



Problem-Solving Strategies

Arthur Engel

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Problem-Solving Strategies is a unique collection of competition problems from over twenty major national and international mathematical competitions for high school students. The discussion of problem solving strategies is extensive. It is written for trainers and participants of contests of all levels up to the highest level: IMO, Tournament of the Towns, and the noncalculus parts of the Putnam Competition. It will appeal to high school teachers conducting a mathematics club who need a range of simple to complex problems and to those instructors wishing to pose a "problem of the week," "problem of the month," and "research problem of the year" to their students, thus bringing a creative atmosphere into their classrooms with continuous discussions of mathematical problems. This volume is a must-have for instructors wishing to enrich their teaching with some interesting non-routine problems and for individuals who are just interested in solving difficult and challenging problems. Each chapter starts with typical examples illustrating the central concepts and is followed by a number of carefully selected problems and their solutions. Most of the solutions are complete, but some merely point to the road leading to the final solution. Very few problems have no solutions. Readers interested in increasing the effectiveness of the book can do so by working on the examples in addition to the problems thereby increasing the number of problems to over 1300. In addition to being a valuable resource of mathematical problems and solution strategies, this volume is the most complete training book on the market.

Problem-Solving Strategies Details

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Hessam says

Yeah! best book!!

Soumyadip Banik says

happy

Ainun Najib says

A must read for mathletes :-)

Akhil says

Classic book for anyone interested in elementary mathematics and problem solving

Sabyasachi Mukherjee says

I really liked this book when I read it in high school. It has numerous problems ranging from hard to routine and can be used effectively for training for mathematical contests and for problem solving in general.

Anuwaya says

it's very pure and nice book thanks engel for this marvelous book

Maurizio Codogno says

La mia recensione: <http://xmau.com/notiziole/archives/00...>

Murilo Andrade says

Another gem every problem solver or math olympic should have on the shelf. It encapsulates problem solving techniques in a handful of concepts, providing several examples and a whole bunch of problems (around 1300 I guess), most of them with solutions or advanced hints.

The book is divided into chapters consisting of a "strategy" or a subject. The range of problems is really wide, and sometimes are quite difficult. In my opinion there is a missing chapter on symmetry, for its applicability on problem solving.

"An experienced problem solver can often infer the road to the solution from the result." - grab all the information the problem gives you.

The chapters are:

Chapter 1 - The invariance principle

Here Engel describes invariants and monovariants. The idea is to construct a function (often integer, positive) that does not change or is bounded and monotonic (in the latter case the algorithm must terminate)

- If you have (or can introduce a transformation), look for an invariant.
- Distance from the origin is frequently used on these problems
- parity is also useful
- If there is repetition, look for what does not change.

Chapter 2 - Coloring proofs

Weird chapter on solving board problems. Typical colorings are: chess-like, column (or row) based, etc. A few parity problems on this chapter.

Chapter 3 - The extremal principle

Very wide-applicable strategy. Many examples on Number Theory, Geometry, Combinatorics, etc are given.

- Pick an object that maximizes or minimizes some function. It frequently has nice properties, allows to simplify or even to arrive in a contradiction.
- Every finite nonempty set of nonnegative numbers has a min and a max
- Every nonempty set of positive integers has a min (well ordering principle)

Chapter 4 - The box principle (pigeonhole)

- If $n+1$ pearls are put into n boxes, then at least one box has more than one pearl.

The difficulty on this chapter is to find the box and the pearls for each problem.

Chapter 5 - Enumerative Combinatorics

- Count by bijection
- Recursion
- Divide and conquer : split a problem into smaller parts, solve the small problem and combine solutions.
- Sum rule, product rule, product-sum rule, sieving

- Construct of a graph which accepts the objects to be counted.
- Count in two ways
- If you cannot find the number of good objects, find the number of bad objects.

Chapter 6 - Number Theory

Basic introduction to NT. Lots of problems.

Chapter 7 - Inequalities

Basic Inequalities (CS , $x^2 > 0$, AM-GM-HM, rearrangement, chebyshev, etc). A few hints for solving such problems:

- does the expression remind you AM-GM-HM? Cauchy-Schwarz?
- Can you apply rearrangement?
- An inequality homogeneous on its variables can be normalized.
- Is there any symmetry on the variables? In that case you can make additional hypothesis (e.g. $a \geq b \geq c \geq \dots$)
- Trigonometrical substitution?
- Convexity and concavity (Jensen)
- Can you transform it into a simpler form?

Chapter 8 - The induction Principle

Small Chapter on induction.

Chapter 9 - Sequences

Nice chapter on sequences. Includes linear recurrence, josephus problem, etc.

Chapter 10 - Polynomials

- Vieta's theorem
- Fundamental theorem of algebra
- Roots of unity
- reciprocal polynomials
- Symmetric polynomials

Chapter 11 - Functional Equations

Cauchy's functional equation and others. Small chapter

Chapter 12 - Geometry

Very long chapter, including:

- geometry and complex numbers
- transformation geometry
- classical euclidean geometry

Chapter 13 - Games

Describes nim, Bachet, Wythoff, etc

Chapter 14 - Further Strategies

- Graph theory
 - Infinite descent
 - Working backwards
 - Conjugate numbers
 - equations, functions and iterations
 - integer functions (floor, ceiling, etc)
-

Suraj Kumar says

Too tough for me. :(

paniz says

I didn't read it yet!

Raymond says

Nice for training for IMO.
