

The Mathematical Art of Guessing

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What would be your answers to each of the following questions:

- ✓ What mathematics topic never requires exactly the right answer?
- ✓ Which mathematics skill benefits from experience, not just knowledge?
- ✓ Which mathematics subject is seldom taught in schools?
- ✓ What learning did TIME magazine recently call “essential foundation for more advanced math skills. . .” and “. . . crucial for abstract thinking?”
- ✓ What mathematics can parents teach their children even better than teachers?

The answer to all of these questions is *Estimation*. The ability to use mathematics to estimate in many different situations is a very useful and important life skill. Those that know how to estimate can make wise decisions without ever picking up a pencil or calculator. A person who can estimate quickly and well has a mathematics skill that is very valuable in daily life.

What is an estimate?

An estimate is a guess or approximation of an amount, a measure, a value, or a position that can substitute satisfactorily in a calculation when an exact answer is not required. The art or act of estimation is the personal ability to come up with an estimate that is good enough to use when either the tools or the time to arrive at an exact answer are not available—or necessary.

Do we all need to estimate?

Everyone makes estimations every day, both at home and at work. While some estimates are more important than others, all good estimates can make our lives a bit easier.

Here are some examples of casual estimates adults make in their daily lives:

- ✓ Do you have enough milk to last until Tuesday?
- ✓ Is that picture straight and/or higher than the other picture?
- ✓ Do you have enough gas to drive to a certain shopping center and back?
- ✓ Do you have enough cash to pay for the groceries in your shopping cart?
- ✓ What size does my wife wear? Well, she is about this. . . (arms spread wide).

Here are some examples of really important estimates you may have to make:

- ✓ Did you put enough money away for your children’s college education?
- ✓ Did you create a monthly budget that you can actually live within?
- ✓ Did you estimate correctly the stopping distance you will need to not hit the car ahead of you?
- ✓ Did you invest enough or work long enough to afford the retirement you desire?

Why not just grab paper and pencil or a calculator?

All of the situations above, as well as many more, benefit from a good estimate. For most situations we do not need, and often cannot find, exact answers. Often only an estimate is possible and must do. Also, if you had to find a calculator or pencil and paper whenever you faced a mathematics problem, you might choose just to avoid solving the problem entirely—not a good way to go through life.

Sometimes we make an estimate with little thought, but other times, when it is really important, we must put a great deal of thought, time, and energy into an estimate. Some estimates can be done in seconds completely in our heads using mental math,

while some estimates require every mathematics tool we have available: pencil and paper, calculators, and computers—and lots of time—in order to get the best possible estimate. Either way, people who are good at the mathematical skill of estimation can both save time and make better decisions!

What skills are needed to make good estimates?

Estimation is basically educated guessing—the more mathematics you know, the better the chance your estimate will do the trick in any given situation. That does not mean that you need to know calculus or have a Ph.D in mathematics to make good estimates, though. The problem or situation that requires you to estimate also determines how much mathematics you need to make a useful estimate. For example, estimates you make in a grocery store usually only require a working knowledge of addition, subtraction, multiplication, division, fractions, and decimals—along with good money sense. On the other hand, if you are estimating the loads needed in designing a suspension bridge, you probably will need calculus.

Beyond the specific mathematics knowledge required to make a good estimate, in many cases you will also need skills with mathematics tools. For example, in the grocery store, besides basic arithmetic skills, you will probably need to know how to do the calculations in your head mentally, or on a calculator. Estimates, such as in the grocery store, seldom require exact answers, making a quick facility with mental arithmetic a much better tool than paper and pencil or a calculator. A quick mental calculation is often “close enough” and is always faster than digging out a pencil and paper, and often more efficient than using a calculator. While very useful and powerful in making quick estimations, remember that mental math is a learned skill, just as with paper and pencil number calculations.

What role does personal experience play in being able to estimate?

You may be able to make 99% of the estimates you need by using addition, subtraction, multiplication, division, fractions, and decimals, but your estimates will always

benefit by another important ingredient: personal experience. Experience plays a key role in making good estimates because you often need to know more than just the mathematics. Each situation and its estimate are unique. Unlike a simple arithmetic problem such as 47×1278 , estimates almost always require specific knowledge of a specific situation. For example, if you are estimating how long it will take you to drive to Grandma’s house if you have to stop for gas first, you cannot simply divide a set speed by the sum of the distances to the two places. You also need to know answers to questions such as: How long is the line at the gas station at noon? How long will it take to pump $\frac{3}{4}$ of a tank of gas? and What is the traffic like on the freeway at 1:00 P.M.? The answers to these questions only come with personal experience and, without that direct experience, tend to make estimates less reliable. Gaining the experience needed in these situations comes from doing—the more times you get gas and/or drive to Grandma’s, the better you will become in estimating the time it will take to get there at a certain time of the day. Experience in estimation is often as important as mathematics!

At what age should children start estimating?

The answer to this question may surprise you; long before you teach your children to estimate or they go to school, children begin estimating on their own. Even babies estimate! An infant reaching for a rattle must first estimate whether it is in reach and which way to move. Toddlers can estimate which pile of cookies has more, long before they can count. The role of parents, guardians, friends, and teachers is to encourage young children to estimate, and foster and support them as they learn to make better estimates. More on this important topic will be suggested in a future column.

Who is best suited to teach children estimation?

We have a tendency to think that almost everything is taught in school. But in the case of estimation, parents are in a better position than teachers to help their children become good estimators. Unfortunately, neither the

current curriculum nor the circumstances of the classroom are ideal for teaching estimation. Many mathematics programs, in their quest to meet the narrow goals of multiple-choice tests, concentrate only on arriving at exact answers to all mathematics questions. While students may learn basic calculation skills very well in the classroom, applying those skills to situations that call for an estimate rather than an exact answer requires a more flexible knowledge of mathematics. For example, if 99% of the calculations students do in class are done with pencil and paper, then it is unlikely that students will develop the skill of doing mental calculations that are key to making most everyday estimates.

Also, unlike a whole page of problems in a mathematics textbook, each situation that calls for an estimate tends to be unique, making each and every estimate not only different, but the mathematics required often different too. But perhaps the biggest reason why parents can excel in teaching their children estimation is the role that experience plays in good estimates. You can give your children the first-hand experience necessary to make good estimates by taking them with you to the grocery store when you shop, and including them while you make your estimates of the number of items in your cart, the space you will need in your refrigerator, or how many oranges to buy to last a week. All direct estimating experiences are very hard for a teacher to duplicate in a classroom, but very easy for you to do in your children's daily lives!



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