

An Abridged Interpretation of the Book:

“How People Learn”

FOR THE COLLEGE-LEVEL MATH STUDENT

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0 Outline

This document is my personal interpretation of a book titled “How People Learn: Bridging Research and Practice” published by the National Academy of Sciences National Academy Press. It can be read online for free at http://www.nap.edu/openbook.php?record_id=9457.

While the book is written for teachers, I think much of it could be useful to students, especially if presented in an abbreviated and discipline-specific form. What follows is my personal view of how the ideas in this book can help a student be more successful in college-level math. Most of what is here boils down to common sense, but often it is helpful think explicitly about such things. (For example, I am more diligent and conscientious about flossing my teeth after blunt talk from my dentist!)

1 Key Finding Number 1

Sometimes we learn stuff incorrectly and, it turns out, being taught the correct version does not necessarily dislodge the incorrect one! For this reason, in addition to knowing the right approach/rule/law, it is important to explicitly confront mistaken ones.

EXAMPLE: The same student X completes the worksheet below:

1. Expand $(a + b)^2$.

$$(a + b)^2 = a^2 + 2ab + b^2 \quad \text{CORRECT!}$$

2. Solve $\sqrt{x^2 + 9} = 2x$.

$$\sqrt{x^2 + 9} = 2x$$

$$x + 3 = 2x$$

$$3 = x$$

...which is clearly false since $\sqrt{18} \neq 6$. So what went wrong?

The student used the (WRONG) formula $(x + 3)^2 = x^2 + 3^2$ and then used this formula to conclude that $\sqrt{x^2 + 9} = \sqrt{(x + 3)^2} = x + 3$.

That is the student knows the correct formula right, but in the middle of a problem, uses an incorrect one. Do you see the issue?

HOW DO YOU MAKE SURE YOU STAMP OUT THOSE THINGS YOU HAVE INCORRECTLY IN YOUR HEAD?

1. Come to class and pay attention. Most instructors know common mistakes and point them out.
2. Read your book. Most texts also point out common mistakes. Our text book puts them in red letters with the international NO symbol in the margin.
3. Look over every graded quiz. Your mistakes will be circled in red. Make sure you understand what you did wrong.
4. Others?

2 Key Finding Number 2

To develop competence, you must have a deep foundation of factual knowledge and that knowledge must be organized in a helpful way. You want to be able to quickly retrieve and apply this material.

Here's the short-hand: You cannot memorize your way to competence. But you're going to have to know (or memorize) some things.

AN ANALOGY: The Fairbanks North Star Borough has thousands of street names, how do you find your way around? Memorize all the streets? No. But it is enormously helpful to know that University runs North-South and meets Airport that runs East-West. The Johansen and Geist are the same and run parallel to Airport. Yes. You could choose to know (or memorize) nothing and just use a map. But is that really feasible? What happens if you lose your map?

When you take Calculus, you need to have facility navigating through the twin cities of Algebra and Trigonometry!

HOW ARE YOU GOING TO DEVELOP THIS FACILITY? THE RIGHT BALANCE OF MEMORIZATION VERSUS ORGANIZATION?

1. Come to class and pay attention. Most instructors give you explicit guidance of the form "Here is something you are going to need to know. But as long as you keep this in mind, you can figure all of these other things out."
2. Practice. (Homework, Quizzes, Tests) This is the equivalent of driving around the city running errands. You develop muscle memory.
3. Pay attention to multiple ways of working a problem or thinking about a mathematical concept. This is analogous to thinking of how many different businesses one can access from College Road. In this class, we will approach crucial topics from multiple views: algebraic, numerical, and graphical, precisely so that your understanding will be deep. (Not just to give you more to do!)

BONUS: Having knowledge in a framework helps you recognize when you must have gone off the rails. (For example, somebody says they live in the northwest part of Fairbanks and begin telling you how to get to their house by taking the Johansen to the Steese, either the person misspoke or they are clueless!)

Question for Discussion: Is *memorization* the same as *knowing*? Do you *know* your SSN or do you have it *memorized*? Do you *know* how to get home by yourself or do you have the route *memorized*?

3 Key Finding Number 3

Expert thinkers have a perpetual internal dialog while working problems. They are monitoring their goals and their progress in achieving these goals. YOU want to be an expert thinker.

Note that there are two kinds of goals intended here.

Small Goal: I need to work this problem correctly.

Big Goal: I need to develop the sort of facility described in Key Finding 2.

AN EXAMPLE OF INTERNAL DIALOG WHILE STUDENT JILL IS WORKING A PROBLEM:

- I should read the problem carefully, especially the directions. :)
- What is the problem asking me to do? What will the nature of the answer be? (a number? an equation? a graph? an explanation?...)
- Can I guess what the answer is? Approximate it? What reason would I give for this guess/approximation?
- What strategies can I think of and, among them, which seems most promising?
- Am I making progress toward the answer I expect? Can I really defend my steps or are there places where my argument is "It's obvious!"? (Beware the obvious.)
- Is my answer reasonable? Is it possible to determine explicitly that it is correct? Approximately correct? If not, is there another way to work the problem to check my answer? Can I check the answer with the solutions manual or a friend?
- Am I using all the information in the problem? Did I assume something that wasn't stated in the problem?
- If my answer is wrong, is it of the right type? If it's the right type, is it close to the right answer?
- OK. Now I have the right answer. How well do I understand what I just did? If someone gave me the exact same problem 1 hour from now, could I work it? If someone gave me a problem from this section 1 day from now, could I work it without any help? What did I use to get the answer? (Solutions manual, computer, notes, book, friend, tutor?)

QUESTIONS: In this dialog, when did Jill begin working the problem and how many questions must she have asked before she asked "What's my first step"? Which questions are monitoring Small Goal and which are monitoring Big Goal?