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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 4.1,
"Making Smaller Ballots: Introducing Exponential Decay"

The video was shot in real time and edited from 1.5 days,
approximately 70 minutes, to 31 minutes.

Growing, Growing, Growing, Investigation 4.1
Class: 8th Grade
Date: October 24-25, 2006

Chapter 1: Launch *Growing, Growing* 4.1.

Time: Approximately 00:00 – 02:54 (Times from start of video)

Slide:
Title slide

Line 1, 00:12 T: I want to look at Investigation 4 now. So everybody's on page 48. In our notebooks we're going to title this problem "Problem 4.1 - Making Smaller Ballots."
[Slide: Showing Problem 4.1]

We're going to find out what is this thing called exponential decay. It starts with a problem that you will be familiar with. Do you remember the first problem in the book – with Chen - And we made ballots.

James: Ballots.

Line 10, 00:51 T: Remember how Chen just had one sheet of paper and his job was to make a bunch of ballots for an election that was going to happen that night. And at that time we were counting how many ballots he could make every time he made a cut in the paper. And what was the concern you had as Chen was doing that?

S: It would get so small you couldn't write on it.

T: And you guys were really bothered by that, on how small some of these ballots were going to be.

James: It was too big of numbers.

Line 20, 01:15 T: And the numbers got really big, and that was the first time we saw these numbers growing really big, and we were bothered by, yeah, [we were getting a lot of ballots, but they were so tiny it was going to be hard to write on. So now we're going to investigate that exact problem that you guys were concerned about from the very beginning of this book. Chen is only going to have one sheet of paper, but now they've told us that sheet of paper is 64 square inches. How big would that be?

Line 30, 01:41 Collin: Really big.

T: If it's 64 square inches, can you give me an example of what some dimensions might be?

T: I heard 8 by 8 -

James: 4 by 16.

T: 4 by 16 and -

Collin: 32 by 2.

T: 32 by 2. And 1 by 64. So you got a feeling for how this could be. We're going to start with that 64 square inch paper and we're going to look at what
Line 40, 02:04 happens when he makes those cuts. How big is each ballot as he starts making those cuts in the paper.

The first thing you're going to do is make a table showing starting with zero cuts in the paper, how big is a ballot, then one cut in the paper, how big is a ballot, two cuts, etc., all the way down to if he makes ten cuts in that paper,how big is each ballot. Then from the table, you're going to analyze what's happening to the size, what pattern do you see? Then letter C says "Can you write an equation to represent

Line 50, 02:39 what's happening?" And then our favorite part. We're going to make a perfect graph so you're going to need graph paper and decide independent and dependent variable and make a graph of the data, and E, how is this similar or different to all of the stuff we've seen so far in this unit.

Chapter 2: Exploring 4.1
Approximate times 02:54 – 04:35(Times from start of video)

Line 1, 02:55 Jon: 2 - 1 -

Heather: Um, .5 -

Jon: .5 -

Heather: .25

Jon: .25

Heather: .125 -

Jon: .125

Paige: And then 10 is?

Heather: And then .0625.

Line 10, 03:09 Jon: .0625. Okay. Now tell me the equation.

Heather: You should figure it out by now. It's...okay, how was the area of the ballot that changed with each cut. It gets cut in half.

[new students on camera]

Sarah: No, Divided by …

Mike: .0625

Mike: So that's it right there.

Sarah: Didn't work.

T: How do you know that didn't work?

Line 20, 03:38 Sarah: 'Cause it goes from 1 to - wait - maybe it did work.

Mike: Yeah.

T: What'd you do? I didn't see your equation.

Sarah: Y = 64 divided by 2 to the X.

T: And why does that make sense to you? You started with 64, I heard you say.

Sarah: And then you're dividing each of them by 2.

Mike: 'Cause that's the starting point.

Sarah: Yeah. 64's the starting point and then you divide them by 2 to the X.

Line 30, 03:59 Mike: Yeah, that works.

[new group n camera]

Heather: Negative x, you get the same thing in your table as if you had 64 divided by 2 to the X. 'Cause when you divide it you're cutting it in half, and when you have it negative, you're also cutting it in half, or it's going down, so, it's doing the same thing.

S (unidentified): You can't do it by .5. You have to do it by like...

[new group on camera]
James: What'd you have to go up by? Um, we'd have
Line 40, 04:33 to go up by like fives, wouldn't we?

Chapter 3: Student Notice a Similarity
Approximate times 04:36 – 05:41 (times from start of video)

Line 1, 04:36 T: So it does look like it's very similar to inverse. Keep that out so we can talk about that in a few minutes, 'cause I've heard a couple other people bring that up. Let's compare them.

Collin: There's a downward swoopity one, the, the -

T: Inverse?

Collin: Yeah.

T: Um, she just went and got one out of her folder to compare an inverse one to this one.

Line 10, 05:00 Collin: Well, it's - wouldn't it basically be the same because - the only difference is that this actually has a Y intercept, right -

T: Oh –

Collin: Before it, like, it could go but never really reach that - you could, if you want to be really -but it, this one actually starts at a Y intercept.

T: So there's a difference there that you -

Line 20,05:22 T: Talk to Megan about that, 'cause she hear me talk about that.

Collin: This could -

Collin: That could actually make a difference 'cause like, that could like, whoooo.

T: Okay.

Megan: It's right now. Is this correct? I switched them all over -

T: Yes, yup. Yeah, now I see it. Yup.

Katie: I have two equations that work. Can we do one or both?

Line 30, 05:37 T: Oh, I think two would be awesome.

Katie: Cool.

T: Write those both down so you can talk about them in a minute.

Chapter 4: Summary of 4.1 begins
Approximate Times 05:42 – 08:00 (times from start of video)

Line 1: 05:43 T: Let's have a conversation about what you've seen. So let's bring it all together. Guess I can't get them both on there at the same time. Alright. I asked Steven to fill in the table so that we had a table of data to look at, and as I walked around I saw this table of data virtually everywhere. Um, you had to look at how are the ballots - how is the ballot area changing as Chen makes a cut. What did you say about that? What pattern did you see or how
Line 10, 06:22 is the ballot area changing? Sarah.

Sarah: Well, the first thing that I did saying divided by 2 divided by 2, because that's what I noticed at first. I, uh, I typed in the calculator of what I thought the equation would be, cause I knew it wasn't going down by 2 then I got Y = 64 divided by 2 to the X, and so I got the table like that, 'cause it was starting at 64 and I was dividing by 2 each time.

T: Somebody else. Jon.

Jon: Oh, never mind.

Line 20, 07:01 T: So you're saying you noticed it was dividing by 2 every time, and so that immediately said to you, "Make an equation."

Sarah: Well, like when I was trying to figure out the table, I … it was easier than saying divided by 2 divided by 2 divided by 2.

T: So you, because of that constant pattern, the idea it was always going to divide by 2, you went right to an equation.

T: Katie.

Line 30, 07:29 Katie: Times - it was dividing by 2 or multiplying by half. I got the equation 64 times .5 to the power of X.

T: So you have a different equation than Sarah's?

[Slide: Heather comes up with a third equation]

Heather: 64 times 2 to the negative X.

Jon: Yeah.

Chapter 5: Investigating the Equivalence of Three Equations
Approximate time 08:00 – 14:53 (times from start of video)

Line 1, 008:03 T: I think we need to decide about these equations. Let's put all of them in our calculator so that everybody has them to look at.

[General Classroom Chatter]

S(unidentified): The third one won't work.

T: The third one won't work?

S(unidentified): It doesn't work for me either.

S(unidentified): They're all the same.

S(unidentified): The third one doesn't work for me either.

S(unidentified): I got the third one to work.

Line 10, 08:40 S(unidentified): They all work.

T: How do I decide if they all work, Megan?

S(unidentified): They're all the same.

Megan: Um, you can go to the table.

T: Ooh. My table's way messed up. I gotta get back to zero. There, I'm more comfortable. Okay.

Megan: And then they're all the same.

T: All my tables are the same?

S(unidentified): Yeah, they are. Yeah, they are.

Line 20, 09:09 T: Let's see. That one starts at 64. Okay. So does this one, starts at 64. And the last one. They all do look the same. Why do they all work?

James: 'Cause they're all the same things, just written differently.

T: How are they all saying the same thing but written differently? Let's start with the first one. Does the fact that we started with 64 and then we divide by 2 to the X power seem reasonable?

Class: Yeah.

T: Why does that seem reasonable? Brittany.

Line 30, 09:35 Brittany: Because on the equation that's really what - I mean, on the table, that's what you're doing. You're, you're dividing it by 2 so it goes down by 2 each time.

T: So I'm dividing by 2 every time. As I make a cut, I divide by 2, make a cut, divide by 2. So if the second equation also gets me the table, what does the second equation say to me? Sarah.

Sarah: Well, um, when you divide by 2 it's the same as multiplying by a half, because, like if you were to take 64 divided by 2 you'd get 32, and if you take 64 and multiply it by half you get 32.

T: So 64 times a half is 32.

Sarah: Yeah.

James: 64 divided by 2 is the same.

T: So dividing by 2 is the same as multiplying by a half.

Class: Yeah.

T: Makes me think of stretching and shrinking last year when we wanted to shrink those figures when we were looking for that scale factor. When she was saying that that was what was going through my head. So those two seem reasonable. What about that last one that gave us the same table. 64 times 2 to the negative X.

S(unidentified): That's kind of funny.

T: That one's kind of funny - is that what somebody just said?

S: It works.

T: It works? Why does it work?

T: So what does that negative X do?

Jon: Makes it go down.

T: Makes it go down?

Jon: Yeah.

T: Why?

Jon: Um, because the minus, well, yeah, a negative is going down and a positive is going up.

T: So this positive makes it go up, but these were going down.

Jon: Because - they were going down because it – they're, they're dividing, and it's .5. Oh, I don't know for a second. I don't know.

T: What does –

Jon: The first one's going down because it's dividing by 2.

T: So that's what causes that one to go down.

Jon: Yeah.

T: It has nothing to do with the X. It's the division.

Jon: Um hmmm.

Line 80, 11:34 T: Heather.

Heather: Well, I know for the second one it's going down because when you multiply by a fraction it's get a smaller piece -

Jon: Yeah.

Heather: Because like the multiplication sign means like half of 64, and a half of that. But for the last one, it's going down because the negative X, when you put that in there, it makes it - oh, what was I going to say? Crap. Um, you're multiplying by a
Line 90, 11:58 negative, and when you have it it goes down because multiplying by negative - wait, no, that's the wrong thing, sorry.

T: So, give me something else to try so I could try this negative X idea.

Logan: 27 -

T: So I'm going to get rid of these. How about you guys get rid of them for a minute.

Logan: 27 -

T: 27 -

Line 100, 12:18 Logan: Uh, negative 3, then... and do like a negative, do a negative, like 3 - 1

S: 3 to the minus X.
Logan: Yeah.

T: 3 to the negative X.

Logan: Yup.

T: So, wait a minute. What are we guessing this is going to do?

Students, off-camera: Divide. Divide by 3.

T: Divide by 3?

Line 110, 12:38 S: Yup.

T: So we think if I had it raised to a negative X,it's going to say the same thing as 27 and keep dividing by 3, dividing by 3?

Class: Yeah. [General comments]

T: Well, let me see. Did this do what you thought it was?

Class and James: Yeah.

T: So it did divide it by 3, divide it by 3, divide it by 3?

Line 120, 12:56 Students, off-camera: Yeah. Yeah.

T: It's interesting. Why is a negative X doing that? Hmmm, I've got to think about that one for a while. Sarah.

Sarah: Well, is it 'cause we're dividing a positive by a negative - er, we're multiplying a positive by a negative for the most part. 'Cause like -

T: That's where Heather was starting to go and then changed her mind. Why did you change your mind from that?

Line 130, 13:22 T: Here's what I would like to do. I want to keep this idea of that negative X out there. What is actually happening when I have that negative exponent? It's the first time it's come up. Why do we have this negative exponent and what's happening? Oh, Logan has another idea?

Logan: Yeah, I got it. It's 27 times parentheses 1 divided by 3 uppity X.

T: Like that?

Logan: Uh, no.

Line 140, 13:48 T: No? Sorry. My fault. You want to type it in?

Logan: Sure.

T: Oh, so you put 1/3 in parentheses?
Logan: Yeah.

T: Alyssa asked to go back to Y= so she could see it.

T: So this idea of 3 to the negative X you're saying is the same as if I had 1/3 to the X.

T: So if I had 27 divided by 3 to the positive X, you're saying that's the same as multiplying by 3 to
Line 150, 14:48 the negative X? Is that true?

S(unidentified: Yes.

T: It is?
S: Maybe.

S: I'm not sure.

Chapter 6: A Bejillion Ways
Approximate Time 14:54 – 16:05(times from start of video)

Line 1, 14:55 Collin: Like, isn't - like there are a like a jillion ways to get the same answer and they're all really wonky.

T: Is it okay that there are a bajillion ways to get the same answer?

Collin: That's a, that's a good thing because that just means you have, that just means you have more options

T: I want to try and make sense of all of them in
Line 10, 15:13 some way, but then like Collin said, it's nice to have something to pick from.

Collin: I mean, you don't want, it's, it's bad because some, um, some of the things we've been doing, there's only one equation that worked and that, that, that equation might not make sense to you and that makes it hard. But since there are so many different ways to do this that makes it easy, but one of these ways is bound to make sense to you and that, that one will just help you more than going with some
Line 20, 15:42 - going with just one that worked for everyone else.

T: I know that there are many of you that wanted to talk about the graph. How is this graph different from the graph we'd had the day before? Sarah.

Sarah: Well the other exponentials that we've done, they started low and then went high on a curve, and this one started high and then went down on a curve.

S: So it's like almost like an inverse.

T: And that's where I want to pick up tomorrow.

Chapter 7: The Summary Continues
Approximate Time 16:06 – 21:45 (times from start of video)

Slide:
The next day the class finishes their summary of 4.1

T: And we weren't quite sure as time was running out yesterday why this worked, and we were kind of wrestling with why a negative X was going to give us the same as divided by 2 to the X and multiplying by half X. Yesterday I felt as if we were comfortable with these two and the relationship there that Collin and Jon were talking about at the beginning, but this one we're still a little iffy on. So I think we'll kind of leave this idea of a negative exponent, kind of something to ponder, and it'll keep coming up at different times throughout the unit and we'll keep coming back to it. Um, and we'll focus on these two right now, where this idea of dividing by 2 to the X power or multiplying by a half to the X power and how those two related. And then we'll keep this one there but, um, kind of keep it on the back burner for a little while and come back. Now what we didn't get a chance to talk about at all yesterday was what the graph looked like for this data. And I asked a group to make the graph so we would be able to look at it. Who wants to start off what their group was talking about with it? James.

James: Um, well it, it looked, almost inverse-

T: So in our last unit, the "Thinking with Mathematical Models" unit, we saw inverse variation graphs. And you're saying this reminded you a little bit of an inverse variation graph.

James: Yeah.

T: And Megan, you went and got one out of your folder -

Megan: Yeah.

T: To remind - 'cause you were also thinking that. Did it look just like an inverse variation graph?

Megan: Yeah.

T: You saw a lot of similarities also. Collin.

Collin: I looked at one of the inverse graphs as well and I realized something, that this one has a Y intercept and inverse never had a Y intercept. And I just- And I think that, uh, this will actually hit the -it'll go into negative X and the other one won't, I don't think, 'cause it didn't make sense mathematically.

T: Let's investigate both of those ideas.

T: Does anybody remember one of the situations that was an inverse relationship? That could help us talk about it? James, do you remember one?

James: It's like a much different, uh, factor pairs of each other that makes the graph. Like if there were 24, you know,if you were going to buy 24, um, uh, 24,000 square feet of land,or something, um, then you could, you'd find all the factor pairs, like, you'd, I don't know, it's kind of hard to explain. Like whatever the X is, like if the X was 2, then, then it'd be like 120,000 because, yeah, because the one would be 240,000, so then, yeah, it's, it's like factor pairs of each other, like 2 times 120,000, that's 240,000, and then you just like multiply the X by the Y.

T: So you're thinking like of that problem back in the last unit where there was the pieces of land -

James: Yeah.

T: That they were going to give away to people. I think it was like Roseville was the name of the town. And we were looking at all the different rectangular pieces they could have with a certain area. So you're saying what if the area was 240,000. This is one of the rectangular pieces of land.

James: Yeah.

T: It would be a 2 by 120,000. And then you listed several of those and that's the factor pairs you were talking about.

James: Right.

T: Is that also true on the exponential?

James: Um, no.

T: Are these also the factor pair idea that he's talking about?

S(unidentified): Not really.

T: So it is a slightly different relationship. Why isn't there a Y intercept on this one, like Collin said? The Y intercept would be when X is zero. What would be Y? Sarah.

Sarah: Um, well, um, zero times nothing would give you 240,000, so there can't be a y-intercept.

T: There isn't zero times something to get that area, so this wouldn't exist.

S(unidentified): Hmmmm.

T: Does a zero exist for this situation?

Class: Yes.

T: At zero cuts, did he have an area?

Class: Yup.

T: Yeah. So there would be a Y intercept on this one, where here there wasn't a Y intercept. The relationship between the X and the Y wasn't exactly the same relationship between the X and the Y that we're finding here. What did the graphs look like for this, when we graphed the area and the length and width idea?

T: Megan, you had an example. Did the inverse variation graph have this type of a shape?

Line 100, 21:13 Megan: Yes.

T: Yeah, it had this type of a curve,

S(unidentified): But it was going up like this.

T: But it was a slightly different curve and it wasn't going to hit the Y axis. So I would agree there is some similarity in the way those graphs look, but the relationship wasn't exactly the same. It was interesting that you guys saw that relationship, that "Oh, this is also one of those
Line 110, 21:35 types of curves." But now we can see there is a slight difference in how the curves are working - where they're hitting the Y axis, if they are, and then the relationship between the axes isn't exactly the same.

Chapter 9: Features of the Graph of 4.1
Approximate Times 21:45 – 24:26 (times from start of video)

Line 1, 21:47 Then Collin brought up a second point. Besides this Y intercept and the relationship that James just talked about, what about down here? Does this one go into the negative?

James: Yeah, so -

T: When will this go into the negatives?

James: At 7 -

T: At 7 it goes into the negatives?

James: I think so.

Line 10, 22:10 S(unidentified): It never goes into the negatives.

S(unidentified) No, it never goes into the negatives. It just keeps getting into smaller and smaller-

T: Carson.

Carson: Um, if you always, if you cut them by half, there'll always be a part even if you can't see it.

S(unidentified): Yea its never gonna go away.

Carson: Yeah.

James: Right, but like on, on the graph it was -

Line 20, 22:28 T: So your graph did go in the negatives?

James: Yeah - er - wait-

Carson: It'll always just be split by half. It'll just be a really huge decimal.

S(unidentified): It would be like point zero something - always have a part of them.

Students, off-camera: Yeah, part of them. It'll be part of a part. Yeah. It'll always be part. Part of part.

Line 30, 22:47 James: Oh yea you're right, you're right, just got into decimals.

T: So you're getting smaller and smaller decimals, James?

James: Yeah.

T: But you're not going to have a negative?

James: Right.

Collin: Well, like you said with - when we filled the bunny with math,after a while there's not going to be any bunny pieces left, really.

T: In a realistic world, you're right. It's going
Line 40, 23:04 to be so small -

Collin: The bunny is going to be completely gone from existence.

T: In this the ballots themselves also would be completely gone. But mathematically we could probably always represent it with a number.

Collin: That's one of the things that screws me up with math - how it, how you, you can't put it into real life a lot of the times, because, like, at some point with real life like decay, like problems that
Line 50, 23:32 decay like this,this, surely there's going to be nothing, but with math there's never going to be a nothing really.

T: Um, how is this similar or different to the exponential growth graphs that we've had throughout the unit? Sarah.

Sarah: Um, the other ones started low and went high. This one started high and went low.

T: So it starts high and went low, and the other ones started low and went high. What else did you
Line 60, 23:58 recognize or feel differently about this one, Elle.

Elle: Like, the lines aren't connected?

T: And there were several people wanting to have a conversation about that. Should we connect these dots or not? Carson, what do you think? Does it make sense to connect the dots?

Carson: I didn't think so because, um, if you connect the dots it means like there's a part of a cut, but we didn't have part cuts, so -

T: So having parts of cuts didn't make sense to you?

Line 70, 24:24 Carson: Right.

T: So you wouldn't have connected them.

Chapter 9: Students Define Decay Factor
Approximate times 24:26 - 29:36 (times from start of video)

Slide:
On Day 2 students begin to define what Exponential Decay and Decay Factor might mean.

Line 1, 24:32 T: Logan.

Logan: Uh, instead of like an increase of the factor it's a decay factor.

T: Say that again. I couldn't understand you.

Logan: It's a decay factor instead of a growth factor.

T: And what tells you this is not a growth factor?

Logan: 'Cause it's not going up –

James: It's not growing.

Line 10, 24:48 T: It's not growing.

Logan: It's decreasing.

Elle: Oh, I think I get what decay factor means now.

T: What do you think decay factor means, Elle?

Elle: It's sort of like going up, like if you decay, you go down, so like this would be like, the, the decay is going down instead of up.

T: So let's put that in vocab. How can we put in vocab what Logan and Elle have just said? To help us with that, can somebody tell us how we defined growth
Line 20, 25:14 factor? Ashley.

Ashley: It's the number you multiply by on an exponential table.

T: So you said it's the number you multiply by on an exponential table. What are we going to say for decay factor? Somebody have an idea? Logan.

Logan: It could be just the same, because you can still multiply by a fraction of a number.

James: It's like the, it's like the same as decay factor, except it's -

Line 30, 25:43 Logan: It's the same as decay -

Students, off-camera: Same as growth factor -
James: It's the same as growth factor, except it's decaying.

Logan: Yeah. Only it's like, it's not, it's not a whole number, it's -

James: You're multiplying, multiplying by a decimal.

Logan: Yeah.

James: A part of it.

Line 40, 25:54 T: So, how can we put into words what you guys are saying to it'll make sense to us a day from now?

Collin: Like, it's how much it decreases by in either multiplication or division, like how much the, like, line or graph or whatever that is, how much it will go down by, uh, and it can be either multiplication or division, alright? Does that make sense, or no?

T: You guys said "how much it decreases by," -

S: Right.

Line 50, 26:28 T: And then you said "using multiplication or division." Can you clarify that, 'cause that confuses me? Why do you have using multiplication or division?

T: So how will I know whether I'm going to be using multiplication or division if I have exponential decay? I see what Elle is saying, that in one of these equations we talked about it as division, and in one of these equations we talked about it as multiplication. I just wanted a way to kind of clear it up in my vocabulary because I don't want to look
Line 60, 27:02 at this in a couple days and go "Do I multiply or do I divide?"

James: Well, it doesn't matter as long as you can,as long as you can make'em the same, like if it - like you can divide by 2 or multiply by half,

Logan: 'cause it's the same thing.
T: But how can I write that in here to remind myself of that. Katie.

Katie: Um, you divide it when there's a whole number and you multiply it when there's less than 1.

Line 70, 27:27 T: Okay.
S: Part of a whole.

T: Could I use negative numbers?

Class: Yes. Yeah.

T: And would negative numbers cause the exponential decay to happen?

S: Yeah.

T: Okay, Collin, would you try a couple and see if a negative number will work.

Collin: Okay,

Line 80, 27:44 T: And then while he's trying that, for division you guys had said something and now I've forgot what you wanted me to write here. Jon.

Jon: Um, if it's a whole number and then you, then you have to divide.

T: Would it help, like Logan said, to put an example in?

Class: Yes.

T: Should we put this one in?

Logan: No.

Line 90, 28:00 T: No?

Class: No.

T: A different one?

James: Yeah.

T: What one, what'd you want to put in here that would help us?

Logan: Uh, like 27, um, divided by 3 - what was, wasn't it divided by 3 uppity X yesterday?

T: I think we did do one like that yesterday.

Logan: Yeah, and then, then the other one I did was
Line 100, 28:22 Y = 27, uh, er -

James: Times –

Logan: Times, er,parentheses 1 divided by 3 uppity X.

T: So this is what you guys mean by using a whole number when you're dividing?

S: Yup.

T: And this is the fraction that you would multiply by and they mean the same thing?

Logan: Yeah.

Line 110, 28:44 T: Or the decimal of you'd put the 1/3 as a decimal. Heather.

Heather: I tried the equation on the board, 64 one, and I put it as a negative 2 to the X, and it doesn't work, 'cause you, it goes up but it's negatively going up.

T: So you're getting more and more negatives?

Heather: Yes.

Collin: Yeah. I've, I've been doing it. I've been trying a whole bunch of different numbers with the
Line 120, 29:10 negative. Every time I do it it's, uh, it's going down but it's negative down, so it's -

T: And that's not what you want.

Logan: You can't, you can't use a, you can't use a negative number, so I guess we're gonna have to put "between zero and 1" for the fraction part.

Slide:
Showing Student Definition of Decay Factor

Chapter 10: Teacher Reflection after Day 1, 4.1.

Approximate times 29:37 – 31:18 (times from start of video)

No transcript available

Chapter 11: Teacher Reflection after the Summary of 4.1
Approximate times 31:19 - end (times from start of viedo)

No transcript available