**Is NN Bigger than Menette?**

**Professor Ginsboo Explains Everything You Need to Know about Measurement**

by Professor Ginsboo

Himself

## Setting the Stage

One day, I, Professor Ginsboo, was deep in thought, strolling along a blank computer screen,



when a little girl emerged to face me. It was my dear student, Menette.



“Professor Ginsboo,” she exclaimed, “I need your help. My brother says that he is taller than I am. But I know that he is definitely shorter, and when I try to explain, he does not understand. He keeps insisting that he is taller.”

I knew right away that I could easily help Menette. After all, what could be simpler than measuring a brother?

“Menette, I can instruct you and your brother in the proper use of a ruler so that you can then measure each other and thus settle the matter.”

“I already know how to use a ruler and so does he. He said, and I quote, ‘Using a ruler is boring. I want to learn about the *mathematics* of measurement. After you clarify the

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underlying ideas, then we can discuss why I am taller than you.' That is a bit precocious, I know, but that's what he said."

"Does your brother have a name?"

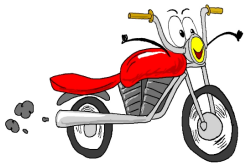
"No," said Menette.

"Well, I guess that doesn't matter. In five lessons, I will teach you everything you and your brother need to know about the ideas underlying measurement.

**Lesson 1**

**Measurement does not have to be boring**

I proceeded as follows, directing my remarks to the absent brother No-Name (NN for short) as Menette took notes. "The first thing you need to learn, NN, is that taking measurements does not have to be boring. Abandon this canard. Here's why. Imagine that you, NN, and Ms. Motorcycle have agreed to share the banana that she is chasing. Once she catches it, your job is to measure it so that both of you receive equal shares. In this case, measurement is the key to sharing, peace, harmony, and beneficence."





Menette did not seem convinced. "Unfortunately, my brother NN is selfish; he is not interested in sharing, peace, harmony, and beneficence."

I replied, "That is no problem. Measurement is also useful for cheating! Your brother NN could break the banana into two unequal pieces, measure them, and then use subterfuge (I will not tell you how) to give the smaller piece to Ms. Motorcycle. NN will be very happy. What do you think?"

"I think that makes sense and will ask my brother NN right away. Excuse me for a minute."

Menette walked off so that once more I was deep in thought, strolling along a blank computer screen, thinking and thinking, and contemplating the use of measurement to cheat. It goes without saying that I, Professor Ginsboo, do not condone cheating. At the same time, cheaters should be helped to realize their full potential so that they can cheat in a mathematically sound manner.

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Menette then reappeared and said, “My brother NN was grateful for your lesson on cheating but declared that he does not himself cheat. He pointed out that measurement can be used for a variety of other purposes, like weighing a donut or determining the height of a skyscraper. Measurement, he said, can be considered, and I quote him, ‘…a useful tool for the implementation of the engineering impulse, the need to build and create new structures, gadgets, buildings, and other appurtenances.’ He also said that precise and objective measurement is ‘applied mathematics, stemming from the ancient Greeks, and as such is basic to scientific endeavor.’ And because both engineering and science are inherently fascinating, measurement can be, and I quote, ‘a lot of fun, like, duh, depending on the context.’ Isn’t my brother smart?”

I replied, “If he is so smart, how come he doesn’t have a name?”

**Lesson 2**

**How long is Elly’s trunk?**



Having helped NN to appreciate the excitement of measurement, I was now ready to present my insights regarding its concepts and methods.

“Menette,” I said, “I will begin by explaining the mathematics of measurement. The goal of measurement is to determine the amount of some continuous attribute like the length of an elephant’s trunk. To do this, we employ a unit of measurement, an exercise which dates back to prehistoric times, when Cavette, the first cave-person to encounter an elephant said, ‘Wow. That’s a big elephant. What a long trunk! I want to tell my cave-mates how long it is.’ To accomplish this goal, Cavette first commanded the elephant, whose name was Elly, to lay down and extend its trunk, whereupon she measured it by the number of strides it took her to go from one end of the trunk to the other.

“The mathematics of measurement is straightforward. Imagine a straight line corresponding to Elly’s trunk. Imagine that we divide the line into segments corresponding to the length of Cavette’s strides (all of which are exactly the same

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length). The total length of Elly's trunk is the number of Cavette's strides into which the line is divided. The Cavette-Stride is a non-conventional unit of measurement.

"Later the cave-people thanked Cavette for her hard work and dedication to measurement, but decided to develop a shared unit that did not require stepping on elephants or other dangerous animals. They settled on the inch and the foot. Again, imagine the straight line corresponding to Elly's trunk. The conventional measure divides it up into feet and inches (or meters and centimeters. More about that later!) The length of the line (and Elly's trunk) does not change. But measuring length by Cavette Strides gives a different result (four Cavette Strides) than measuring length by feet and inches (6 feet 4 inches) because cave-persons, needing to flee all kinds of animals, have extremely lengthy strides.

"The foot/inch unit of measurement is *standard* because all of the cave-people agreed to use it. Indeed, generations of cave-people continued to use feet and inches to measure things. And because this group of cave-people lived in what later was called London, the method is sometimes called the *English* measurement system.

"At the same time that the English cave-people created their standard measure, the French developed theirs, which involves centimeters, meters, and so on. Later, I will discuss the differences between the two standard measures (*English* and *metric*)."

I, Professor Ginsboo, paused so that Menette could assimilate the full meaning of my length-of-Elly's-trunk lesson, and then asked her to give it to her brother, NN.

When she returned, Menette reported that NN thought that the detour into historical events was not too boring and that he wanted to learn more about standard units of measurement. I decided to grant the cheeky fellow's request, as is shown in the next lesson.

**Lesson 3**

**Conventional units foster communication and understanding**

"Menette," I said, "listen carefully and take notes so that you can educate your brother NN. My lesson on conventional units will be in the form of a haiku that captures the essence of the zen of measurement, as follows.

Conventional u-
nits are better than non-con-
ventional units.

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“Did you notice how the first line has five syllables, the second seven, and the third five? The syllable itself is a conventional unit!

“But I have even more to reveal. Conventional, standard measurement allows everyone to share the results. The units are familiar to all. Whether you are in India or Portugal, you can talk the same measurement language.”

Although I had finished my lesson, Menette stared at me in a somewhat puzzled manner. After 43 seconds (the second is a standard measure!), she said, “Is that your full lesson? It seems obvious.”

“It is. Please inform NN.”

Within 17 seconds she returned (maybe she didn’t really go to see NN), saying that upon hearing the full lesson (haiku and the rest) NN smiled and asked “But what about different kinds of conventional measures, in particular the English and metric systems that you described in lesson two and promised to explain? Please tell Professor Ginsboo that addressing this topic is essential.”

Cheeky little NN! Nevertheless, I explained as follows.

“Forget about the cave people and focus on the current situation. In a country called ‘the USA,’ somewhere over the screen saver rainbow, citizens use *customary* or *traditional* measures such as *inches* and *pounds*. USAers say, for example, that this pencil is six inches long and weighs two ounces. These customary units derive from their older English counterparts.

“Nowadays, most countries, and almost all scientists regardless of country, use the metric system, in which length, for example, is measured in *centimeters*, one hundred of which comprise a *meter*, one thousand of which comprise a *kilometer*, and so on. All of the measures are related to one another by means of a base-ten system. This is not true of the customary units of measurement.

“The metric system is clearly superior to the customary system, which is used (at least at the end of 2017 it still was) by only three countries: Liberia, Myanmar and the USA.” (Professor Ginsboo acknowledges that he had to google this last result. Unscholarly but convenient [and perhaps even true].)

Menette nodded her head in deep appreciation for 14 seconds, left and returned in 19 seconds, and said, “NN was grateful for your lesson, but now has another question, namely, and I quote, ‘Do you have anything more interesting to teach me?’

Thrice cheeky little NN! Wait until he sees what’s next.

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**Lesson 4**

**Close enough: The case of the fickle slouching Professor Ginsboo doll**

I, Professor Ginsboo, then addressed Menette: "I will now teach you an important but normally overlooked feature of measurement. After you have mastered my lesson, you may convey it to NN.

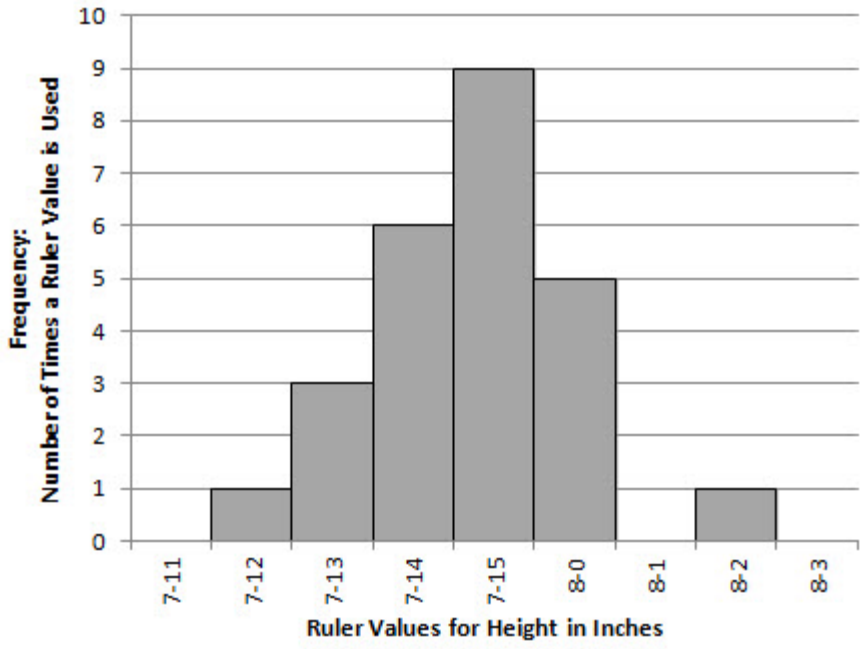
"We are going to play a game. In this game, you are attempting to measure the height of your favorite Professor-Ginsboo-as-a-young-child doll (may be available soon at a site like https://www.ProfGinsbooDoll.com). Like most dolls (and real children), he wants to keep track of his height, so he obtains a measure of it at each birthday. To help, you stand him up against the wall, place your ruler next to him, and find that the top of his head is a certain number of inches and fractional parts of an inch from the floor.

"At this point, you may congratulate yourself on a job well done. But suppose that you celebrate by eating a magic ice cream cone that unbeknownst to you has the effect of making you forget your measurement. You therefore measure again and eat another celebratory cone, which has the same forgetting effect as the first. The cycle stops only after you have obtained 25 height measurements, at which point you have exhausted the supply of cones."

Menette agreed that this was a splendid game and began to play.

When finished, Menette, looking a little queasy, reported back. "Look at the following graph I constructed. I find it distressing because the results show that I recorded several different height measurements for the very same doll. This means that I got at least some wrong answers. Are *all* my answers wrong? Did I get *any* correct answers?"

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Note: 7-1 means 7 1/16, etc.
25 observations total

I comforted her. "Don't worry, Menette. This is entirely typical. Let's review the situation. Almost all of your measurements involved three values, namely $7^{14}/_{16}$, $7^{15}/_{16}$ and 8 inches, and the rest are infrequent. So you weren't just guessing or making random selections. But think about *why* you might have obtained different values.

- When you stood the doll up against the wall each time, he may have moved or slouched a little on some occasions but not others. Your measurements may simply have reflected the reality that the object of the measurement may change unexpectedly.
- When you got tired of the activity, or were perhaps bloated by ice cream, you may have lost focus, with the result that your measurement acuity was diminished.
- You may have found it difficult to read the hatch marks on the ruler. Look at it. Determining the number of sixteenth-inch markings is simply not easy.

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“So changes in the physical reality of the thing being measured (the fickle standing-slouching doll), fluctuations in your concentration, and the objective difficulty of the task may have resulted in inconsistent measurements. And remember, Menette, that you are not the only measurer affected by these factors.”

Naturally, Menette was overjoyed with my lesson.

But she had a comment and a question. “I am glad that my fluctuating measurements were not abnormal, atypical, or otherwise unusual. Yet I don’t understand the practical implications of this information. Please inform me.”

“The implications are as follows, Menette. “We must be tolerant of variability. In many cases, it is appropriate to apply a margin of error to our measurements. For example, in the case of the fickle slouching doll, you might consider that judgments in the range of $7^{14}/_{16}$ to 8 inches are close enough. After all, if the goal is to compare growth from one birthday to the next, 1/16 of an inch matters little. If you purchase an upgrade to the Professor-Ginsboo-as-a-young-child doll on his next birthday, you will see that he has grown several inches, and that you need not be concerned with those tiny hatch marks (the sixteenths of an inch) on the ruler. On the other hand, if you want to measure the daily increase in height, then finer measurements involving the sixteenths would be necessary and there should be almost no margin of error.”

Suddenly Mz. Zoler, Menette’s teacher, jumped into the computer screen and exclaimed:

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"Your ideas about tolerance for variability are very important for education. Teachers need to understand that on some occasions and for some purposes there is no single right answer and that students must be flexible enough to embrace and understand the ideas of *good enough* and *margin of error*. Goodbye."

**Lesson 5**

**Fair measurement**

After absorbing the deep ideas in lesson four, Menette turned to me and said, "Professor Ginsboo, I have learned a great deal, but you haven't yet said how I can convince my brother that he is indeed shorter than I."

I explained to Menette that she needs to learn about *fair measurement*, that is, how to ensure that the results are not biased, defective, or incorrect.

"First, Menette, know what you are measuring. If two measurers get different results, you need to determine exactly what they are measuring. For example, Eliya saw Bear A sitting on a park bench on the left, and Melina saw Bear B sitting on a park bench on the right. Eliya and Melina each measured their personal bear. Eliya said that Bear A is bigger than Bear B. But Melina disagreed, saying that Bear B is bigger than Bear A. Who was right? Both, because Eliya measured height and Melina measured width. Bear A was tall and skinny, whereas Bear B was short and fat."

"Second is the issue of the origin. I once gave the following problem to a young child:

'Please look at these two sticks," I said. "Which is longer?'

A _____

B _____

"He pointed to B.

"Asked to explain why, he said that B was obviously longer because it stuck out to the right beyond stick A.

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“So make sure that two objects you are comparing begin at the same origin. This of course will result in a reversal of the previous judgment: now A is clearly longer.

A _____

B _____

“Third, use the measurement tool properly. One child I know, Michèle MMM, measured the height of her 10 pound dumbbell by placing the ruler next to the dumbbell as shown below. She put the 12th inch on the bottom and the zero on the top. Reading this ruler, she concluded that the dumbbell was two inches high. She *did* put both the weight and the ruler in the same place on the floor and stood both up next to each other. But she did *not* appreciate that the numbers on the ruler need to start with zero on the floor.”




Menette looked very impressed with my lesson. She said, “Professor Ginsboo, I now understand fair measurement: I know I want to measure height; I know that the origin needs to be at zero; and I know how use the ruler properly.

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“But you have not answered the question with which we began our educative conversation, namely: how can I help my brother understand that he is not taller than I am?”

I replied that now is the time to bring brother NN into the conversation. I said, “I, Professor Ginsboo, will now convince NN, face to face, that he is shorter than you.”

**The surprising ending**

NN immediately appeared on the computer screen. I, Professor Ginsboo, thought it was highly irregular for Menette, who is a cartoon figure, to have an actual human “boy” for a brother. But because we welcome diversity, I chose to ignore the incongruity and proceeded with my lesson. After careful (and lengthy) inspection, I concluded that NN was standing on a chair.



I asked, “Dear NN, Menette’s brother. Why do you say that you are taller than Menette?”

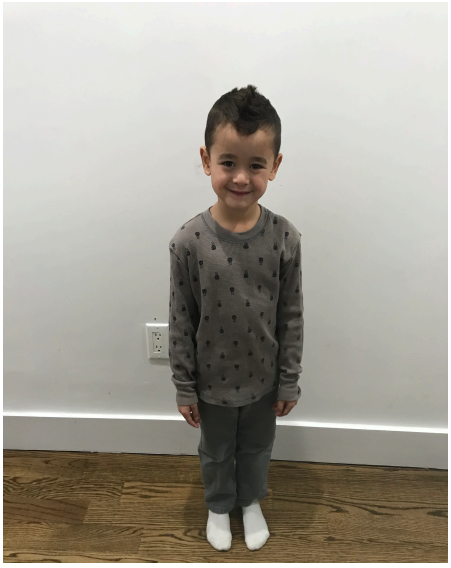
“I say that I am taller because I am up here and she is down there.”

“But NN, you have to consider the rule about beginning measurement at the origin. Step down so that we can measure you and Menette both standing on the floor.”

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NN did as I requested. I was dumbfounded at the result! NN was clearly and considerably taller than Menette, even when he was standing on the floor! No measurement was required to establish this fact.





Menette exclaimed, “What happened?”

NN calmly replied, “I’m taller. I told you so, Menette, my teeny sister.”

And I concluded that my final lesson on measurement is: Never take anything for granted (especially a sneaky sibling or a story ending).

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