Teaching "Efficiently" Can Stifle the Development of Critical Thinking and Problem-Solving Skills

By Ed Meyer

One of the pleasures of problem solving is exploring the solution space in a casual relaxed fashion without a sense of urgency or even a specific purpose.

To start a presentation Mark Kac of Rockefeller University, a pioneer of the development of mathematical probability, stated:

> *Before I explain the title and introduce the theme of this lecture, I should like to state that my presentation will be more in the nature of a leisurely excursion than of an organized tour. It will not be my purpose to reach a specified destination at a scheduled time. Rather I should like to allow myself on many occasions the luxury of stopping and looking around. So much effort is being spent on streamlining mathematics and in rendering it more efficient, that a solitary transgression against the trend could perhaps be forgiven.*

The first problem in the book, *Probably a Good Book – Probability Problems for Everyday People*, is to calculate the probability that each hand in the game of bridge (four hands of thirteen cards each) will contain exactly one ace. Professors of mathematics will be able to get an answer quickly with a formula involving combinations, permutations and factorials. However, the authors of *Probably a Good Book* spend 28 pages wandering around the solution space, exploring many fascinating aspects and simplified versions of the problem. Those interested in getting the answer as soon as possible will wonder why the author don't just present the formula to the reader and tell them the number to plug into it. For the curious, the formula is

$$\frac{4!\,48!\,13^4}{52!}$$

When problem solving for an employer, the goal is usually to find the solution as quickly as possible. However, in an educational setting, the priority should be to develop the problem solving and critical skills of the students by letting them wander around the solution space on their own to see what they can find. Doing so will develop a problem-solving intuition that will guide the students towards the path to the solution in a more efficient manner.

Without this experience, students often will be nonplussed and reluctant to attempt to solve problem if they "don't know what they are supposed to do."

With this experience, they will explore the solution space, draw a diagram, simplify, build a model, and try some things.

Perhaps a more compelling reason to allow the students to explore by themselves is that it is fun and the dopamine rush of the AHA! moment is addicting. Directing the student down the path to the solution without letting them explore steals the opportunity for them to have that AHA moment.

Developing problem-solving and critical thinking skills is very similar to developing any skill, you must practice independently.

After all, if you go to a chess tournament and your teacher tells you what moves to make, you will not develop your chess playing skills as much as if you thought deeply about the possible moves and made the decision on your own. Whether the move is the optimal one is virtually irrelevant – you will develop your skills either way.

Quote Acrostic

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Instructions: Fill in the words at the bottom from the clues. Then write those letters in the grid at the top to reveal a quote. Black squares indicate the end of a word and punctuation has been removed. When you're done the first letters of the answers to the clues will be the author and subject of the quote.

QUOTE

1D	2G	3I	■	4F	5A	■	6H	7B	■	8F	9M	10C	11J	■	12J	13F	14M	15B	16E	17L
■	18I	19K	20L	21F	22B	23N	24D	25N	■	26E	27I	28G	■	29F	30L	■	■	■	■	■
31N	32K	33C	34I	35B	36J	37M	38K	39F	40C	41H	■	42N	43H	44G	■	45G	46B	47J	■	■
48L	49K	■	50E	51L	52B	53L	54B	55A	■	56D	57E	■	58C	59H	60D	61F	■	62E	63H	■
64C	65H	66M	67A	68J	69D	70A	71M	72B	■	73D	74J	75D	76K	■	77N	78L	79E	80K	■	■
81J	82M	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

CLUES

A. One might be slipped
_____ _____ _____ _____
55 70 5 67

B. A song without a name
_____ _____ _____ _____ _____ _____ _____ _____
52 72 15 54 7 35 46 22

C. Intended
_____ _____ _____ _____ _____
58 64 10 40 33

D. Non-believer
_____ _____ _____ _____ _____ _____ _____
75 69 1 24 56 60 73

E. Not likely to change
_____ _____ _____ _____ _____ _____
50 57 26 62 16 79

F. Like a snob
_____ _____ _____ _____ _____ _____ _____
39 21 13 8 4 29 61

G. A sight in DC
_____ _____ _____ _____
44 2 45 28

H. One way to fly
_____ _____ _____ _____ _____ _____
59 43 6 41 63 65

I. A gang of workers
_____ _____ _____ _____
18 27 34 3

J. Site of a colony
_____ _____ _____ _____ _____ _____ _____
68 47 11 74 81 12 36

K. Skimpy bathing suit
_____ _____ _____ _____ _____ _____
76 19 49 32 38 80

L. Carbon-14 or Uranium-235
_____ _____ _____ _____ _____ _____ _____
20 48 30 51 78 53 17

M. Be a better batter than
_____ _____ _____ _____ _____ _____
71 66 82 9 37 14

N. Lowest point
_____ _____ _____ _____ _____
25 42 77 31 23