Professor Ginsboo's Story of Perfect Shapes

By Herbert P. Ginsburg

Prologue

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 little student, Menette!



"Professor Ginsboo, please teach me something new," she said.

"But I already taught you everything you need to know about counting and how many," I said.

"Your lessons were extremely educational, but I want to know more."

"What if I teach you about differential equations?"

"Professor Ginsboo, I already know about differential equations. Like, duh."

There she goes again. She's a charming little girl but occasionally uses vulgar expressions.

"So, Menette, I will teach you all about perfect shapes!"

“Professor Ginsboo, I already know about shapes. Who doesn’t know about shapes? Like, duh.”

“Menette, I am afraid that you are mistaken. Many people think they know about shapes, when they really don’t. I will help you learn about shape names, attributes, and transformations, and also about the classification of shapes. I will show you shapes that you might see anywhere you go in the so-called real world. And then at the end, I will teach you some philosophy as well.“

Menette didn’t seem convinced. But then, a most unusual occurrence occurred (or happening happened, I’m not sure which), namely that this object flew across the computer screen, from left to right, and disappeared out the other side.



“What was that?” asked Menette.

“It was an omen. It means that you are destined to learn about shapes.”

Menette began to waver. “Well, this omen suggests that maybe a little Euclidean geometry and a sprinkling of philosophy will be intellectually satisfying. So let’s go, Professor Ginsboo. What are you waiting for?

Lesson 1

Shapes and Names

Pleased that Menette was ready for my lesson, I said, “Let’s begin. What can you tell me about these things?”



She said, “They are all different?”

“Yes, they are all different, but how are they different?”

“This is blue, this is red, this is blue, and this is red.”

“Dear Menette, that’s not what I meant. What else can you tell me?”

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“I see! It’s a pattern: blue, red, blue, red.”

“Dear Menette, that’s not what I meant. What else can you tell me?”

“They are shapes?”

“Yes they are shapes, but what else can you say about them? Here’s a hint. They all have names.”

“Ah, now I see! This is Theresa, this is Roland, this is Otto, and this is Squeamish.”

Menette was driving me to distraction. She started by discriminating among the shapes, seeing that they are different. This is essential but even very young children can do this. Then she focused on a surface feature, the color of each. But it’s important to go beyond mere appearance to consider deeper features. Next she noticed a pattern, which is promising, because it shows abstract thinking, but she was not yet dealing with shape. I thought she was really getting somewhere when she employed the correct word—shape—to identify a higher order category. But then she disappointed me when she named the shapes Theresa, Roland, Otto, and Squeamish: they sound like the names of particular people (I personally know three Professors named Squeamish), not kinds or categories of people, like boys or girls or uncles or bankers. Menette still had a great deal to learn.

At that very moment, a frog appeared, parachuting down from the top of the computer screen, and, perhaps surprisingly, into a pond.



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Menette and I were startled and said in unison, “Who are you?”

“It's obvious. I am an etymologist. I know words. I know lots of words. Nobody knows as many words as I do. And I know where they come from. Nobody can put anything over on me, word-wise. I will teach you the correct names for these figures. First look at this one:

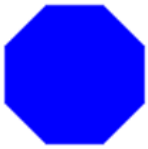


“It is called a triangle. Do you know why? Because in Latin it means three corners, which indeed describes that figure.

“Next look at this one. It’s called a rectangle, which in Latin means right angle. And this figure has four of those.



“Next is the octagon, which means eight-angled in Greek. So you see that I know Greek too!



And finally we have square, which derives from the Latin word for four, *quadra*, which doesn’t really sound like square, but I disclaim responsibility for the error.



“I am sure that I helped you enormously. I’ll send a bill. Goodbye.”

Well, I, Professor Ginsboo, would have liked to talk with the frog-etymologist at greater length, but it left the computer screen with amazing speed—pooferino!

I saw that Menette was crying and asked her why.

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“I am very sad, because I can’t remember those Latin and Greek words. Triangle and rectangle, octagon, and square are all nonsense words to me because I don’t know Latin or Greek! What can I do?”

“Dear Menette. There are two solutions to your dilemma. One is to learn Latin and Greek.”

“That’s not an option. What’s the other solution?”

“Do you know the names of different dinosaurs?”

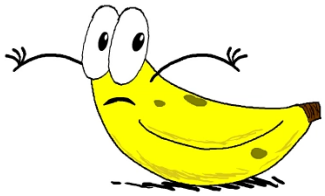
“Of course. Like easy peasy! Listen: Tyrannosaurus Rex, Stegosaurus, and Iguanodon.”

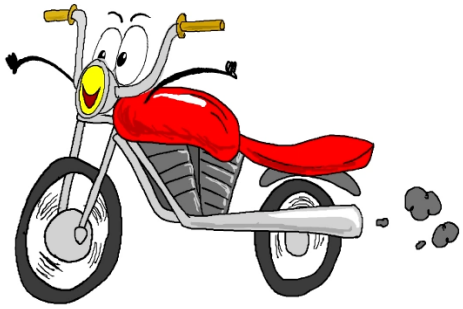
“So, Menette, if you can remember the dinosaur names, why can’t you remember triangle, rectangle, octagon, and square?”

“Professor Ginsboo, I can remember those words, but they make no sense. Why can’t I call the shapes Theresa, Roland, Otto, and Squeamish?”

Sometimes, Menette asks deceptively deep questions. I replied, “Actually, Menette, you are right. You could call one shape banana and the other motorcycle. It doesn’t really matter… “

When I said that, an unusual event evented, namely that a banana and a motorcycle flew across the computer screen, from right to left, and disappeared out the other side.





I told Menette not to worry: this happens all the time. The banana and motorcycle were left over from another of my lessons.

And then I continued. “It doesn’t really matter what you call the shapes. But even so, you have to learn the conventional names because other people have already agreed to use them. Actually our shape names are not so bad. You are lucky that you don’t have to learn the Finnish word for octagon—kahdeksankulmio. Much more interesting than the names is their meaning. What is a Squeamish/square, and what is a Theresa/triangle, and… “

Menette interrupted. “Now I understand. I certainly wouldn’t want to learn from a teacher who taught us only the names of the shapes. I want to know what they mean! Let’s dig down under the surface to reach the mother lode of meaningful mathematics. What are you waiting for?”

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Sometimes she is a little fresh, but she clearly had benefitted a great deal from my brilliant first lesson.

“Listen carefully, Menette, as I summarize this lesson.”

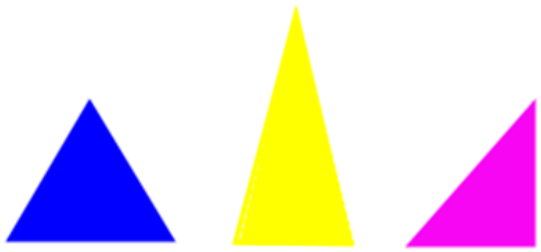
“What’s in a name? Nothing much, unless you speak Latin or Greek.”

“What’s in the meaning of a name? Ahh, that’s what we are going to find out next.”

Lesson 2

Attributes and Transformations

I then asked Menette to touch Theresa the triangle as she said “plane geometry” and immediately, Roland, Otto, and Squeamish disappeared, and two more triangles joined her on the screen.



“Menette, what do you see?”

“I see Theresa the triangle, and then I see these other shapes. They are triangles too.”

“That’s right, Menette. They are all from the triangle family.

“Theresa is a cute equilateral triangle. Equilateral is from the Latin, and means equal sides. The one in the middle is isosceles, which derives from both Latin and Greek and means having two equal sides, but not three. And the one on the right (wink, wink) is a right triangle, because it has a right angle.”

“What’s a right angle?” asked Menette.

“Look at the right side where the up and down line is standing up straight as can be on the bottom line which is stretched out on the ground as straight as it can be. That is a formal definition of a right triangle.

“Is that really a mathematical definition?”

“Don’t be fresh, Menette. Sometimes I try to make geometry simple so that even you can understand it. Anyway, do you understand how each of these members of the triangle family are distinctive?”

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Menette replied: “Yes, Theresa has three sides the same length, but Ike has only two sides the same, and Righteous is happy because it is the only one with a right angle (although it sweating because it has an angle of 90 degrees, which is pretty warm).”

I then congratulated Menette on her definitions of Theresa, Ike, and Righteous, although I can’t figure out how she learned about the 90 degrees.

All of a sudden another triangle appeared.



Menette shrieked, “What is that? It’s got three sides that are all of different lengths so it can’t be Theresa the triangle or Ike the triangle. And can’t be Righteous the triangle because, as you said with mathematical precision, it hasn’t got a side that’s standing up straight as can be on the bottom line which is stretched out on the ground as straight as it can be. Besides, it’s so skinny. I don’t think it’s a triangle at all!”

I was quite surprised at Menette’s surprise.

“Dear Menette. This is a triangle because it has 3 straight sides like the others. Please be kind to it.”

Menette asked, “What is this new triangle called?”

“It’s a scalene triangle. I anticipate that you will want to call it Scaley, like a fish.”

Menette thought for a bit, as indicated by hand on chin and arm and elbow at 90 degrees, and eventually give her considered judgment on the triangle’s name. “Like whatever.”

I was thrilled, not with the crude “Like whatever,” but with how I had taught Menette a brilliant lesson.

“Menette, Professor Ginsboo is so proud of himself for helping you learn to think about triangles.”

“You understood that:

- Theresa’s equilateral soul springs from its three sides, all the same length (along with some cute angles);
- Ike is different from Theresa because Ike has only two sides the same length whereas Theresa has three:
- Righteous derives righteousness from the fact that it is the only triangle with a side that’s standing up straight as can be on the bottom line which is stretched out on the ground as straight as it can be (and is the only one sweating);
- Scaley’s sides and angles are all different from one another.

“And, dear Menette, you **reasoned** about the triangles. When you said, ‘It’s got three sides that are all of different lengths so it can’t be Theresa the triangle or Ike the

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triangle,' you did **deductive reasoning**! I swoon when I think about your deductive reasoning.

"Remember this, Menette: The essence of the geometry we need to teach our young children is learning the defining attributes of shapes and using deductive reasoning to differentiate among them."

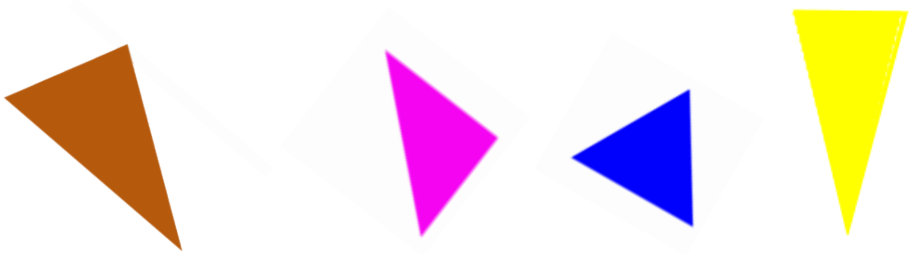
Menette smiled, and said, "That was an excellent lesson, Professor Ginsboo. But you forgot to teach me two important principles."

I was shocked. How dare she!

"You forgot to teach me about transformations. Watch this. Here are the triangles: a slightly bigger Scaley, Righteous, Theresa, and Ike."

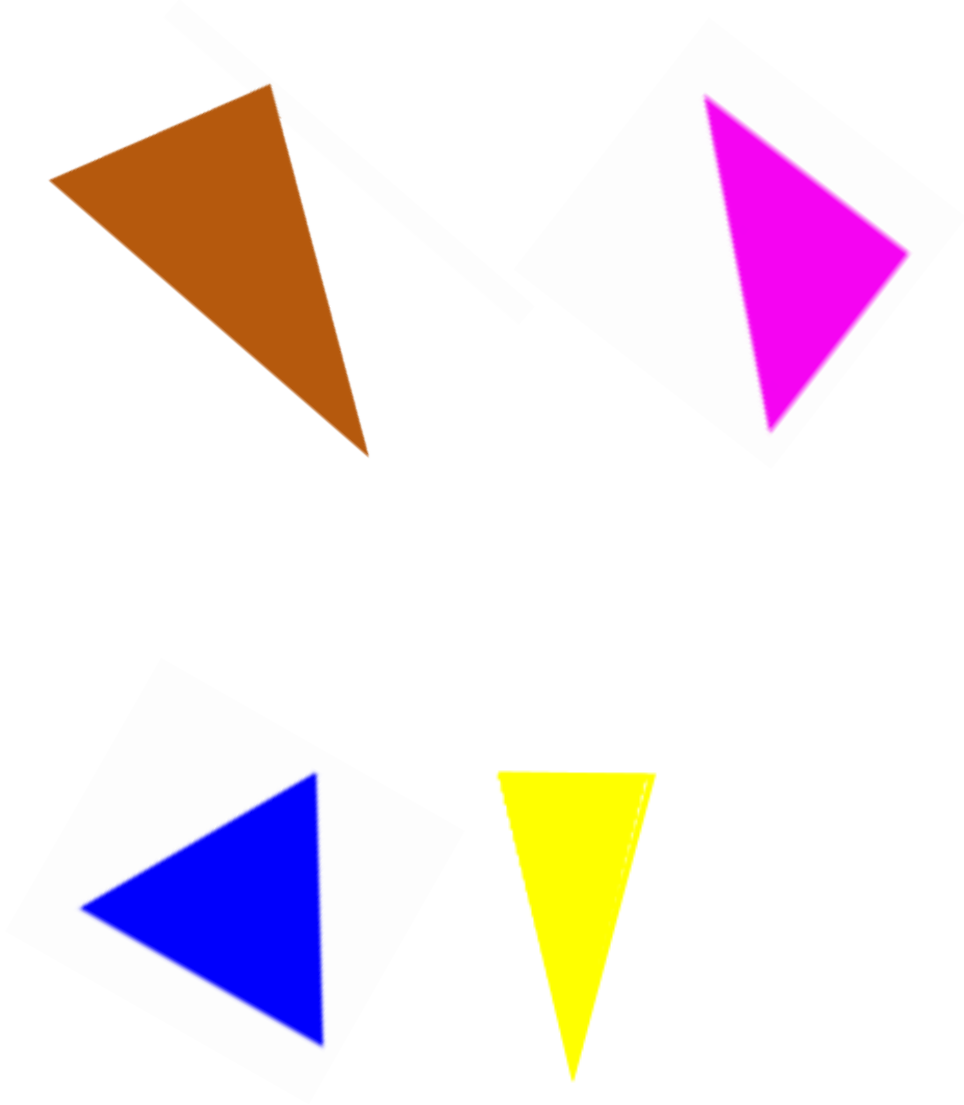


"Look at them now, below! They have all been rotated without changing any of the defining attributes. Theresa still has three sides the same length, Ike has only two, Scaley doesn't have any, and Righteous is still sweating in 90 degrees. Rotating the figures is a transformation that does not change essential features."



"And you also forgot to teach me about size transformations. Look at these. They are all bigger, but Scaley, Righteous, Theresa, and Ike are still Scaley, Righteous, Theresa, and Ike. Size transformations do not change the defining attributes."

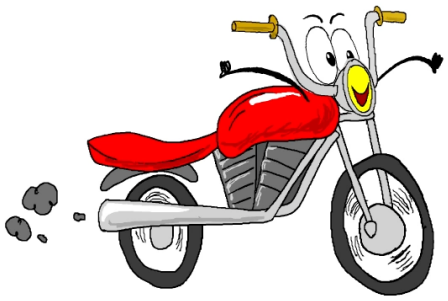
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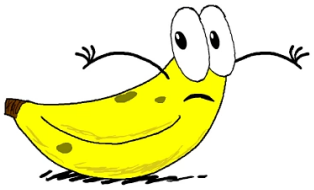


“My dear Menette, I was saving transformations for another lesson. Let’s go on. (And by the way, color doesn’t matter either.)”

But before I could start the next lesson, it happened again!

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Just ignore it.

Lesson 3

Classification

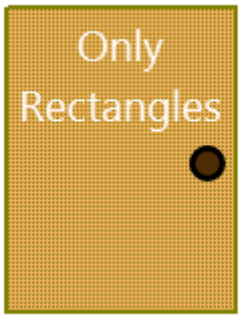
“Here’s a story, Menette, about two of the shapes you saw earlier. We won’t need quotation marks for this story because you are not going to say a word. Only I will talk.” Strangely, she was silent throughout and I dispensed with the quotation marks.

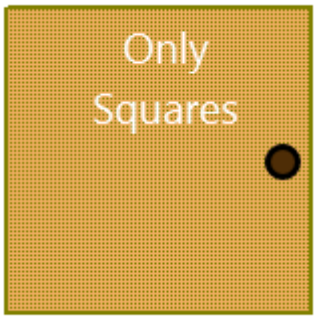


Roland the Rectangle and Squeamish the Square were standing outside two classrooms in a school.

One door was in the shape of a rectangle, and the sign on the door indicated that only rectangles were allowed inside. The other door was in the shape of a square, and the sign indicated that only squares were allowed to enter.

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Roland the Rectangle marched into the room on the left, and Squeamish went into the room on the right. After a while, they emerged. Roland said that the rectangle room had fantastic rectangle shaped brownies, and Squeamish said that the square room had delicious chocolate squares (72% cacao with almonds). Roland wanted to try the chocolates and Squeamish wanted to try the brownies.

So Squeamish stepped into the room designated for rectangles. But Roland encountered a problem: he could not open the door to the classroom reserved for squares. Then he huffed and he puffed, but could not blow down the door.

After a while, Squeamish came out the rectangle room, exclaiming with great joy that the brownies were the tastiest ever.

Roland was almost crying. He wanted to know why Squeamish could go into the rectangle room to have brownies, but he could not go into the square room to have chocolates.

Squeamish, her face covered with the remains of brownies, did not exactly gloat, but she bragged that she was not only a square (because she had four straight sides all the same length and four 90 degree angles), but she was also a rectangle (because she had four sides and four identical 90 degree angles).

So the bottom line (wink), dear Menette, is that the class (get it?) of rectangles includes within it the class of squares, but the class of squares does not include within it the class of rectangles. Squares are a sub-set of rectangles.

She broke her silence to exclaim, “So if you are a square you get to eat both brownies and chocolates (72% cacao with almonds). But if you are a rectangle you get to eat only brownies. So unfair! I want to be reincarnated as a square, not a rectangle.

Lesson 4

The real world

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Now that I had taught Menette important ideas about names, concepts, defining attributes, transformations, and classification, I wanted her to see their relevance in the real world.

So I took some pictures to show her. Here are the pictures along with our dialogue. M stands for Menette, and Professor Ginsboo stands for Professor Ginsboo.

Scene 1

The initial observation of the triangle and rectangle

Professor Ginsboo: This is a picture of a lamp in my apartment. What do you see?



M: I see a tall, straight pole and on top is a lampshade that is made of triangles and rectangles. And look at all the other shapes! The wall behind the lamp has parallel straight lines running up and down. On the left side is a metal tray. No doubt it is a circle, but we only see a semi-circle.

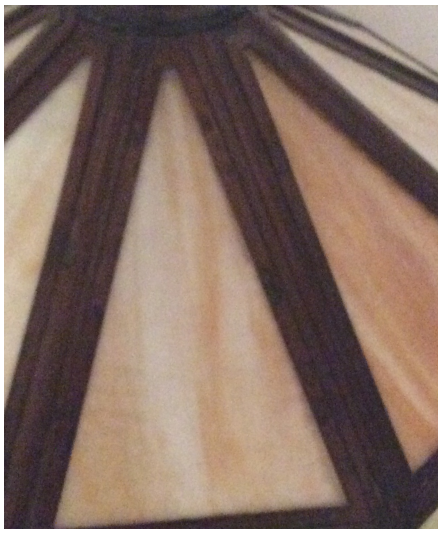
Professor Ginsboo: That's a very good observation about what appear to be the triangles and rectangles on the lamp. But let's look at a close-up. Look at the vertical side on the right of what you say is a rectangle. Is that line straight?

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M: Mmm… Well, not really. But there's a pretty good triangle on top.

Professor Ginsboo: Not true. Look more closely at what you say is a triangle.



M: Mmm… Well, the top vertex is rounded. So I guess it really isn't a triangle.

Professor Ginsboo: So is it accurate to say that you saw a triangle and rectangle that do not exist in the real world?

M: Mmm… I guess so. But wait! I just thought of something.

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Scene 2

Further inspection



M: You showed me a picture of the lamp, not the real lamp. Maybe the picture does not do justice to the reality. Imagine that you take a picture of the lamp under poor lighting conditions (how ironic!) so that the picture is blurry but the real lamp isn't. So in the picture you showed me, the lamp really does have a triangle and a rectangle too; it's the representation (picture) of the lamp that is faulty. What do you think of that, Professor Ginsboo? QED! (This means "Na, Na" in Latin.)

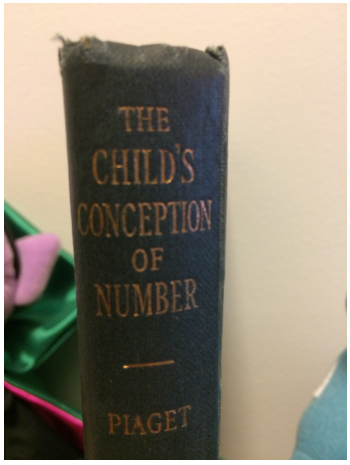
Professor Ginsboo: An excellent argument, Menette. But of course you are wrong again. Go over to my apartment, inspect the triangles and rectangles on the lamp, and then report back to me. You must return before I finish counting to 100.

M: I'm back.

Professor Ginsboo: That was very quick. What did you find?

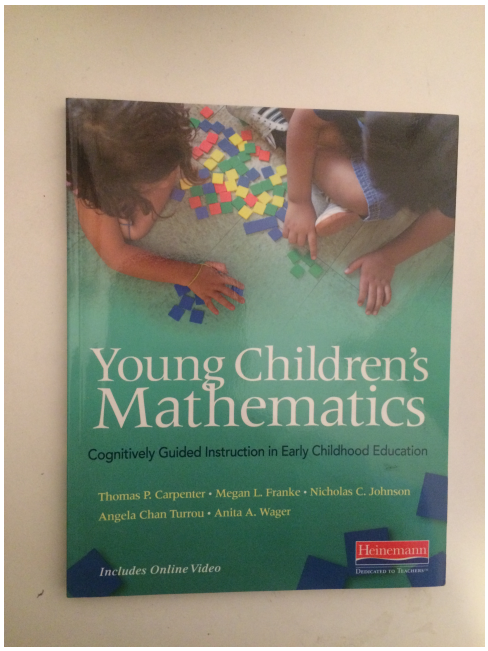
M: I found that you were right. Upon looking closely at the lamp, I found that the shapes were not really triangles and rectangles. The lines weren't really straight and the angles were not quite right (angles, that is).

And then I looked around the apartment and found a book that I thought showed rectangles on its faces, but I was wrong about that too. Look how un-straight the lines are, particularly the top one.



But then I thought that this is a really old book from a time when they didn't know how to make straight edges, so I looked at a new book.

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Now the front face of this book looks like a rectangle. But observe the lower right corner: it's just a little curved. Of course, one explanation could be that the book is mostly about number, not geometry. But that doesn't make sense.

In any event, I think you are right, Professor Ginsboo. I can't find pure shapes in the real world.

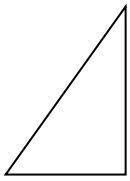
Professor Ginsboo: That's right, Menette. The shapes exist not in the real world, but in your head.

M: But wait! I have another objection to your argument. What about abstract drawings of shapes?

Scene 3

Abstract drawings

M: So as I was saying: suppose that you have abstract drawings of shapes like this.





They are perfect figures, are they not?

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Professor Ginsboo: Wrong again. If you look very closely at these lines you will see that they are not perfectly straight. Get your magnifying glass and check. You must return before I finish counting to 100.

M: I'm back.

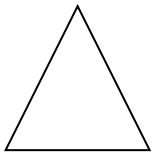
Professor Ginsboo: That was very quick. What did you find?

M: Well, when I used my magnifying glass, the lines were very straight. But when I looked at them with my very powerful microscope I found some tiny imperfections.

Professor Ginsboo: Naturally I was right. But, dear Menette, what is this commotion? Who is approaching us from the bottom of the screen?



E: Don't you know me? I'm Euclid. Why didn't you invite me here earlier so that I could straighten out (ha!) this argument about lines? In my *Elements* I define a line as: "…a breadthless length." By definition this figure



Is not a triangle because the black border is not breadthless. It has a small breadth, but a breadth nonetheless. This means that none of my shapes exists in the real world. Theresa the triangle, Roland the rectangle, Otto the octagon, and Squeamish the square are all imposters! Nice meeting you. I have to go now. I'll send a bill.

Professor Ginsboo: I know that this is hard to accept, Menette. But shapes are abstractions. In pure form, they exist only in thought. That's why my story refers to "perfect shape."

M: This is very odd, Professor Ginsboo. When I was in preschool, my teacher told me that, "shapes are all around us." Was she wrong?

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Professor Ginsboo: Maybe a better way to put it is that if we have ideas of shape, then we will have many opportunities to see approximations to the shapes in the real world. And these ideas about pure shapes will help us to understand what we see.

M: Why is that important for a teacher to know?

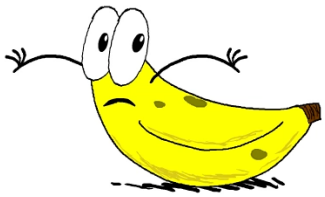
Professor Ginsboo: Honesty and precision of thought are the main reasons. My esteemed colleague, Professor Platas, writes the following about perfect shapes:

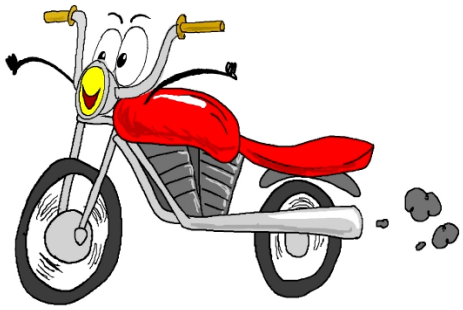
> Is the window frame really a rectangle? After all, it is a three-dimensional object, not a two-dimensional object. And, are the corners really right angles (generally, after time and a few paint jobs, the corners have a bit of a curve to them!). How do we handle these questions from ourselves and the children we teach? Teachers need to break out the honesty… 'This looks like a rectangle to me, but what do rectangles have to have? Does this window frame have all of those attributes?' Imagine what kind of conversations and deep understanding this can support in the classroom.

I salute you, Professor Platas, for your splendid idea. And I, Professor Ginsboo, add the following. Some of the resulting conversations might touch on the topic of approximation—the idea that the real life window frame or the line drawing—are *close enough* for the purpose at hand. Sometimes a reasonable approximation suffices. Indeed this idea is central to engineering and statistics, to cite two key examples.

M: Professor Ginsboo, why is the motorcycle chasing the banana again?

Professor Ginsboo: Mmmmm…I have figured it out! They are both chasing perfection but never seem to find it.





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