

Problem Solving

I can do it, and so can you.

Here's how.

Learning a Skill

- In general, to learn a skill (golf, driving car):
 1. Skill is demonstrated to student
 2. Student is directed and guided while practicing
- What about analytical reasoning skills?
 - It goes on inside the head – hard to demonstrate
 - Hard to direct and guide student

Excerpted from *Introduction to Problem Solving* by Clifford A. Shaffer, Dept. of Computer Science, Virginia Tech
copyright © 2007 Clifford A. Shaffer

Thinking Aloud

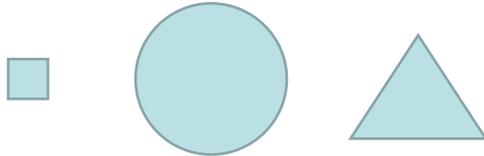
- The most effective way to expose the process is to verbalize our thinking process
 - This is hard work! Not our normal mode
 - Need to be careful to explain every step
- Demonstrate analytical reasoning by watching problem solvers solve problems while thinking aloud
- Practice problem solving by thinking aloud to a partner

Pairs Problem Solving

- We will use the technique of Whimbey & Lochhead
- The partners have distinct roles:
 1. One partner should read and think aloud.
 2. The other partner is the listener
 - Continually check accuracy
 - Demand constant vocalization
- Thinking is a skill... but it is largely invisible
 - So we need to do everything possible to make it visible during this process

Problem 1

Draw the following figure.



If the circle above is taller than the square and the triangle is shorter than the square, put a K in the circle. However, if this is not the case, put a T in the second tallest figure.

Problem 2

Write the word, sentence.

If the word *sentence* contains less than 9 letters and more than 3 vowels, circle the first vowel. Otherwise circle the consonant which is farthest to the right in the word.

Characteristics of Good Problem Solvers

- Positive attitude
 - Belief that academic reasoning problems can be solved through persistence, as opposed to believing “either you know it or you don’t”
 - Engage a confusing problem
- Concern for accuracy
 - Actively work to check your understanding
- Break the problem into parts
- Avoid guessing
 - And don’t jump to conclusions
- Active in problem solving
 - Do more things as part of the process

Problem 3

Bill, Judy, and Sally have the occupations of teacher, plumber, and teamster but not necessarily in that order. Bill is shorter than Judy but taller than Sally. The plumber is the tallest and teamster is the shortest. What is Judy’s occupation?

Role of the Listener

Crucial role, hard work.

1. Continually check accuracy

- Catch errors
- Must work along/understand every step
- Don't let solver get ahead of him/herself
- Point out errors, do not correct

2. Demand constant vocalization

- Solver must spell out EVERY step

Not a passive role!

Problem 4

Write the letters A and B on your paper.

If the second letter in the word *west* comes after the fourth letter in the alphabet, circle the letter A. If it does not, circle the B.

Getting Started with a Problem

- “Eighty percent of success is showing up.”
 - Woody Allen
- To successfully solve any problem, the most important issue to get actively involved.
 - The Principle of Intimate Engagement: You must commit to the problem
 - “Roll up your sleeves”
 - “Get your hands dirty.”

Easy vs. Hard Problems

- Easy problems: See the answer
- Medium problems: See the answer once you engage
- Hard problems: You need strategies for coming up with a potential solution, sometimes for even getting started

Effective vs. Ineffective Problem Solvers

Effective: Believe that problems can be solved through the use of heuristics and careful persistent analysis

Ineffective: Believe "You either know it or you don't."

Effective: Active in the problem-solving process: draw figures, make sketches, ask questions of themselves and others.

Ineffective: Don't seem to understand the level of personal effort needed to solve the problem.

Effective: Take great care to understand all the facts and relationships accurately.

Ineffective: Make judgments without checking for accuracy

Mental Toughness

- Need the attributes of **confidence** and **concentration**
 - Confidence comes with practice
 - Attack a new problem with an optimistic attitude
- Unfortunately, it takes time
 - Need to develop a life-long habit

Engagers vs. Dismissers

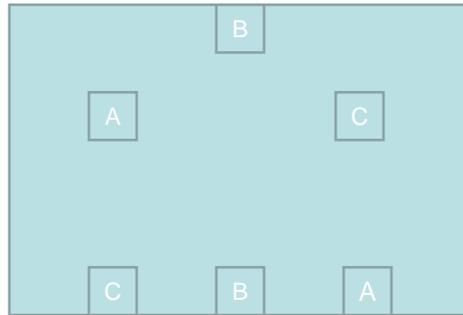
- Engagers typically have a history of success with problem solving.
- Dismissers have a history of failure.
- You might be an engager for one type of problem, and a dismitter for another.
- You can “intervene with yourself” to change your attitude of dismissal

The Mental Block

- Many students do significant problem solving for recreation
 - Sudoku, computer games, recreational puzzles.
- These same students might dismiss math and analytical computer science problems due to a historical lack of success (the mental block)
- To be successful in life you will need to find ways to get over any mental blocks you have
- Learn to transfer successful problem-solving strategies from one part of your life to other parts.
 - Example: Writing is a lot like programming

Example Problem

- Copy the figure below. Connect each box with its same-letter mate without letting the lines cross or leaving the large box.



Engagement Example

- Cryptarithmic problem

$$\begin{array}{r} AD \\ + DI \\ \hline DID \end{array}$$

“Real World” Engagement Examples

- Repairing something (dryer, toaster, etc.)
- Dryer example: Clean it out
- Wobbly table example: Look for the loose parts
- Car seat example: Reattach spring wire
- “Taking the time”
- You **can** screw something up or do something dangerous. But often you are not faced with such a prospect.
 - Some domains require that you study/practice/build expertise to be effective
 - The act of engagement can help you build domain knowledge

Overcoming Procrastination

- (Writing/programming/project) procrastination
- Just sit down and write, don’t care about quality to start
- Write whatever part of the document/program appeals. Don’t do it start to finish.
- Schedule to work. Milestones, etc.
 - Commit to someone outside if that helps
 - Invent deadlines if you are deadline driven
- Do part of it at a time, over time
 - People don’t write books, they write sections or pages
 - People don’t write programs, they write functions, etc.

Verbal Reasoning Problems

- For this type of problem, we need to parse the text into the proper steps
- Then we need to sort out the steps
- Since they can get long and complicated, we usually need to resort to a diagram (externalize the information)

VR Problem 1

José is heavier than Fred but lighter than Marty. Write their names in order of weight.

VR Problem 1 Solution

- For these problems, as we work in pairs to solve them, we need to spell out the steps involved.
 - We will try having the solver take notes during the process
- Step 1: José is heavier than Fred... [He would be placed above Fred on the diagram.]
- Step 2: ... but lighter than Marty. [So Marty is placed above José in the diagram.]

VR Problem 2

Jack is slower than Phil but faster than Val.
Val is slower than Jack but faster than
Pete. Write the names in order of speed.

VR Problem 2 Solution

- Step 1: Jack is slower than Phil... [He would be placed below Phil.]
- Step 2: ... but faster than Val. [This says Jack is faster than Val. Val is added below Jack.]
- Step 3: Val is slower than Jack... [We already knew this.]
- Step 4: But faster than Pete. [Val is faster than Pete, so Pete comes below Val.]

VR Problem 3

If Dumani and Fred are both richer than Tom, and Hal is poorer than Dumani but richer than Fred, which man is the poorest and which one is the next poorest? Write the names of all 4 men in order.

VR Problem 3 Solution

- Step 1: If Dumani and Fred are both richer than Tom...

The problem does not indicate whether Dumani and Fred are actually equal to each other. So they can be represented at the same level for now, both above Tom.

- Step 2: ... while Hal is poorer than Dumani but richer than Fred...

This means that Dumani and Fred are not equal; Hal is between them with Dumani richest.

Tom is poorest and Fred is next poorest.

VR Problem 4

Paul and Tom are the same age. Paul is older than Cynthia. Cynthia is younger than Hal. Is Paul older or younger than Hal?

Other Diagrams

- Some problems are best supported by a 2D table.
- Some problems need another approach to organizing the information, such as a graph.

VR Problem 5

Three fathers – Pete, John, and Nick – have between them a total of 15 children of which 9 are boys. John has 1 more child than Pete, who has 4 children. Nick has 4 more boys than girls and the same number of girls as Pete has boys. How many boys each do Nick and Pete have?

VR Problem 5 Solution

	Boys	Girls	Total
Pete			
John			
Nick			
Total			

VR Problem 6

On a certain day I ate lunch at Tommy's, took out 2 books from the library (The Sea Wolf and Martin Eden, both by Jack London), visited the museum and had a cavity filled. Tommy's is closed on Wednesday, the library is closed on weekends, the museum is only open Monday, Wednesday, and Friday, and my dentist has office hours Tuesday, Friday, and Saturday. On which day of the week did I do all these things?

VR Problem 7

Belle, Irma and Steven are engaged in the occupations of librarian, teacher, and electrician, although not necessarily in that order. The librarian is Steven's cousin. Irma lives next door to the electrician. Belle, who knows more facts than the teacher, must drive 45 minutes to visit Irma's house.

What is each person's occupation?

VR Problem 8

Sally loaned \$7 to Betty. But Sally borrowed \$15 from Estella and \$32 from Joan. Moreover, Joan owes \$3 to Estella and \$7 to Betty. One day the women got together at Betty's house to straighten out their accounts. Which woman left with \$18 more than she came with?

VR Problem 9

Lester has 12 times as many marbles as Kathy. John has half as many as Judy. Judy has half as many as Lester. Kathy has 6 marbles. How many marbles each do Lester and John have? You do not need to use algebra to solve this problem.

Six Myths about Reading

1. Don't subvocalize when you read
2. Read only the key words
3. Don't be a word-by-word reader
4. Read in thought groups
5. You can read at speeds of 1000 or more words a minute – without any loss of comprehension
6. Don't regress or re-read

There are no short cuts to comprehension!