Problem Solving an dCreativity

Steve Mazza

Naval Postgraduate School
Monterey, CA

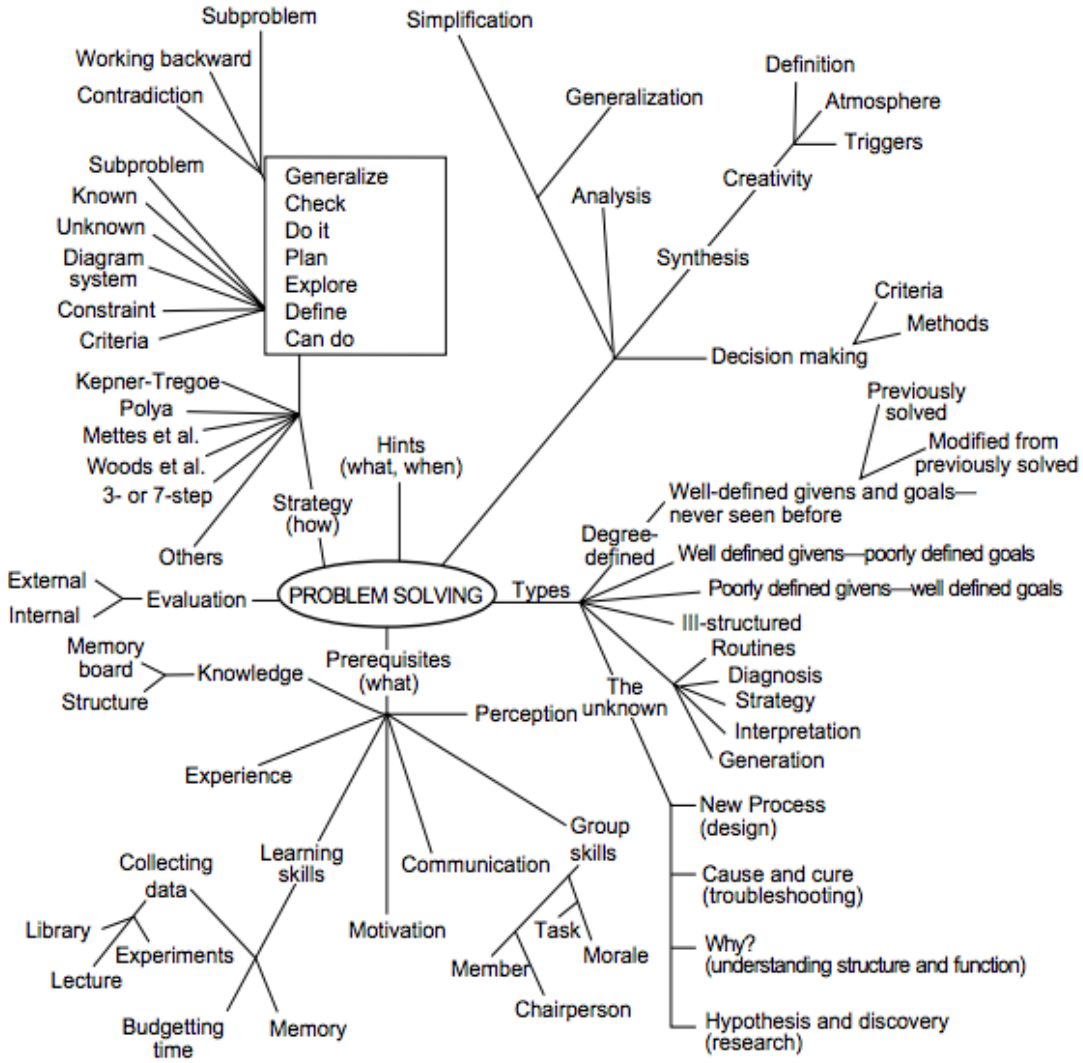
SE4920, Summer/2014

Introduction

We will...

- Briefly discuss some ideas about problem solving
- Compare novice and expert problem solvers
- Propose a strategy for problem solving
- Discuss teaching problem solving
- Discuss creativity

Overview Of Problem Solving



Novice vs. Expert

Differences

Characteristic	Novices	Experts
Memory	Small pieces, few items	Chunks or patterns, 50,000 items
Attitude	Try once and then give up	Persistent, confident
Categorize	Superficial details	Fundamentals
Problem statement	Inaccurate	May redefine several times
Simple problems	Work backward	Work forward with known procedures
Strategy	Trial and error	Known strategy
Information	Don't know what is relevant	Recognize and draw inferences
Parts	Does not analyze parts	Proceed in steps, look for patterns
Sketching	Not done	Considerable time here

Novice vs. Expert

Differences (continued)

Characteristic	Novices	Experts
Limits	Do not calculate	May use to bound solution
Equations	Memorize or look up	Use fundamental relations to derive
Solution procedures	Uncomplicated	Equation and solution method are same
Monitoring progress	Does not	Checks off versus strategy
If suck	Guess, quit	Use heuristics, persevere
Accuracy	Not concerned	Very accurate, check results
Evaluation of result	None	From broad experience
Mistakes	Ignore	Learn, adapt
Actions	Sit and think	Sketch, subvocalize
Decisions	No clear criteria	Understands decision process

Problem Solving Strategies

0. I can
1. Define
2. Explore
3. Plan
4. Execute
5. Check
6. Generalize

Getting Started Or Unstuck

Heuristics

1. Simplify the problem and solve limiting cases.
2. Check for under/over simplification.
3. Relate the problem to something familiar.
4. Generalize the problem.
5. Try substituting in numbers.
6. Try solving for ratios.
7. Be sure there actually is a problem.
8. Change the representation of the problem.
9. Ask questions about the problem.
10. Concentrate on the parts of the problem that can be solved.

Getting Started Or Unstuck

Heuristics (continued)

11. Be a good listener and maintain group harmony.
12. Use a plus-minus-intersecting (PMI) approach when presented with possible solutions.
13. Use a mixed scanning strategy.
14. Alternate working forward and backward.
15. Take a break.
16. Seek hidden assumptions and look for what you forgot to use.
17. Apply a control strategy.
    1. What are you doing?
    2. Why are you doing it?
    3. How will it help you solve the problem?
18. Focus on the fundamentals.
19. Guess the solution and check the answer.
20. Ask for help.

Teaching Problem Solving

- Problem solving should be integrated into the entire curriculum.
- Students need to solve problems to learn how to solve problems.
- Neat, regular structure and process is useful.
- Present a combination of application, analysis, synthesis, and evaluation problems.
- Cover all steps of a problem solving strategy.
- Verbalization during problem solving is very useful.

Creativity

Creativity

"...A novel and unexpected way of defining or solving a problem which leads the observer to ask, 'How did you think of that?"'

- Required divergent thinking.
- Usually appears at the *define* or *explore* step.
- Is only part of the problem solving step (must be proven to be valid).

Importance Of Creativity

"Engineering is an art as well as a science, and good engineering depends upon leaps of imagination as well as painstaking care."

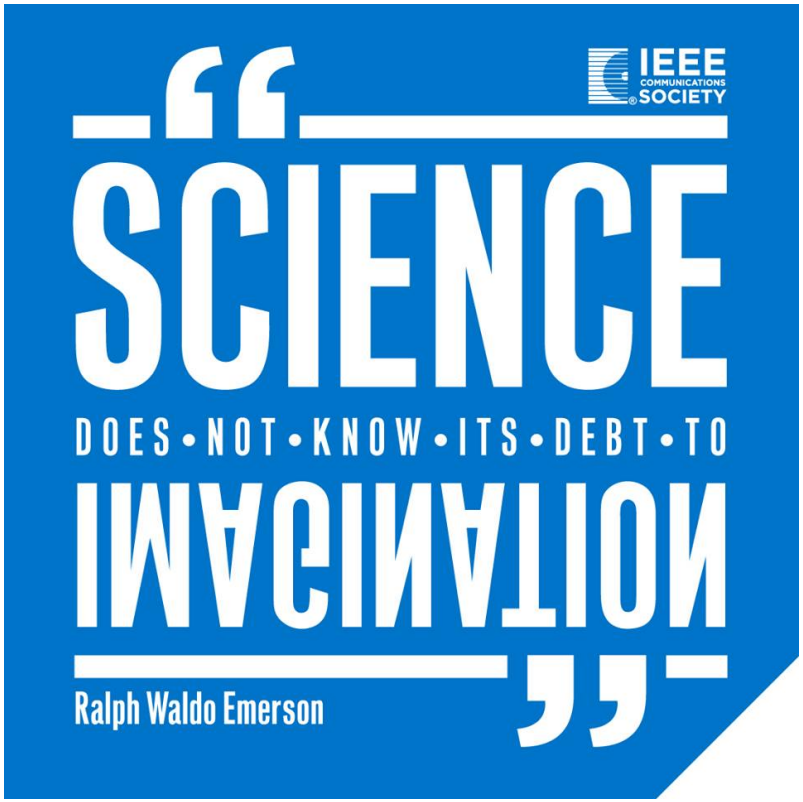
Creativity

Creativity Paradox

- Everyone is born with creativity.
- Creativity increases until about age 8.
- Creativity tends to decrease with further education.
- Engineering requires creativity.
- Engineers are educated.

Creativity

Fostering Creativity



1. Tell people to be creative.
2. Teach/foster creative methods.
3. Accept creative results.

Creativity

Fostering Creativity (continued)

Fostering creativity

- Develop creative solutions to a problem.
- Talk about different ways to interpret the problem statement.
- List many possible solutions to the problem.

Brainstorming

1. Develop a lot of ideas.
2. Build on the ideas of others.
3. Make no criticism during the development phase.
4. Evaluate the ideas afterward.
5. Further develop promising ideas.

Creativity

Heuristics

The following may help with creativity.

1. Have many ideas.
2. Reverse the problem.
3. Build on a random stimulus.
4. Think of something funny about the problem.
5. Think of analogous solutions in nature.
6. Develop word lists of stimulus words, properties, or key concepts.
7. Use checklists or keywords to trigger different ways of looking at a problem.

Creativity

Acceptance of Creative Solutions

- Be careful of criticism. Make it positive.
- Use the Plus, Minus, Intersection (PMI) approach.
  - First note the *plus* aspects of an idea.
  - Then note the *minus* aspects of the idea.
  - Finally note the *intersecting* aspects that can be built on.
- Praise creative solutions.

Summary

We should now be able to. . .

- Describe differences between novice and experts with regard to problem solving.
- List the steps of a problem solving strategy.
- Propose methods for getting started or unstuck.
- Relate problem solving to engineering.
- Relate creativity to problem solving and engineering.