**“Approximate” Multiplicative Relationships between Quantitative Unknowns**

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***Corn Stalk Tomato Plant Heights Problem.*** There is a tomato plant and stalk of corn growing in the garden, each of unknown height. The height of the stalk of corn is 5 times the height of the tomato plant.

1. Draw a picture of this situation and describe what your picture represents.
2. Write an equation for this situation that relates the two heights. Explain what your equation means in terms of your picture.
3. Can you write another, different equation that relates the two heights? Explain what your equation means in terms of your picture.
4. If you wrote an equation using division, can you write it with multiplication? Explain what your new equation means in terms of your picture.
5. Let’s say that the stalk of corn’s height is 150 cm. How tall is the tomato plant?  
   Use this example to check all of your equations.   
   If an equation does not work, see if you can change it so that it does.   
   Explain any changes that you make.

**Data Excerpt 1:** Tim7 states his idea of “approximate” relationships between two unknowns in episode 11 on 10/15/13.

*Tchr1*: So in all cases, people were showing that five tomato plant heights fit into a corn stalk height. They were showing this in different ways. But everybody showed that in some way on their pictures. Okay, so that was a similarity across everybody’s. Now nobody chose exactly these two letters [pointing to what is written on the board, “z = number of cm tall that the corn stalk plant is” and “q = number of cm tall that the tomato plant is”]. [Tim’s hand goes up.] Yes, Tim.

*Tim*: Approximate.

*Tchr1*: Approximate.

*Tim*: Five tomatoes equals approximately corn stalk height.

*Tchr1*: Approximately?

*Tim*: Yeah.

*Tchr1*: Hmm. Why do you say that?

*Tim*: Because we don’t know that. We don’t know what anything is. We don’t know what height it is, we don’t know what width it is, we don’t know what it is.

*Gabriel*: It did say that five,

*Tim*: The corn stalk it said.

Gabriel: Yeah, but still, uh,

*Tim*: But not the tomato.

*Gabriel*: We may not know the actual value, but we do know that it’s five times.

*Tim* [gesturing to Gabriel]: Exactly! We don’t know it.

[Gabriel throws his hands up.]

*Tchr1*: So Tim brings up a good point that other groups talked about last time a little bit. Can you, if both of the heights are unknown, the corn stalk’s height is unknown, and the tomato plant’s height is unknown, can the five be exact? Can the relationship between the two of them be exact? Or is that also unknown? [Gabriel raises his hand and the teacher points at him.]

*Gabriel*: We don’t necessarily know what the values are, but we do know how the relationship between those two things are.

[Tim gets up and goes to the board.]

*Tchr1*: Is that possible? Gabriel has weighed in and he believes it’s possible. But I want to know what other—

*Tim* [at board, looking at his picture]: I did not put it. I did not put it. [Turns around and comes back to his seat.] I thought I did.

*Tchr1*: Okay. I think you had it on a different piece of paper, when you guys were working with the example [Stephanie’s hand goes up]. Stephanie, do you want to add?

(2:41) S: Um, in the question, we’re still doing [question] one—

*Tchr1*: Uh-huh [yes], yeah.

*Stephanie*: Um, it says the height of the stalk of corn is five times the height of the tomato plant? So it is five times. [short pause]

*Tchr1*: [Connor’s hand goes up; Tim also moves.] Okay. What do you guys think about that? Is it okay? Connor?

*Connor*: Yeah.

*Tchr1*: So, you think we can have a definite relationship between the two [Gabriel’s hand goes up, and he points down as AH continues talking] even if we have indefinite heights?

[Gabriel’s hand comes down across the table, pointing, and he says yes.]

*Tchr1* [pointing to match Gabriel’s gesture]: Gabriel is saying yes.

*Connor*: Can I sa—

*Tchr1*: But I don’t know what other people really think, be honest.

*Tim*: Say it again.

*Tchr1*: Can we have a definite relationship, a known relationship, between two heights even though the heights themselves are unknown? [pause] We don’t know for sure how tall the two plants are,

*Tim*: We can make an estimate.

**Continuation of Data Excerpt 1:** Continued discussion of the five times relationship in episode 11 on 10/15/13.

*Gabriel* [to Tim]: Well, for example I mean we know that five of these green sharpie pens [holds up a green pen] is say, a jumbo green sharpie pen. I mean, we know that, but we don’t know the actual measurement of this [holding green pen], precisely. I mean, to—

*Tim*: Well that’s giving you like more information. Because you don’t know what size the jumbo pen is, but if you were to, ah—

*Gabriel*: But we do know it’s five times the length of this [holding up the green pen].

*Tim*: That’s what I was saying, I mean, you can still sort of like find it out in a ways. Like if you found out the, uh, pen and it equals five of—

*Connor*: But doesn’t it say the height of the corn stalk is 150 [cm], doesn’t it say that [in part (e) of the problem on the activity sheet]?

*Gabriel* [to Connor]: Well yeah, but we’re just assuming it is. Just to plug into our equation.

*Tim*: And if you add them all together that would equal the jumbo height. So basically you’d find it all out so you’d never, so technically you would know each measurement because if you had a pen right in front of you, you could instantly measure it out. But as for this [holding up the worksheet], you don’t know the corn stalk height, you don’t know the tomato plant height. So you don’t know anything. That’s what I was trying to point out.

*Gabriel*: Yeah. But, okay [raises hand slightly and lets it fall].