Jacqueline Stewart and Elizabeth Phillips, Connected Mathematics Project, Michigan State University

Transcript for October 23- 27, 2006

"Making Sense of the Concept and Representations of Exponential Decay: *Growing, Growing, Growing*, Investigation 4."

The class is seen working on Investigation 4.2,
"Fighting Fleas: Representing Exponential Decay"

The video was shot in real time and edited from approximately 50 minutes, to 22 minutes.

Growing, Growing, Growing, Investigation 4.2
Class: 8th Grade
Date: October 25 - 26, 2006

Chapter 1: Launch Growing, Growing 4.2
Approximate Times 00:00 – 00:25(times from start of video)

Slide:
Title slide

Line 1, 00:10 T: Let's use decay factor in another situation. Wahoo. I can just feel the enthusiasm. There it is.

T: So we're going to be representing exponential decay.

T: Alright. So here's the situation we're going to investigate today. Yesterday we looked at Chen and the ballots. Today we're going to look at a flea medication.

James: Oh, boy.

Line 10, 00:43 T: And it's for dogs, not for people.

Collin: Didn't we do it with Fido and the fleas?

T: We did have Fido with fleas at the kennel in an Ace problem. So now we're going to look at if we had Fido coming home from the kennel with all those fleas, how could we help him. It told us on the top of page 50,"After an animal receives this flea medicine, the medicine breaks down in the animal's blood stream." So the dog doesn't take the medication and instantly all those fleas are gone. It
Line 20, 01:09 would be nice if it worked that fast but it doesn't do that. It's going to break down in the system,[in the animal's system. With each hour that goes by, the medicine's going to get used to kill those fleas, and there's going to be less and less medicine left in his blood stream. There is a table and a graph on page 50, and I think I have a copy of that.

[Slide of Table and Graph]

So this is representing what's happening to the flea medication,showing as the hours go by what's happening to the amount of active medicine that's
Line 30, 01:37 still left in the dog's blood stream. And then this is a table showing from the beginning of when the dog got the medicine how much is still active in his bloodstream to fight the fleas as each hour goes by. With your group, I want you to study this pattern, see is it exponential decay, and you're going to find out how does the amount of active medicine change as one hour goes to the next to the next to the next, see if there's an equation that would model this situation, and then how is this graph similar or
Line 40, 02:10 different to the graph about Chen and the ballots, and then in letter B you're going to look at a different flea medication that's breaking down in an animal's bloodstream in a different way. And you're going to look at the table of data for that one and a couple of equation ideas from some other students.

Chapter 2: Exploring 4.2
Approximate Times 02:26 – 05:16(times from start of video)

Line 1: 02:27 Kendra: No. 400 divided by 100, which is 4.

Carson: Okay. Then what?

Kendra: 400 divided by 100, which is 4 -

Carson: I know.

Kendra: Um, 100 divided by 25 is 4, and then - it's definitely going down by 4.
[Slide of table and graph for 4.2A]

Carson: Okay.

Kendra: So, to kinda get what it's going down - it's going down by 4, though.

Line 10, 02:51 Carson: Alright.

[new group on camera]
Logan: It's tricky.

T: And you're saying your equations say the same thing?

James: Well, yeah, because they both say the same thing as the table.

Logan: At least I hope so.

T: So you multiplied and you had division in your equation?

James and Logan: Yeah. Yeah.

Line 20, 03:10 T: And why do they - why do they both okay?

Logan: Because mine's a smaller part, I guess. Er, 'cause mine's less than 1. Yeah.

James: Mine's less than 1. Yours is more than 1.

[new group on camera]
Megan: What is your equation?

Collin: My equation? 400 times .25 uppity X.

T: And why are they going to come out the same?

Megan: Because, um, On his you're multipliying by a decimal.

Line 30, 03:41 Collin: And decimals are going to make it go [down and if you're dividing it's going to make it go down, too.

T: So multiplying by a fourth and dividing by 4 is going to do the same thing?

Collin: They're equivalent change thingies, or something.

[new group on camera]
Sarah: 60 parentheses -

Mike: Parentheses .2 -

Sarah: .2

Sarah and Mike: Uppity -

Line 40, 04:03 Mike: X. And then, yeah. Then it's that. And so 1 equals -

Sarah: 12.

Mike: Yeah.

Sarah: 2 = 2.4 -

Mike: Yeah. And 4. -

Sarah: Wait. How do you know - is this 4 or 3 or 5? What is that?

Mike: It says right there.

Sarah: Nu-uh.

Line 50, 04:16 Mike: For here?
Sarah: Yeah.

Mike: Oh, yeah, it just didn't want to write all of them.

Sarah: So, is that four or -

Mike: The book didn't want to write -

Sarah: Oh, we gotta write all of them? Jeez oh Pete.

[slide of problem 4.2B]

Mike: Okay. Well, and 4 = .096 and 5 is .0192 and 6 is .00384.

[new group on camera]
Elle: Katie, does it - it divides by 4 every time?

Line 60, 04:43 Katie: It divides by 5, because 5 equals 20% -- is 48, so one hour is 48, and then you divide that by 5, 9.6, so 48 minus 9.6 equals 38.4. And then you divide that by 5 to get another negative 20%.

Chapter 3: Logan and James Disagree about an Equation
Approximate Times 05:17 – 06:41(times from start of video)

Line 1, 05:18 Logan: Because it says it breaks down at a rate of 20% per hour, so you don't have 100% so you have to add 80% to get 100%.

James: Well, I think it is 0.2 because, like, it said that it was 12-1/2 for 1, didn't it?

Tyler: I just got - I just got 12 for 1.

Logan: But, but -

James: Okay. Well it's 12 -
Tyler: When it's saying -

Line 10, 05:42 James: So what you can do, is you can do - it'd be 60 -

Logan: 20% of the active medicine is decreasing, er its gone not that it's losing that, not that 80% of the medicine is losing, because 80% - it'd make a lot more sense -

James: Right. But, but like, with the equation that we did first, um, it goes from 60 to 12, and when you do, uh, 60 divided by 12, that equals 5, and 1/5 of 100% is 20. 1/5 also
Line 20, 06:19 equals 0.2. 'Cause it's 20%.

Logan: Yeah, but you want to, you have to do 80 because you have to make it 100%.

James: So what, you think its 0.8?

Logan: Yeah.

James: That isn't going to work. But 48.

Logan: It makes a lot more sense.

Chapter 4: Taking away 20% Every Time
Approximate Times 06:42 – 07:58 (times from start of video)

Line 1, 06:42 Katie: You have to take away 20% every time, so first you have to find the 20%, and then take it away from the previous numbers.

Elle: Okay.

Katie: You got it?

[new group on camera]
Zach: You're taking 20% from 60 and that's 12, so you take that away from 60 and it's 48, and then -

T: Okay. Hold on a minute. You're going to take 20% away from 60. How do you know that's 12?

Line 10, 07:05 Zach: Because if you move - when in the 6th grade we were taught to move the decimal over one, and that's 10%, and 10% of 60 is 6, and then you just double that, so it's 12.

T: Okay. So 20% of 60 is 12 and you're taking that away -

Zach: Yeah. And then it's 48 and you have to find 20% of 48 and take that away -

T: So your table - is it going to show what you're taking away or what we're keeping?

Line 20, 07:28 Zach: What we're keeping.

T: What we're keeping. So your table, you wanted to show 60 and then the 48.

Zach: Yeah. Collin, Collin has the table at his desk.

Alyssa: I don't understand that equation.

Zach: I don't understand the equation but I, but it makes, the graph, the table makes sense.

Alyssa: Where'd you get .8?

Collin: First I did .2 and that looked, like
Line 30, 07:47 retarded so-

Alyssa: Yeah, but you're taking away 20%.

Megan: Yeah.

Zach: But you're leaving 80%. That's how we got it.

Collin: Yeah, we're -
Zach: We're leaving 80% - that's what it's showing.

Collin: Yeah -
T: So the equation is showing what you're leaving?

Collin and Zach: Yeah.

Chapter 5: Summary of 4.2A
Approximate Times 07:59 – 11:38(times from start of video)

Line 1, 07:59 T: I think the majority of your conversations were
focused around letter B, so I want to focus most of
our discussion there, but before we jump to B, you
first analyzed this one. So see if you can take
yourselves back to the first flea medication, and you
saw this curve, and when you took off working on the
problem you thought it might be exponential decay
because of the curve, and you saw this data set. From
that, did you write an equation that would
Line 10, 08:28 create this curve or this data set? What equation did
you write for the first flea medication. Brittany.

Brittany: We did, um,Y = 400 times .25 to the power of X.

T: And why did that make sense to your group?

Brittany: Because, like, every time, 'cause like, it goes,'cause it like goes down by - no, wait, hold on -

Katie: Because it divides by 4 every time.

T: And then why do you have .25 in your equation and
Line 20, 09:07 400?

Katie: Because .25 is 1/4 of 100, so it's 25%.

T: You have a different equation, Jon.

Jon: Yes.

T: What's your equation?

Jon: 400 divided by 4 uppity X.

T: Is that why you said 4, Katie?

Katie: Huh?

T: 'Cause you said 4.

Katie: It divides by 4, and then a fourth of 1 is .25

Line 30, 09:39 T: So the divide by 4 that Jon has and the multiplying by 1/4 that you guys have is what you guys were talking about in your vocabulary and why you wanted both in the vocabulary for decay factor.

Katie: Yeah.

T: What's that mean happens to that medicine inside that dog? Sarah.

Sarah: The medicine -

T: Yes.

Sarah: Is going down by 4 times, so like when it's
Line 40, 10:01 at 400, if you divide that by 4, er, by 4, you get
100, and then if you take 100 and divide that by

4,you get 25, and so forth. So you're going down by a factor of 4.

T: So this number in the equation is going to tell me what's happening on my table -

Students, off-camera: Um hmmm. Yeah.

T: So the fact that it was at 400,you're saying you divided by 4 and that's where this 100 comes from.

Sarah: Yes.

Line 50, 10:24 T: Or multiply it by a fourth and that's where that 25 comes from.

Sarah: Yup.

T: What do these numbers tell me about the medicine?

S(unidentified): It's going down.

James: It decreases, um, by, decreases one fourth every time. Er, it, it decreases, um, 25% each time.

T: So you're saying the medicine lost 25% to go from here to here.

James: No.

Line 60, 10:53 T: It lost 75%?

James: It loses a -

S(unidentified): It loses a fourth of the whole.

James: Yeah. It loses a fourth of the previous, like 100 is a fourth of 400. Like -

S(unidentified): 25% is a fourth of 100.

James: Yeah.

S(unidentified): And _______guess would be-

S(unidentified): You have 1/4 of what you originally had before.

T: So this is what I have still in the dog.

Line 70, 11:18 S: Yeah.

T: So I give the dog this medicine. An hour later this is how much he still has? So does he still have a fourth of that, or does he have the 75% that Logan said? He has a fourth -

S: Yeah.

T: And he lost 75%?

Chapter 6: Summary of 4.2B
Approximate times 11:39 - 13:55 (times from start of video)

Slide:
The next day the class summarizes the issues that were raised in 4.2B.

Line 1, 11:49 T: Um, just somebody start us off talking about it to get us back into it, because it's been 24 hours and we want to figure out what was this problem about, and then what was your group thinking. So James, you guys want to start us?

James: Yeah, um, well it was about flea medicine for this dog, and um, how much, um, it started out with, uh, 60 milligrams of it, and then it broke down 20% each hour, so, yeah, and then, what we were thinking
Line 10, 12:18 is when we were trying to think of an equation, I was thinking that it'd be, um,

Logan: 60 times 0.2 -

James: Yeah, I thought it'd be 60 times 0.2 -

Logan: Because of the decay rate.

James: Because of the 20%, but then Logan was thinking that it was, um, 0.8, because after you took that 20% away you'd still have that 80% left.

James: We couldn't really decide which one to do, so what I did is, I did 60, I did 60, um, times 0.2,
Line 20, 12:56 'cause that'd be 20%, and I got 12, so I know that 12%, er, 12 is 20% of 60, so I'd know that from zero, from the Y intercept, to 1 on the X axis, it'd have to go down by 12, and then when I looked at Logan's equation, it went from 60 to 48, so it went down by 12, and mine didn't. Mine went down a lot faster.

T: And then you wanted your table -did you want this to be 12 or you said you wanted it to be 48.

James: I wanted, I wanted it to be 48 because it
Line 30, 13:30 goes down by 12.

T: Oh, I see.

James: Er, well it goes down by 12 for that one, and then you'd find 12% of 48, and so on. Yeah.

T: And then you were going to take that away?

James: Right.

T: So your table wasn't going to show you the 12. You're saying the table was going to show you the 48.

James: Yeah. But, see, I, I don't know why, but I thought it'd be 0.2 because it was 20%, but I guess
Line 40, 13:55 Logan was right, then, yeah, yeah.

Chapter 7: Different Equations for 4.2B
Approximate Times 13:57 – 17:04 (times from start of video)

Slide:
Heather wants to keep the idea of being able to use division in the equation.

Line 1, 14:03 Heather: Kind of, but we found a different equation, and it's Y equals 60 divided by 1.25 to the X. And it still works but it's just kind of different, so.

T: Why does that work?

Heather: I'm not sure.

T: How did you come up with divided by 1.25 to the X?

Heather: I knew that for the one it had to be 48
Line 10, 14:26 'cause I did the 60 times 0.2 and everything, and so then I started typing in like random numbers for - to the X power before that, and I found like 130 was too high and then 120 was too low, or 1.2, so I put 1.25 in and it got me what I needed.

T: So you used a guess and check idea to come up with this.

Collin: I was doing something that makes me happy mathematically because it's mathematically because after a while, soon there wouldn't be any medicine
Line 20, 15:00 but mathematically it's just going to go on forever and ever. I found the point where actually it does say that there's nothing left.

T: So the calculator finally reached a zero.

Collin: Yes. It's, uh, 1,022 hours, which is 42 days and 14 hours.

T: And then the medicine is mathematically even gone because -

Collin: Yes.

T: the calculator's stopped making numbers.

Line 30, 15:20 Collin: And that makes me happy.

Jon: Well, the, Heather's and the, um, the 60, uh, the 60 parentheses 0.8 X is the same thing, but that's timesing and that's dividing, so -

T: So this is the same as Y equals 60 times 0.8 to the X. So these two, you're saying, are equivalent equations?

Jon: Uh huh.

T: What about the other two?

T: And why did your group like this one?

Line 40, 15:56 Becca: Well, because first we tried to the 0.2 X, and it went down to 12, and we knew that there wouldn't be

12 left if you're only losing 20% of it, that there wouldn't be 12 milligrams of the medicine left if you started with 60, so we tried 80 since that's the difference of the whole and the 20, so we tried 80 and that gave us 48 and that seemed more reasonable to be losing that much medicine instead of going all the way down to 12.

T: Brittany.

Line 50, 16:33 Brittany: Um, my thing is wrong. It's times instead of take away.

T: So this shouldn't have been a minus.

Brittany: No.
T: You want to change that to times.

S: It looked like a minus sign, so -

T: Oh I see. You used a dot for multiplication.

It sounds to me like I'm hearing a lot of agreement now that if I wanted to represent what's happening to this medicine, I'm going to use 60 times 0.8 to
Line 60, 16:58 the X power if the decay rate is 20%.

Chapter 8: A New Problem
Approximate Times 17:05- 20:58 (times from start of video)

Line 1, 17:05 T: So let's do a "what if." Let's add a letter C to this problem. What if I had another dog and this dog was taking a flea medication that started with 110 milligrams in the initial dose. This flea medication has a decay rate of 40%. Could you come up with an equation that would show me what's happening to this medicine over time how much medicine is still active in this dog's blood stream?

[Carson and his group]
Carson: I said that you get 110, and then you
Line 10, 17:48 multiply that by 0.6, you'll get the like that.

T: Okay.

Carson: But, like, she doesn't understand why it's 0.6 and not 0.4. And I told her that when you take 0.4 away from a whole, and it's 0.6.

T: Um hmmm. So your decay rate is 40%. What does the decay rate tell you?

Carson: Um, how much it goes down by each time?

T: So what does the 60% tell you?

Carson: That's how much the whole is.

Line 20, 18:17 T: How much is left. So the decay rate is telling you how much you're losing, and your decay factor is going to tell you how much you're keeping, then.

Carson: Okay, thank you.
T: Yup.

Carson: It's the whole, er you get 60% of the whole. That's the whole, then divide into 10. Pretend that's 10, and you do 60 of that.

T: A table that has a different equation?

Logan: Mine. Y equals 110 (6 divided by 10) uppity
Line 30, 18:51 X.

T: How does this equation compare to this one or this one?

Sarah: They're the same.

T: Sarah?

Sarah: They're the same.

T: How are they the same?

Sarah: Because James' is the same as the first one. The only difference is that he used a multiplication symbol instead of parentheses.

Line 40, 19:09 T: Which both mean to multiply.

Sarah: Right.
T: Okay.

Sarah: And Logan's - if you were to put that, if like you were to take 6 and divide it by 10 you'd get 0.6, so it's the same thing.

T: So if I ask this question: "If you know your decay rate, how are you getting this decay factor?" If you had another situation with a decay rate, how would you know your decay factor when you're writing
Line 50, 19:37 your equation? Logan.

Logan: Uh, you, uh, use the decay rate. If it's like 30% you have to try and get a 100%, so you use whatever makes it a whole, so if you had 30% you'd need 70% so it'd be 0.7 for your decay factor.

T: So if you - you're saying if you had a decay rate of 30%, your decay factor would be 70%.

Logan: Yeah, so, yeah, so you have to -
James: Like make a whole. You have to make a whole. Yeah, you have to make a 100%.

Line 60, 20:13 T: Heather.

Heather: Um, for the C one you had 110. I found another really cool equation.

T: A cool equation. All right.

Heather: And I know how I found it.

Heather: And when you divide a whole number by a fraction, you have to like, flip the fraction upside down so you just multiply it across and so 5/3 flipped upside down is 3/5, which is the same as 0.6, and so when you flip the 3/5 upside down you got 110
Line 70, 20:40 times 5/3, which is the same as 1.6666, so you would do 110 divided by 1.6666 take the same as the multiplication one.

T: So this idea of decay rate and decay factor, they do have a relationship. And if you know how much something is decaying, at what rate it's decaying, you can use that to figure out what your decay factor is.

Chapter 9: The Teacher's Reflection After the First Day on 4.2
Approximate Times 20:59 - end (times from start of video)

No transcript available.