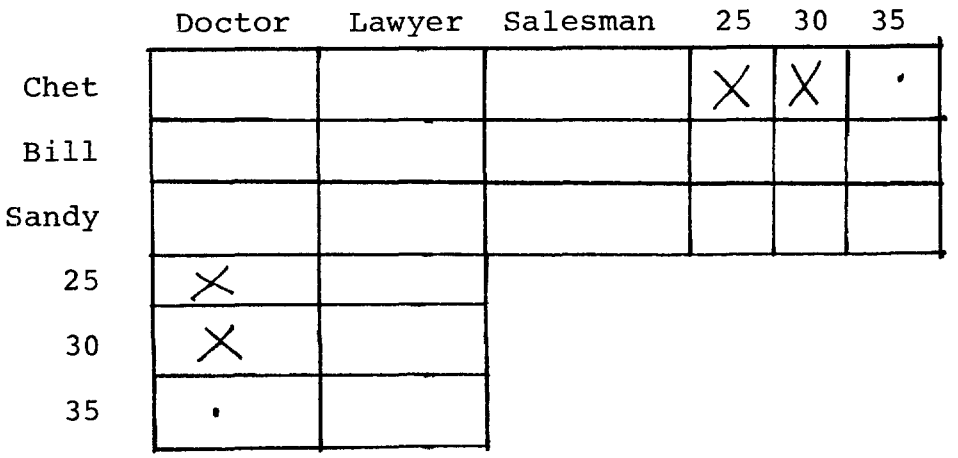
Each logic problem must be solved in this way. Especially with smaller children, the instructor cannot jump from point to point without establishing some type of sequence or link to the clues. This confuses elementary children and it makes the problem seem much more difficult than it is.

If the problem is lengthy or complicated, a graph of the information can be helpful. For the problem of Tom and Danny a picture of the results was not necessarily needed. If it had been utilized it would have looked like this:



If Danny doesn't eat chocolate, then according to the graph he must eat vanilla. Since the boys don't like the same kind of ice cream, Tom must eat chocolate and not vanilla. This solution is self-evident with the use of the graph above.

Depending upon the number of variables used in the problem, a graph might look like this:



This graph plots three variables such as name, age, and occupation. When one portion of the problem is determined to be positive, a dot is placed into that box and the rest of the options are cancelled as shown above. (Chet is 35 years old. This narrows other alternatives, and Bill and Sandy must be either age 25 or 30).

These graphs assist in organizing the information from the clues in the puzzle. With tight organization the puzzles are easier to solve. Now that you have solved a logic problem it is time to teach the class. The following lesson plans will serve as a guide to the unit.

Lesson Plan for Question-Clue Problems

Objective: To guide the students through the solution to a logic puzzle from the first reading to the conclusion.

Materials: Enough copies of the logic problem for the class.

Procedure:

a. Write the entire problem on the board.

b. Tell the students they will be playing detective to solve the puzzle.

c. Say to the students that as detectives they will have to solve the problem systematically.

d. Write the following Rules for Good Detectives on the board:
   1. What is the exact problem or "crime" that needs to be solved?
   2. What are the clues?
   3. How do the clues fit together?
   4. What is the solution to the problem?
   5. Check: do all the clues fit the answer?
   6. Redo the solution if necessary.

e. Have a student read the above "Rules." Discuss how a good detective needs to put his finger on the problem before he can solve it.

f. Discuss how a good detective assembles all the clues to his puzzle and tries to put them together before he jumps to a conclusion.

g. Discuss how a detective takes his solution from the clues and then re-checks his answer against the clues. If his solution does not mesh with the clues he must change it.

h. Ask the students if they have any questions.

i. Distribute copies of the problem to the class. Then return to the written problem which is still on the board. Using the Rules for Good Detectives solve the problem.

j. Ask a student to state the problem which needs to be solved.

k. Ask another student to come to the board and underline all the clues he can find in colored chalk. Has he found them all? Ask the students.

l. If no one can find any more clues and the student has missed one or two, point to them and explain why they are clues. Underline them.

m. If no additional clues are found, continue with the problem after checking for questions.

n. Explain how the clues fit together to form a solution. Guide the students in determining an answer to the problems through the given clues.

o. Once the clues have been explained and grouped logically on the board, ask a student to state or restate the solution.

p. Do all the students agree with the solution?

q. Does the solution fit all the clues?

r. If the solution fits the clues, congratulate the class on good detective work.

s. If it does not, guide the class in finding the correct answer.

t. Sketch the four-square graph on the board. Quickly rework the problem with the graph to show how it is used when working a problem. Tell students that most of the puzzles they will receive have accompanying graphs in case they would like to use them.

Results:

Evaluation:

Facts Plus Thought Equal Answers

The lesson plan for the question-clue problem can be used for most types of logic problems. Many times the process will be easier for both the instructor and the students if the problem is mimeographed along with a corresponding graph. Each student can then be given his own copy of the problem and he can work at his own pace in his seat while you demonstrate on the board. Some students will be able to work more rapidly at these problems than others, so it is best that each student have his own copy.

Students may be momentarily confused at the sight of the later logic problems in this unit. The clues are not listed below an introductory sentence or paragraph. Instead, they become part of the paragraph itself which explains the situation and asks the problem question.

Once the students are adept at the question-clue logic problem, they are ready to move to a more difficult type of puzzle. Here the clues are not so blatently stated. Students must think on their own to devise the answer from the clues. The second lesson plan will cover problems of this type.

Lesson Plan for Paragraph Problems

Objective: The student will think through and solve correctly logic problems which have few or no blatently stated clues.

Materials: Copies of logic problem for the class.

Procedure:

a. Each student will be given a copy of the problem.

b. Have a student read the problem aloud.

c. Use the Rules for Good Detectives. What is the problem which needs to be solved?

d. Write the problem question on the board.

e. Ask the class if all agree on the main problem in the puzzle.

f. What clues are given in the puzzle? With class assistance list them on the board.

g. How do the clues fit together? Discuss the problem. What are some possible solutions? List them as well.

h. What solution is the most probable?

i. Does the class (or the majority) agree?

j. Check: does the solution you've chosen fit the details of the story?

k. If it does, the problem is solved. If it does not, rework the solution using all the available clues.

Note: By this time the class should be familiar with the Rules for Good Detectives, so they need not be written on the board. A spoken reminder should be enough to engage the class in "Detective Thinking."

Results:

Evaluation:

Working Together

Thus far the class has been exposed to problems which are worked by one person. The class can contribute to the example on the board if it likes, but such participation is not required to solve the problem. All the facts are before each student.

Every class needs to work together, and the group type of logic problem affords the class this opportunity. The group problem is the basic logic problem with a twist. Each problem is divided into six parts and given to six members of the class. The members of the group are to read their sections of the problem aloud, but they may show their slips of paper to no one. Clues may be read as many times as necessary for the group to agree upon a solution.

For the class which is already excited about puzzles and problems, group work adds challenge. Problems progress more slowly when tackled in this fashion, expecially in the beginning while everyone tries to piece together the clues. Once a link has been found the remainder of the puzzle usually fits together quickly and easily.

Lesson Plan for Group Logic

Objective: A group of six students will work together to solve a problem of logic.

Materials: Logic problem whose clues have been separated into six strips.

Procedure:

a. Distribute to a group of six students the separated parts of a group logic problem.

b. Tell the students they will be working on a problem together.

c. Explain the rules of the problem to the group.
   1. They may show no one their slips of paper.
   2. They may read their clues aloud to the group.
   3. Clues may be read as many times as needed to solve the problem.
   4. Each person's clues are different, and each set of clues must be read in order to solve the problem.

d. Send the group to a corner and allow them a reasonable amount of time and noise. Conversation is needed to solve the problem and at times the group could become loud.

e. Check the group periodically to see that the students are progressing.

f. Have a spokesman for the group explain the group's solution.

g. If the answer is not correct, point out the clue the group has missed and allow them to adjust their solution on their own.

Results:

Evaluation:

Creativity Exercises for Whiz Kids

Most problems of life, unlike those on paper, are not based on pure logic or pure creativity. They call for a combination of the two problem solving techniques, and the student who wishes to successfully solve them needs exposure to both.

This unit has emphasized a logical approach to problems. Now everything must be combined from the pages before -- logic, thought, and cooperation -- and added to a spark of creativity. This mixture lends itself to the solving of yet another type of puzzle, the Mind Game.

Mind Games are logic problems which require more thought and creativity than normal problems. They begin with no clues whatsoever. Mind Games can utilize a whole class, a group of ten, or a pair of students. They consist of a situation which is usually stated in three to four sentences. Then class members must ask questions which can be answered "yes," "no," or "that information isn't necessary to the solution of the problem." These problems can be difficult to solve, and they require patience on the part of the solver.

Before the class moves to Mindgames, however, it should become familiar with a few creativity exercises to oil the wheels of imagination. Begin with something

simple. How many uses can the class think of for a paperclip? a baseball card? a brick? (Remember to require an answer from everyone). Go around the room, and beginning with the letter A and progressing to Z, ask for a word which starts with the letter. Ask for names, places, objects, or animals whose names begin with each letter of the alphabet.

Ask someone to describe life as a circus performer, a ghost, a murderer, a king. Ask the class questions which require them to think on a completely different track. Which is taller, the color orange or air? Why? Discuss the answers that you receive from the class. Your students may consider you a little strange, but they will be thinking.

Use your imagination. Possibilities for creativity exercises are endless. Once creativity has been introduced to the class, it's time for Mind Games.

Lesson Plan for Mind Games

Objective: Class members will ask pertinent questions toward the solution of a problem situation, and they will solve the problem itself.

Materials: A Mind Game

Procedure:

a. Explain to the students that they will be working as a class (or as a group) on a problem.

b. Tell the class that this problem has no clues, but that they will have to determine the facts of the case by asking questions.

c. Read the problem.

d. Give the class a sample pertinent question. It should be answerable by "yes" or "no."

e. Explain that all questions will be answered with "yes," "no," or "that question won't help you solve the problem."

f. Let them think. Answer any questions according to the rules.

g. If the class becomes stumped, help them with a clue or two.

h. Periodically repeat to the class the information which has already been determined by them.

i. Near the end of the problem help the class to reconstruct the information they have. This will alleviate frustration and lead to a more coherent solution.

j. After a close "I know what happened" guess has been made, tell the class the actual situation of the crime or problem or help the student to reconstruct the situation completely.

Results:

Evaluation:

Question-Clue Problems

Ice Cream Fans

Tom and Danny are twins.

They both like ice cream.

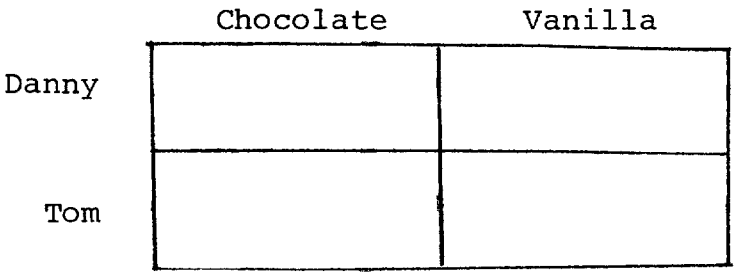
One likes chocolate best.

The other likes vanilla.

Which likes which ice cream?

Clues:

1. Neither boy ever eats the other's favorite flavor.
2. Danny likes the color of his ice cream to match the color of his cone.
3. Danny and Tom cannot buy brown cones.



The New Puppy

John bought a puppy. He chose between three: a brown pup, a black pup, and a gray and white pup. Which one did he buy?

Clues:

1. The brown pup wore a green ribbon around its neck.
2. The gray and white pup wore no ribbon.
3. The black pup wore a red ribbon.
4. The pup John bought had one brown eye and one blue eye.
5. The brown pup had brown eyes.
6. John's pup wore a ribbon.

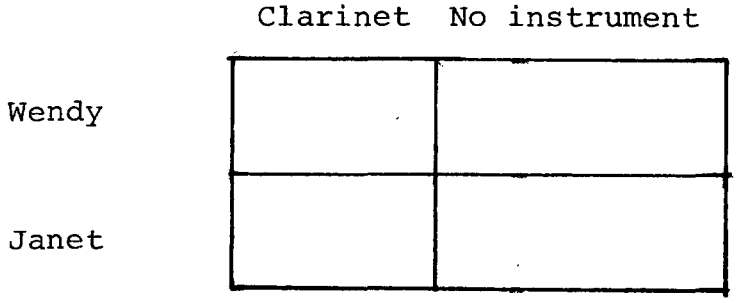
				Ribbons		
	Brown	Black	Gray/White	Green	Red	No
Brown/Blue eyes						
Brown eyes						
Other eyes						
Green ribbon						
Red ribbon						
No ribbon						

Who Likes Math?

Wendy and Janet are in the same class at school. One girl likes math better than she does English, and the other girl likes music better than she does math. Who likes math best?

Clues:

1. Wendy plays the clarinet.
2. Neither girl likes art.
3. Janet is good at problems.
4. The girl who likes math best does not play a musical instrument.

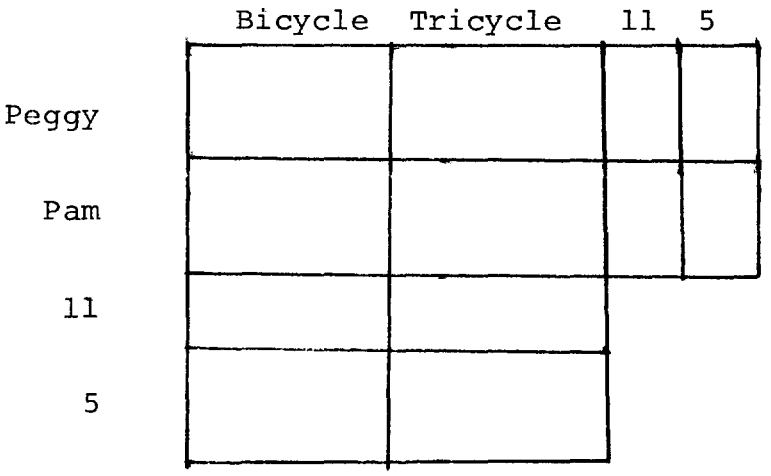


Whose Bike Is Whose?

Peggy and Pam each received a bike for Christmas. One bike was a tricycle and the other was a bicycle. One of the girls is 11. The other is 5. Who received the bike and what are the girls' ages?

Clues:

1. Peggy and Pam are sisters.
2. The girl with the tricycle has blonde hair.
3. The tricycle owner is the younger of the two sisters.
4. Pam is a brunette.



Paragraph Problems

Haircuts

Mr. Bushyhead was driving through a strange town when he decided to stop, park his car, and get a haircut. He asked a boy where he could find a barbershop.

"We have only two barbers in this town," said the boy. "One of them has a shop at the north end of Main Street and the other has a shop at the south end."

Mr. Bushyhead walked north on Main Street until he reached one of the barbershops. It looked as if it hadn't been cleaned in two months. Cut hair was all over the floor. The barber himself needed a shave and his haircut looked terrible.

Mr. Bushyhead walked in the other direction until he came to the second barbershop. It looked neat and cheerful inside. The floor had been swept. The barber was neatly dressed, freshly shaved, and had a neat haircut. Why did Mr. Bushyhead walk back to the first barbershop to get his haircut?

Gardner, M. (1969). Perplexing puzzles and tantalizing teasers. New York: Simon and Schuster. 42.

Transportation Problem

John saw in a newspaper that there was to be a big display of airplanes in a month's time. Unfortunately the place where the show was to be held was a good 25 miles away, and there were no trains or buses going directly to the spot.

John's father wanted to see the plane show as well, so he took John to the local Rent-a-Car to see if they could hire a car to take them.

"H'm!" said the garage owner, who thought he was very clever. "That week is not good. You see, on Monday I have to take a group to the beach. On Tuesday I have to go to old Mrs. Jones' funeral. Wednesday is my day off, and Thursday there's a big sale in town. I know I'll be booked up then. Friday and Saturday I have to be here for weekend visitors. Looks like I can't take you."

John's father looked disappointed, but John just grinned. "Right," he said. "We'll go Tuesday."

The owner grinned back. "I see you're no fool, young fellow. Tuesday it is!"

Why was John so sure about that particular day?

Walls, F. (1970). Puzzles and brain twisters. New York: Franklin Watts. 37.

The King's Trick

Seeing a need to remove one of his advisors, old King Rudolph III, being of sporting blood, placed two pieces of paper in his crown. He then asked the doomed man to remove one of them and show it to a judge standing by. If the paper was marked with an X, the advisor was to be set free. If it was unmarked, he would be put to death. The crafty old king had left both pieces unmarked, however. But when the judge was shown one of the papers, he could do nothing but release the prisoner. Why?

Hirsch, T. L. (1966). Puzzles for pleasure and leisure. New York: Abelard-Schuman. 95.

Group Problems

Farmer Leon's Crops

Problem: Farmer Leon planted his crops this year. What were the positions of each vegetable in his garden?

1. The beets did not touch the corn.

2. He planted the corn behind the onions.

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3. Eggplant is hard to grow.

4. Tomatoes were planted next to the eggplant.

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5. The onions were diagonally across from the tomatoes.

6. The eggplant was on a corner of the plot.

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7. The tomatoes were in the middle with the beans.

8. All the crops grew well this year.

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9. Farmer Leon planted corn, tomatoes, onions, beans, eggplant, and beets.

10. The beets were to the left of the beans.

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11. Farmer Leon planted orange tomatoes and green onions.

12. The farmer forgot to plant potatoes.

/ corn / eggplant / beets /

/ tomatoes / onions / beans /

Who Plays Which Sport?

Problem: What are the names of the best class athletes in track, football, and baseball?

1. The track star and Bill are twins.
2. The three athletes are named Bill, Shelly, and Janet.

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3. Janet and the track runner are best friends.
4. The baseball player is an outfielder.

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5. Bill is so busy training he doesn't have time to play baseball.
6. The athletes all live in the same neighborhood.

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7. All the athletes eat balanced meals.
8. Janet and the football player trade notes during class.

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9. Bill and the baseball player sit together in the cafeteria every day.
10. All these athletes are in the same class at school.

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11. Janet and Bill live next door to each other.
12. The school is proud of Bill, Shelly, and Janet.

Lost Treasure

Problem: Three divers located treasure in the ocean. Who were they and what did they find?

1. Treasure was found on the Calypso Lady.

2. Tony, Shirley, and Allen were the divers.

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3. Tony and the diver who found the jewels went down together.

4. Shirley and Allen are married.

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5. Tony was the first to spot the sunken ship.

6. The treasure's worth was estimated at 22 million dollars.

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7. The divers located gold, silver, and jewels.

8. Allen is more excited about his own find than he is about precious metals.

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9. Shirley found her treasure by diving alone.

10. Tony, Shirley, and Allen plan to split the final profits evenly.

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11. The two divers who searched together found gold and jewels.

12. All three treasure hunters work for a salvage company in Florida.

Whole Class Participation -- Mind Games

Mind Games

1. After the train passed by they were found dead. Who were they and what happened?

"They" are two fish in a bowl by a picture window. When a nearby train passed by the home it jolted the bowl, which fell off the table. The bowl broke with the fall, and the fish could not survive without water.

* * * * * * * * *

2. On his way home from work each day, Mr. Smith rides the elevator to his apartment. On rainy days Mr. Smith takes the elevator to the 24th floor, where he lives. On sunny days he only rides to the 17th floor and walks the rest of the way by stairs. Why?

Mr. Smith is a midget. With his umbrella tip on rainy days he can reach the button to the 24th floor. Without it he can only reach to the 17th floor button, and must walk the rest of the flights of stairs by himself.

3. The minute he saw the cabin, he knew how they had died. Who were they and how had they died?

The cabin is the front of an airplane. The plane crashed with a pilot and navigator (or passenger) in the cabin. It crashed in a wooded hillside. The biggest challenge here is to make the students see "cabin" in a creative way -- as something other than a home made of logs.

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4. A woman walks into a restaurant and asks the man behind the counter for a glass of water. The waiter pulls a gun from under the counter and points it at her. The woman smiles and thanks him. Then she leaves. What happened?

The woman who walked into the restaurant had the hiccups. The waiter who pulled the gun on her scared the hiccups out of her. Her problem gone, she thanked the waiter and left.

More Difficult Mind Games

1. If he had seen the sawdust, he wouldn't have died.

The man was a midget clown. He couldn't see the sawdust because he was blind. When he awoke one morning and grabbed his cane, he found that it was shorter. He automatically assumed he had grown. Because he had been billed as the "Shortest Man in the World" in the circus, he assumed he would be out of a job. Therefore, he shot himself. If he had been able to see the small amount of sawdust on the floor of his bedroom, however, he wouldn't have died. He would have known that his cane had been cut and that he had not grown.

* * * * * * * * *

2. A woman is found guilty of murder by a jury, yet the judge cannot sentence her to prison. Why?

The woman was guilty of murder, but could not be sentenced because of her sister -- a Siamese twin. Although one was guilty of a crime, the innocent sister could not be sent to prison. Since the innocent cannot be sentenced in good conscience, the judge had to release them both.

Solutions to the Problems

Ice Cream Fans -- Danny prefers vanilla ice cream while Tom likes chocolate.

The New Puppy -- John's puppy was black. It wore a red ribbon and had one brown eye and one blue eye.

Who Likes Math? -- Janet likes math better than Wendy because she does not play a musical instrument. Wendy plays the clarinet.

Whose Bike is Whose? -- Pam is a brunette, age 11, and rides a bicycle. Peggy is blonde, age 5, and rides the tricycle.

Haircuts -- Mr. Bushyhead went back to the barbershop at the north end of Main Street. Since the town only had two barbers, they must cut each other's hair. The man's hair on the north end of the street looked terrible. The barber's hair on the south end was very neat. Since the neat man's hair was cut by

the barber at the north end of the street, Mr. Bushyhead went there for his cut.

Transportation Problem -- John knew that the owner could not schedule a funeral weeks in advance. Therefore, he must be lying, and he was actually free on Tuesday to take John and his father to the show.

The King's Trick -- The advisor had an idea that the King would try to trick him. When he pulled a slip of paper from the King's crown, he immediately swallowed it without opening the folded sheet. Then the man handed the other piece to the judge, saying that he chose the piece he had swallowed. Since the paper in the judge's hand had no X, the swallowed paper must have held the X. The King could not admit that neither slip was marked, so the advisor was set free.

Farmer Leon's Crops -- The corn, tomatoes, and eggplant are in the back row. In front are the onions, beans, and beets.

Who Plays Which Sport? -- Bill plays football, Janet is the baseball player, and Shelly runs track.

Lost Treasure -- Tony found gold, Shirley located silver, and Allen found the jewels.

Mind Games -- The solutions to each Mind Game is with its problem question.

References

Gardner, M. (1969). Perplexing puzzles and tantalizing teasers. New York: Simon and Schuster. 42.

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Walls, F. (1970). Puzzles and brain teasers. New York: Franklin Watts. 37.

Appendix

Suggested Additional Readings

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Burns, M. (1976). The book of think. Boston: Little, Brown, & Co. 128 p.

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Gardner, M. (1961). Mathematical puzzles. New York: Thomas Y. Crowell. 114 p.

Gerstig, J. L. & Kuczkowski, J. E. (1977). Yes-no; stop-go. New York: Thomas Y. Crowell. 34 p.

Harnadek, A. (1981). Mind benders -- deductive thinking skills. Pacific Grove, CA: Midwest Publications. 30 p.

Summers, G. J. (1983) Mind teasers. New York: Sterling. 128 p.

Yawin, R. A. (1976). Math games and puzzles. Middletown, CN: Xerox. 90 p.