

Description: Building large models to show equivalence: A generalization (side view) Date: 1993-10-11 Location: Colts Neck Elementary School Researcher: Professor Carolyn Maher	Transcriber(s): Yankelewitz, Dina Verifier(s): Yedman, Madeline Date Transcribed: Spring 2009 Page: 1 of 23
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Line	Time	Speaker	Transcript
11.0.1	3:24	T/R 1:	Well, good morning! I surprised you, I came back! Yeah! I just couldn't stay away. I heard such really wonderful things happened on Friday and I watched a tape on Thursday, so I had to rearrange my schedule so I could be here, and I'm just so happy to be here. Um, I was watching the tapes, you know I do that, and I was reading your papers, and I did that, and I was also talking to some of the people who were here when I wasn't here, and trying to figure out some of the things you were doing. And I understand that, uh, let's see, I think it was on Thursday, that you were working on all sorts of problems, everybody was working on something, I know this group here with Amy James and Jackie, they discovered a secret, they told me, do you remember? Yes, and then I know that there was a group here, I think that was Alan, Erik, David, and Meredith, who were testing a theory? Is that right, you were testing a theory? So we have a secret that we want to hear about, we have a theory that was being tested, and then I know that, um, Andrew's not here?
11.0.2		CT:	Yes he is but [some excuse]
11.0.3	3:45 (S)	T/R 1:	Ok, but he and Jessica had also built a model, right, that was rather interesting for one of the problems, that they were sharing with Brian and Michael. Remember that, and also with Erik was over there, I noticed talking about their model and some other people came over. And um, there were all kinds of interesting things happening, uh, and I read some of the papers of the different kinds of thinking you were doing, and um, Sarah had built a new model that I hadn't seen for one of her problems and Kimberly and Audra and Erin and Jackie, and oh, just such exciting things, I mean, how can we get to all of this? And, um, back there, Graham and Kelly were building their models as well. So I thought that, you know, maybe what we'll do is we'll start with some of the things that confused me and maybe you can help straighten me out. Um, I know that one of the things that happened was when the group built a model on the floor, I looked at that tape, um, on Thursday, and the group built a model to test David's theory which I'm sure David and his friends will share with you, and then the next day, when I think it was David, Erik, and Meredith

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---	--

trying to build it again they had some trouble. Uh, and I wondered if they figured it out, I didn't finish watching that tape, but I watched the one the day before. Some of you are already working on different problems by now, now we have Andrew back he can tell us his theory, so I thought you know, maybe we would start with that and then, you know, try to have you all contribute and share and, wouldn't it be nice to know what other people are doing now? Aren't you interested in what other groups are doing and the way they're thinking about some of these problems? I get kind of curious, you know, once I've worked on something after a while, I wonder I say, I wonder how other people are thinking about this, I wonder what they're doing, what do you think, Alan? Do you get sick of it after a while or do you want to be curious about it. You know, it depends, I suppose. Um, do you remember the problem that, uh, I think everybody in this class has now spent a bit of time working on the problem, which is larger, three quarters or two thirds, and, if you decide which one is larger you were asked, by how much. Do you remember, how- Everybody here has worked on it, isn't that true? Raise your hand if you've worked on that problem? I believe everybody, yeah. Some of you started a new one, but everybody has worked on that. Ok, the question, how many of you have built two models for that problem? For that problem, which is larger, three quarters or two thirds, how many of you built two models? [Some students raise hands] Ok, how many of you have built more than two models? [Three raised hands are seen]. So we have some, you know, really differences here and some time to share, and Gregory you built more than two also and Danielle, you've got two models. Um, how many you think there are? How many models do you think you can build? Michael.

- 11.0.4 6:52 Michael: Um, if you know what you're doing and you know what strategy, you could probably build, you could probably build one for every single rod.
- 11.0.5 T/R 1: What do you mean, one for every single rod, tell me what you mean by that.
- 11.0.6 7:14 Michael: You could, you could build a thing, you could build fractions of every single rod if you know what you're doing

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---	--

- and you have a strategy or a secret that, that you know will work.
- 11.0.7 T/R 1: What can be such a secret?
- 11.0.8 Michael: That's what I was trying to figure out.
- 11.0.9 T/R 1: That's what you were trying to figure out? Does anybody else have any ideas about that? Those of you who built three models, do you think that's all? Can you build more? This table here, Jackie and James, Amy, you think there can be more? [mmm hmm] How many do you think?
- 11.0.10 Amy: Well, we got six
- 11.0.11 T/R 1: You think that's it?
- 11.0.12 Jessica, Amy, James: [Shake heads] No.
- 11.0.13 T/R 1: No? Anybody else? Any thoughts? [Meredith raises her hand] Meredith? What do you think?
- 11.0.14 8:00 Meredith: Well, maybe if you, say you had a white rod, and you divided the white rod, maybe you could make more models that way, if you divided the white rods.
- 11.0.15 T/R 1: So you're thinking if you had more, different size rods?
- 11.0.16 Meredith: Yeah, yeah.
- 11.0.17 T/R 1: Like if you took the white rod and designed one smaller than the white rod? [mmm hmm] Ok. Anybody else, what do you think? There was a theory, I know David's looking at what we built here, David you had a theory that you were testing about uh building some models. There were some models that everyone here built, maybe we should put two of them on the overhead, if you can help me do that, to compare which is bigger three quarters or two thirds. Um, to decide with the rods you have, what was the smallest model you can build? With the rods you had available, not being able to cut them or make them different. Did you find- is there a smallest model, when you compared three quarters or two thirds? [pause] Can you remember? What, what do you think, Mark?
- 11.0.18 Mark: um, I think, (Pause) I'm not that sure.
- 11.0.19 T/R 1: You're not sure, you want to think a little bit more? Sarah, what do you think? I see Sarah and, uh Beth? What do you think?
- 11.0.20 9:42 Sarah: Um, there's a smaller one.
- 11.0.21 T/R 1: What do you think it is? You want to come up and build it really quickly? [Sarah and Beth get up] Maybe while they're, they're building the small one, you can think of the

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---	--

- next one. I don't think all will fit on the overhead, but at least we'll get some of these models up, we might have something to talk about. [Sarah and Beth build a model of a light green and white train, two red rods, and four white rods] Ok, what do you think?
- 11.0.22 Erik: I think it's, they're right, but one green and uh, and a one I think equals one purple, because if you would put that to that it would just equal one purple and put the
- 11.0.23 T/R 1: Ok, tell me what you're showing up here, uh, Sarah and Beth. You can put a purple up there, too. Erik is suggesting above it.
- 11.0.24 Sarah: Yeah [She places a purple rod above the model]
- 11.0.25 T/R 1: Ok, but tell us what you're showing. We're trying to show three quarters and two thirds, is that right? [mmm hmm] Uh, can you show us how that shows three quarters and two thirds? [Sarah and Beth whisper to each other]
- 11.0.26 Beth: Oh, we don't have, [to T/R 1] We don't have thirds in there.
- 11.0.27 T/R 1: oh, ok.
- 11.0.28 Beth: We only have the half and the whole.
- 11.0.29 T/R 1: Ok, so you have three quarters and a half. Ok. Can you build one for three quarters and two thirds? Does someone have any other suggestions? Alan? Did your hand go up or did you just wave it? Anybody else remember how you did that? Kelly, you think you have something, you want to come and help? Graham, you can come and help.
- 11.0.30 Kelly: I don't have fourths in my one that I made
- 11.0.31 T/R 1: You don't have fourths? How about here? Amy? James? Jackie? [Amy James and Jackie come to OHP] Oh we're starting to get think- we're starting thinking now. [Amy, James, and Jackie build the model using orange and red train as one, purple as one third, and light green as one quarter.] Ok, you want to tell the class about what you have there?
- 11.0.32 James: Ok, um, well um, we had this model and we uh this is two thirds and three fourths and we think that three fourths is bigger by one twelfth. [He separates two purple rods and three light green rods from the original model to show the comparison].
- 11.0.33 T/R 1: Questions, anybody? What's one twelfth?
- 11.0.34 James: Because, um, twelve whites equal up to this. Let me show, here. [He puts two white rods on his model]

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- 11.0.35 T/R 1: Are you all convinced?
- 11.0.36 Jessica: But didn't you say to make a smaller one?
- 11.0.37 T/R 1: Well I said you make the smallest one you can make?
- 11.0.38 Jessica: But I don't think that's the smallest one.
- 11.0.39 T/R 1: Can you make a smaller one? It's an interesting question. If you don't think there's a smaller one you should be able to show it, or at least-. [James and his partners continue placing the twelve white rods on the OHP]. What do you think?
- 11.0.40 James: Well, we just put twelve whites on there and it takes one white to equal the two pinks, to the three, oh yeah, purple to the three greens. So that's why we think it's one twelfth.
- 11.0.41 T/R 1: How many of you agree with that? How many of you agree with that model? How many of you found that same model when you worked it out? Raise your hand if you found the same model. [All students visible raise hands] Ok, it looks as if everyone did. I have a question that Jessica is raising, I'm listening to Jessica next to me. Jessica says she thinks there's a model that you can build that's smaller, now, when I use the word smaller, you use the word smaller, what do you think we mean? What do you think, Erik?
- 11.0.42 Erik: Smaller in size-wise? Like size for the thirds, the fourths, and, and the whole. Smaller by size.
- 11.0.43 T/R 1: Ok, so what what we called one in this problem was what, what did we call one? Brian?
- 11.0.44 Brian: Well, um, the orange and the red.
- 11.0.45 T/R 1: Yeah that train we called one, right? And I guess the question is, that train has a particular length, right? You can see the length of that train? Is it possible to build a model to show the comparison of three quarters and two thirds with a train that has lengths smaller than that, now if you think it isn't, you've gotta convince me with some argument.(Oh I know) Oh, Erik thinks he has an argument to convince me there's not a smaller one because Jessica doesn't believe it. Right, Jessica? Jessica seems to think there's one that can be made with a train that has length shorter than the one up there. So if you think you have an argument, Erik thinks he does, raise your hand. I want you to think about this. You might want to talk to your partner about your argument and see if your partner buys it. You don't have to talk to your

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---	--

- partner. Ok, we'll let you guys go first and Erik is listening to see if he agrees. Ok.
- 11.0.46 17:41 Amy: We say that there was no more, that you can't get a smaller one because every one you use equals up to an orange and a red, and the secret is that every one has three purples and four greens. And so you can't possibly make one smaller because you won't be able to fit, it won't work because every one you make equals up, equals up to the orange and red.
- 11.0.47 T/R 1: So you're telling me the six models that you made
11.0.48 Amy: Were the same length.
11.0.49 T/R 1: Were all the same length. In all of your cases, the, the, what you called one had the same length as the orange and red. That's very interesting.
- 11.0.50 James: Well, well, we could make another model to show that.
11.0.51 T/R 1: We believe you. Does anybody need to have that shown, what they would've done? How many of you did that too? You found different ways to show one, that had the same length as orange and red,
- 11.0.52 Beth: Yeah, Sarah just built another model that uses the exact same length as the other one.
- 11.0.53 T/R 1: And what did, what was, how did she make her train?
11.0.54 Jessica: Yeah, that's what I was going to do.
11.0.55 Beth: Blue, light green, and then the half is dark green, and the third is purple and the fourths were the dark greens- were the light greens.
- 11.0.56 Jessica: See, that's what I did, I was gonna make one that was the same exact size.
- 11.0.57 T/R 1: Ok, so many of the models you made were really models where your, what you called one, that train, really had the same length as the orange and red. Is that all you can make? How do you know that, that, that there's not one smaller? Erik? I'm still not convinced that there's not one smaller. They didn't convince me. How would you convince me?
- 11.0.58 19:22 Erik: Well, see, I agree that, that, I agree with them just at the part that there's no, there's no other smaller. I think, because at their model, they use the twelfth as the white ones, and there's no rod smaller than the white rod. So, therefore, if you make it a rod smaller than it, they can't, you can't divide it into twelfths.
- 11.0.59 T/R 1: Ok. Did you hear what he said? Yeah!

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- 11.0.60 Erik: Because the twelfths right here are the smallest rod possible.
- 11.0.61 T/R 1: Ok, so
- 11.0.62 Erik: Unless you made a new rod.
- 11.0.63 T/R 1: So unless we use Meredith's idea of creating new rods that had, that were smaller than the white rods, then you could make a smaller model, Erik?
- 11.0.64 Erik: Yeah.
- 11.0.65 T/R 1: The rest of you agree with that? So, so then, ok, I'll buy that, how many of you buy that argument? That seems reasonable. So you've made the smallest one already. Jessica, is that reasonable to you?
- 11.0.66 Jessica: Yeah.
- 11.0.67 T/R 1: Ok, my next question is, can you make one that shows the comparison of three quarters and two thirds, that's bigger than this? Are there others?
- 11.0.68 Students: Yeah.
- 11.0.69 Michael: I know, I just did one.
- 11.0.70 T/R 1: Ok, um, you think there are others, ok. You have another one?
- 11.0.71 Michael: Yeah.
- 11.0.72 T/R 1: I would like one, that uh, is the next smallest.
- 11.0.73 Michael: Next sma-
- 11.0.74 T/R 1: Can you predict something about the one that would be next smallest? I mean next largest, I'm sorry. The one that's the next largest. Brian, what's your prediction?
- 11.0.75 Brian: I think it would be twenty-four.
- 11.0.76 T/R 1: You think what would be twenty-fourths? What rods?
- 11.0.77 Brian: Well, the next, the next, the next larger one will be, I think the whole will be twenty-four.
- 11.0.78 T/R 1: But we, we call the whole one.
- 11.0.79 Brian: Yeah, I know, but what I mean
- 11.0.80 21:01 Michael: No, no, it would take twenty four ones to equal a whole.
- 11.0.81 T/R 1: What would be, what would be twenty-fourths?
- 11.0.82 Brian: Like the, there would be, there would take twenty-four white cubes to equal up to a whole
- 11.0.83 Student: I, I also have a strategy
- 11.0.84 T/R 1: Wait, wait a second, you're saying twenty-four white ones would equal your train.
- 11.0.85 Brian: Yeah, yeah.

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--	---

- 11.0.86 T/R 1: That you're going to call one. So then what would one white one be called in that next model do you think?
- 11.0.87 Michael: One twelfth
- 11.0.88 Brian: I think, um
- 11.0.89 T/R 1: What would that white one be called?
- 11.0.90 Michael: Well it's not gonna, we're not gonna. Let me see this [Michael begins to build the model]
- 11.0.91 Brian: Um, one twenty-fourth I think.
- 11.0.92 T/R 1: Brian thinks then white ones in the next train would be one twenty-fourth. You think that too?
- 11.0.93 Erik: Yeah, Alan and I made that same model. We made the same model that was, I think it was two oranges and like one purple, yeah it was two oranges and one purple and then it had the thirds
- 11.0.94 T/R 1: Ok, why don't the rest of you sit down and let's have Erik and Alan make that model. Did you make it too, Michael? Is that what you had?
- 11.0.95 David: I made that also
- 11.0.96 T/R 1: Ok, you watch what they're doing, and seeing if -leave that other one up there ohhh! Ok, can you leave the other one up there maybe while you're making that?
- 11.0.97 Erik: Sure we can.
- 11.0.98 T/R 1: Keep the other one up there. Erik: Just move this over.
- 11.0.99 T/R 1: James, why don't you make the other one too, so it doesn't go away on the bottom.
- 11.0.100 22:14 Brian: Kaitlin, can I borrow some oranges. [whispering, inaudible] 2 more, no [starts to count something in his model] 6 more
- 11.0.101 23:20 (F) T/R 1: The rest of you could be making these if you haven't already, in your seats just so you have them in front of you. I would suggest you to make both models in your seats and keep them in front of you.
- 11.0.103 Brian: Oh, you need a lot. I need some, I need some oranges to make this big one that I made last time.
- 11.0.104 Michael: I know.
- 11.0.105 Brian: I need a lot of them. Nobody can give me any!
- 11.0.106 Michael: [laughs and gets up to look for rods]
- 11.0.107 Erik: Ok, I got it, I got it.
- 11.0.108 Alan: I'll get the ones up.
- 11.0.109 Erik: You want me to help you because there's a lot of them?
- 11.0.110 Alan: Yeah [laughs]

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---	--

11.0.111 Erik: A lot of those little.

11.0.112 Alan: Hold it, let's just straighten this out.

11.0.113 Erik: [whispers, inaudible]

11.0.114 Alan: Oh yeah, you do, you're right. All Mondays.

11.0.115 Erik: We don't need dark greens.

11.0.116 Alan: I know.

11.0.117 Erik: The whites were the twenty- what were the twelfths? Reds.

11.0.118 23:43 Alan: Twelfths, You do the twelfths - Sadly to say I don't think there are enough ones.

11.0.119 Erik: Oh I think we will.

11.0.120 Alan: We might. Don't give up hope now old chum.

11.0.121 Erik: [counting] Oh I found another white one.

11.0.122 Alan: Never mind, we got to the point where I think we have too many.

11.0.123 Erik: Four five six seven eight nine.

11.0.124 Alan: Oh here.

11.0.125 Erik: Ten, I need, ok, perfect, I got twelve, I'll put them up here.

11.0.126 T/R 1: You can use this as a ruler if you'd like.

11.0.127 Alan: Wow.

11.0.128 T/R 1: Here, this might work better.

11.0.129 Alan: those are big.

11.0.130 Erik: I wonder if they work on this.

11.0.131 T/R 1: No, just as a ruler, they won't work on it.

11.0.132 Erik: Did they just turn black?

11.0.133 Alan: Yeah, you just push on that side and I'll push on this one.

11.0.134 Erik: No these look like they're coming out, they're like, they you can't see them.

11.0.135 Alan: Ok, so we do - Erik, move your arm. We need one more, two more ones down at the edge.

11.0.136 Erik: Uh, let's see.

11.0.137 T/R 1: You know what the problem is, some of this you can't see so let's just do it this way.

11.0.138 Erik: I don't if we - do we have enough reds?

11.0.139 Alan: Yeah, no, we need one more.

11.0.140 Erik: One more?

11.0.141 T/R 1: Ok. That's beautiful.

11.0.142 Erik: Let's, there we go. Ok.

11.0.143 Alan: Ok. Erik, you talk.

11.0.144 Erik: Just, I don't think we need this. [laughs]

11.0.145 Alan: What?

11.0.146 Erik: I don't believe we need this right here.

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--	--

- 11.0.147 T/R 1: Ok, leave that there, in fact if I had more whites I would even. But what you can do is show it here, right? Two thirds. Right by the twelfths up here. That's not bad. Let's talk about this.
- 11.0.157 T/R 1: Ok. Now I know, I know you're building these models and I know you don't have enough rods so I know that you have to uh, share some of your uh rods and sometimes you can only build one model on a desk, and I know some of you are able to imagine the models now too. How many of you could imagine what it looks like, even though you haven't quite built it? Raise your hand if you could imagine what it looks like. [A few children raise their hands] I'm kind of curious, what do you imagine that you don't have there, Jessica? I see that you built a model that has two oranges and a purple that you're calling one.
- 11.0.158 Jessica: Well, I imagine the white ones.
- 11.0.159 T/R 1: And you're imagining the whites, and how many do you imagine are there?
- 11.0.160 Jessica: Twenty-four.
- 11.0.161 T/R 1: You're imagining twenty-four. And Andrew, I see, built it. And how many do you have there, Andrew?
- 11.0.162 Andrew: Um, twenty-four whites.
- 11.0.163 T/R 1: Andrew has twenty-four. And can you see on the overhead how many whites, those of you who don't have enough? Can you see? I know it's hard, I have trouble counting when it's not nearby when there's so many little pieces. But you built it too, Amy, how many do you have, Amy?
- 11.0.164 27:08 Amy: Twenty-four.
- 11.0.165 T/R 1: Twenty-four? Yes?
- 11.0.166 Student: Twenty-four.
- 11.0.167 T/R 1: Twenty-four also. How many of you are convinced that with the model, that Alan and Erik have up on the overhead, how many of you are convinced of the number of white cubes there? [Two hands visible are raised]. How many of you are convinced how many are up there? Raise your hand if you're convinced how many. Because if you're not, you may want to go up and count them to be sure or go to someone else who built the model and count them.
- 11.0.168 Michael: I, I built the model.
- 11.0.169 T/R 1: How many of you have a model that shows that there are twenty-four? Raise your hand if you have a model nearby.

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---	---

- Ok, so Sarah and Beth, you built one, you don't have enough?
- 11.0.170 Beth: No.
- 11.0.171 T/R 1: I'm sure Andrew will lend you a few if you want to complete your model. I guess you need some whites and some reds. Ok, they don't need quite that many. Ok, do you believe there are - Sarah and Beth?
- 11.0.172 Beth: Yeah [Sarah nods]
- 11.0.173 T/R 1: Are you convinced, Kelly and Graham? You're convinced? Let's see, Michael and Brian I know you're convinced, I saw you had that built. Kimberly and Audra, are you convinced? [Audra nods] What about Gregory and Danielle - are you convinced [mmm hmmm] You're convinced also? Erin and Jackie? Ok, I know David and Meredith are convinced, and ok, so it sounds as if everyone is convinced that that's the case. So now, let's talk about, um, Erik's theory, Erik says now that the white one on this model, the larger model, where we called one the train that was made up of two orange and one purple, right? That particular train that he built? That he's now going to give the white one the number name, what, class?
- 11.0.174 Students: One twenty-fourth.
- 11.0.175 T/R 1: One twenty-fourth. So you agree with Brian's conjecture. Right? Brian says one twenty-fourth. How many of you agree with Brian's conjecture? [All students visible raise hands] The white one in that model has the number name one twenty-fourth. Now how does that help you solve the problem what is the difference between two thirds and three quarters, gentlemen who are up there? We know the white one has number name one twenty-fourth in that model.
- 11.0.176 29:13 Erik: Uh, see what we did here was we have the fourths and the thirds.
- 11.0.177 Alan: Yes, mmm hmmm.
- 11.0.178 Erik: And then the twelfths and they, they said that the twelfths would do it.
- 11.0.179 Alan: mmm hmmm
- 11.0.180 Erik: So the twelfths would be the reds which is one, which is two whites, and then people think the twelfths would be the answer, but if you take two of the twenty-fourths
- 11.0.181 Alan: It would equal up to a red rod.
- 11.0.182 Erik: It would equal up to a red rod.

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---	---

- 11.0.183 Alan: Which would be equal to twelfths.
- 11.0.184 Erik: Which would be one twelfth. So, see, we think, I think that the answer is either two twenty-fourths or one twelfth.
- 11.0.185 Alan: Mmm hmmm.
- 11.0.186 T/R 1: How many of you agree with what they said?
- 11.0.187 29:46 Alan: So there are two answers. Both the same
- 11.0.188 T/R 1: You agree the answer is either two twenty-fourths or one twelfth. Does anyone think the answer is one twenty fourth? Ok, that's very interesting, that's very nice, gentlemen, thank you that's lovely. That was very helpful. And then I remembered - let's leave that up there, you can sit down. I have another question. I remember then some people had written - do you have a question, Amy?
- 11.0.189 Amy: No, I just want to say something.
- 11.0.190 T/R 1: Ok.
- 11.0.191 Amy: Um, that, but two reds equal up to a purple.
- 11.0.192 T/R 1: So?
- 11.0.193 Amy: So you could put six purples down to make
- 11.0.194 Erik: What do you mean six purples?
- 11.0.195 Amy: Beacu- six purples, because look. [holds up a purple and two reds]
- 11.0.196 Andrew: Ok, but why would you need the purples?
- 11.0.197 Erik: Why would we need the purple? It's only one twelfth.
- 11.0.198 Amy: I know, but you could also do it that way. You could also put six.
- 11.0.199 Alan: Why would we need that?
- 11.0.200 Erik: We only need one twelfth. It's either two twenty-fourths or one twelfth.
- 11.0.201 Alan: They're both the same answer.
- 11.0.202 Erik: They're both the same answer.
- 11.0.203 Amy: I know.
- 11.0.204 Alan: [inaudible drowned out by Erik]
- 11.0.205 Erik: But why would we need the purple. The purple would be too big.
- 11.0.206 Amy: Six purples equal up to the whole train you made.
- 11.0.207 Erik: But why do we need - we don't need sixths. We only need thirds and fourths.
- 11.0.208 Alan: Yeah why would we need that?
- 11.0.209 Erik: And twelfths and twenty-fourths. That's all we need.
- 11.0.210 Amy: Ok [sighs]
- 11.0.211 Erik: I don't think we need sixths.

Description: Building large models to show equivalence: A generalization (side view) Date: 1993-10-11 Location: Colts Neck Elementary School Researcher: Professor Carolyn Maher	Transcriber(s): Yankelewitz, Dina Verifier(s): Yedman, Madeline Date Transcribed: Spring 2009 Page: 13 of 23
---	---

- 11.0.212 T/R 1: So it sounds like Amy is answering a different question. I think I hear the que- I hear what Amy is saying because I heard her say it earlier. Amy is saying there are other ways you can uh make trains, right? That have length [Amy nods] of two orange and one purple. And I know that this table spent a lot of time doing that, of course what Erik and Alan and James are saying that's true, but it really isn't necessary or related to solving this problem. Do you agree with that, Amy? [Amy nods and says mmm hmmm] But that's an interesting thought that there is another way and when you think about all those purples there, what number name would you give to a purple then?
- 11.0.213 Amy and Erik: One sixth.
- 11.0.214 T/R 1: So I think that Amy is saying look! On this same train I could show one sixth! Which almost suggests I could ask you another problem. [Erik laughs]
- 11.0.215 Erik: Which is if you asked another, Which is Which is if you asked a question with a sixth, then you
- 11.0.216 Alan: Then you do it
- 11.0.217 Erik: Then you could do it.
- 11.0.218 T/R 1: Yeah, but I could ask you a question which is bigger a sixth or three quarters. Don't do that now!
- 11.0.219 Erik: Then, then you do a sixth!
- 11.0.220 T/R 1: Don't do that now, but I could ask you that question, couldn't I, which is bigger a sixth or three quarter?
- 11.0.221 Erik: Yeah.
- 11.0.222 T/R 1: And you should be able to answer it with this model. [Erik says yeah] Let's hold that question for a minute. I don't want to lose the question but I don't want to lose what we're talking about so we'll put that aside. I remember last Thursday when I walked around the room then I said could you make another model and a lot of you said "oh you know I don't have enough. I don't have enough of these blocks so I said can you imagine it and I remember talking and I know Andrew actually made the model when David had a theory that he shared with um Erik and Alan and Meredith, right, David? And so he shared a theory and I remember Erik said hey wait a minute that's what Andrew built! And then Jessica said that they already built what the theory was, that's what I heard, so I'd like to hear um, David's theory again, if you don't mind, David, if you think

Description: Building large models to show equivalence: A generalization (side view) Date: 1993-10-11 Location: Colts Neck Elementary School Researcher: Professor Carolyn Maher	Transcriber(s): Yankelewitz, Dina Verifier(s): Yedman, Madeline Date Transcribed: Spring 2009 Page: 14 of 23
---	---

you can remember your theory and Andrew I want you to listen very carefully and Jessica and the rest of you I want you to listen carefully to David's theory because it really has to do with if I were to make another model, is it possible do you think to make another model if we had more blocks, it is a possible thing to do? [Student says yes]. How many of you think we can [Most/all students visible raise hands]. Ok. How many of you think we can make another model? Some of you aren't sure, how many of you aren't sure? Meredith's not sure? Erik's not sure? Danielle's not sure? Audra's not sure. Ok. How many of you are sure we can make another model? [All other students raise their hands.] Ok, that looks like that's James and Alan and Andrew and Jessica and Beth and Sarah, Kelly, Graham, Brian, Michael, Caitlin, did I leave anybody out? David is sure. Ok. Let's listen to David's theory and see if we could convince those or else they have to show us our theory doesn't work.

- 11.0.223 David: Well, first, um, Meredith made um, a model which had one orange, one blue, and one black.
- 11.0.224 T/R 1: Ok, she made a model with an orange a blue and a black. That's what you told me?
- 11.0.225 David: Yeah. And then she had, um, the whites, I think they were something like
- 11.0.226 Erik: Twenty-fourths.
- 11.0.227 David: Yeah, one twenty-fourth and the reds were one twelfth and, um,
- 11.0.228 34:28
35:26(F) Erik: Just like the one up there.
- 11.0.229 David: Yeah.
- 11.0.230 T/R 1: So you're saying that if I had an orange, a blue and a black, that the model should look like the one up here.
- 11.0.231 Erik: Just about.
- 11.0.232 T/R 1: But it doesn't.
- 11.0.233 Erik: well...
- 11.0.234 T/R 1: Right? See what happens?
- 11.0.235 Erik: But then, then the one, then the, the uh, um, I don't know
- 11.0.236 Alan: Then the reds couldn't be twelfths.
- 11.0.237 Erik: Yeah, then the reds couldn't be twelfths and the whites couldn't be twenty-fourths.
- 11.0.238 Alan: Right, it would either take one [inaudible]

Description: Building large models to show equivalence: A generalization (side view) Date: 1993-10-11 Location: Colts Neck Elementary School Researcher: Professor Carolyn Maher	Transcriber(s): Yankelewitz, Dina Verifier(s): Yedman, Madeline Date Transcribed: Spring 2009 Page: 15 of 23
---	---

- 11.0.239 T/R 1: Andrew, what do you think? Andrew and Jessica, what do you think?
- 11.0.240 Andrew: [Refers to twenty-four cm model on desk] Well, I made a model that had the white was one forty-eighth and the purples were twelfths and the white was, I mean the red was twenty-fourths and I took two browns as the thirds and two dark greens as the fourths and they I called them the fourths and then the whole was four oranges and two purples.
- 11.0.241 T/R 1: Now, you're telling me that you used browns, two browns to be
- 11.0.242 Jessica: One, like one, one third.
- 11.0.243 Andrew: Yeah.
- 11.0.244 T/R 1: One brown was one third, two browns was two thirds?
- 11.0.245 Andrew: No
- 11.0.246 T/R 1: Is that what you're telling me?
- 11.0.247 Erik: No
- 11.0.248 Andrew: Two browns was one third
- 11.0.249 Erik: Two browns was one third.
- 11.0.250 Andrew: I took two browns and put them together
- 11.0.251 T/R 1: Two browns to be one third!
- 11.0.252 Andrew: Yeah.
- 11.0.253 T/R 1: Oh, ok, that's not going to fit. But maybe, um, you want to come up here and do that? [Andrew and Jessica come to front of class.] Ok, here you go. Why don't you build that right here. Do it up front here, uh, why don't you come all the way around, Jessica. Ok, let's see what they're doing here because, um, it looks to me as if you need a bunch of rods to do this. [They work for about two minutes to build the model of a train of four oranges and two purples, six brown rods and eight dark green rods, and twelve purple rods, twenty-four red rods, and white rods]
- 11.0.254 Andrew: It might not be enough.
- 11.0.255 T/R 1: Now, I want all of you to see what Jessica and Andrew are building, and, now you all can't come up at one time, so I'm gonna, if it's ok with Mrs. Phillips, I'm gonna ask you in little groups to go up there and take a look at their model and so um we can be able to talk about it and then some of you maybe can look at it from where you're sitting. I know that Gregory and Danielle are very fortunate - they have front row seats. I think, can you see Alan and Erik?
- 11.0.256 Erik: Not really.

Description: Building large models to show equivalence: A generalization (side view) Date: 1993-10-11 Location: Colts Neck Elementary School Researcher: Professor Carolyn Maher	Transcriber(s): Yankelewitz, Dina Verifier(s): Yedman, Madeline Date Transcribed: Spring 2009 Page: 16 of 23
---	---

- 11.0.257 T/R 1: Not really. So some of you are going to have to go up in a minute to see what they're doing. So why don't we start at least with Erin and Jackie, why don't you sort of kind of come up and see what they're building. Be careful there's a cord here too. Ok, if you've seen what they're building and you think you understand how they built their model, then if you can sit down and then I'd like another group to come up and see.
- 11.0.258 Jessica: [Explaining to Erin and Jackie] And what we did is, this was our whole and this was like, these, like, um, two, [takes two brown rods and holds them together] two browns equal one third, like we counted two as one. And those were our thirds, and two greens was one, and one two three four, so those were our fourths, and
- 11.0.259 Andrew: Purples were the
- 11.0.260 Jessica: Purples were the twelfths and the reds were the
- 11.0.261 Andrew: Twenty-fourths
- 11.0.262 Jessica: And the white ones were forty-eighths.
- 11.0.263 T/R 1: Ok, it looks like it's going to be a little harder than I think, I think that you're gonna need an explanation when you go up. And so I think maybe we should have, rather than have you do this a lot of times, maybe we should have a few explanations. Maybe we should have more people up here. Um, some of you can come around while we can hear Andrew and Jessica - would you mind doing this a couple of times?
- 11.0.264 Jessica: Yeah.
- 11.0.265 T/R 1: So why don't you come around, a few of you can come around the table and listen to their explanation. I think that's the best way. Some of you can come behind the table, I think.
- 11.0.266 Andrew: So what we did was, we, um.
- 11.0.267 T/R 1: Ok, just a second, let's wait till as many people, uh, can
- 11.0.268 Andrew: We had, the, um, whole, was four oranges and two purples, and then we, our strategy was we took two browns and we put em together and they were the third. And then we took two dark greens and put them together and they were the fourths. And then the purple was the twelfth
- 11.0.269 Jessica: Twenty-twelfth.
- 11.0.270 Andrew: And the red was the twenty-fourth and the white was the forty-eighth.

Description: Building large models to show equivalence: A generalization (side view) Date: 1993-10-11 Location: Colts Neck Elementary School Researcher: Professor Carolyn Maher	Transcriber(s): Yankelewitz, Dina Verifier(s): Yedman, Madeline Date Transcribed: Spring 2009 Page: 17 of 23
---	---

- 11.0.271 Jessica: Forty-eighths.
- 11.0.272 Andrew: And,
- 11.0.273 Jessica: Cuz, what we did really to figure it out.
- 11.0.274 T/R 1: Well, what's the difference?
- 11.0.275 Andrew: The difference is one twelfth.
- 11.0.276 T/R 1: Can you show us?
- 11.0.277 Jessica: Yeah.
- 11.0.278 Andrew: Ok, we don't have enough, we'll just take them over here. Two thirds, that's all we need, and then
- 11.0.279 Jessica: So, um, do we need anything?
- 11.0.280 Andrew: Here, we need brown.
- 11.0.281 Jessica: We need some of those.
- 11.0.282 Andrew: Ok, well, we came up with the conclusion of that
- 11.0.283 Jessica: That two thirds.
- 11.0.284 43:06 Andrew: That two thirds - that four, three fourths [As Andrew speaks, Jessica points to relevant rods on model] were bigger than two thirds by one twelfth
- 11.0.285 Jessica: By one twelfth [holds up purple rod].
- 11.0.286 Andrew: Or two twenty-fourths [Andrew and Jessica place two red rods and four white rods, to complete the model of a purple, two reds, and four whites]
- 11.0.287 Jessica: Or
- 11.0.288 Andrew: Or four forty-eighths.
- 11.0.289 T/R 1: Ok, now, I'm wondering if some of you can pull aside and maybe the rest of you can come up [break in tape], Ok, can you nice and loud for the people back there show them what you're doing?
- 11.0.290 Jessica: Well, what we did was we made a model and we counted um
- 11.0.291 Andrew: Four oranges
- 11.0.292 Jessica: four oranges and two purples as our whole and for our thirds we counted, we counted two oranges as one, I mean two browns as one. [holds up two brown rods end to end] And we had
- 11.0.293 Andrew: that was our third.
- 11.0.294 Jessica: That was our thirds, and for our fourths we counted two greens as one [holds up a train of two dark green rods], two dark greens as one.
- 11.0.295 Andrew: Purples were our twelfths, the reds were the twenty-fourths [Jessica says twenty fourths] and the whites were forty-eighths.

Description: Building large models to show equivalence: A generalization (side view) Date: 1993-10-11 Location: Colts Neck Elementary School Researcher: Professor Carolyn Maher	Transcriber(s): Yankelewitz, Dina Verifier(s): Yedman, Madeline Date Transcribed: Spring 2009 Page: 18 of 23
---	---

- 11.0.296 Jessica: Forty-eighths. And we think that, we think that, three um, fourths are bigger than two thirds by either, um, one forty- I mean four forty-eighths um, two twelfths, or, um
- 11.0.297 Andrew: No, two twenty-fourths.
- 11.0.298 Jessica: Two twenty-fourth or what's that? One twelfth.
- 11.0.299 T/R 1: What do you think about that, Michael?
- 11.0.300 Michael: I guess I agree with it, it's what I came up with.
- 11.0.301 T/R 1: You came up with the same model, didn't you?
- 11.0.302 Michael: Yeah
- 11.0.303 T/R 1: Did anyone else come up with that same model? That's very lovely. Thank you so much, Andrew, and does anybody have a question to ask Andrew and Jessica before they're finished? Does anybody have a question? Does anybody have a comment? You sure you don't want to ask them any of that? Sarah what do you think?[Sarah says no.] Is that interesting [Sarah says mmm hmmm]? It's very interesting Ok, um, I'm going to ask you to sit down and I want to thank you very much for making that model for us. But I guess I'm asking the question, uh, to Meredith and James and to Erik and Alan right now, uh, does this have anything to do with your theory and the theory you tested? Meredith and David and Erik and Alan - does this model have anything to do with the theory you tested, David?
- 11.0.304 David: Uh, yes because we thought that the ones would be one forty-eighth
- 11.0.305 Erik: And and the
- 11.0.306 David: And then the reds would be, um, one
- 11.0.307 Erik: Twenty-fourth and the purple, well originally, we thought that the light greens would be, well David thought that the light greens would be twelfths, but then we tried it and they would become the sixteenths, so then we tried the purple, yeah the sixteenths and we tried the purple and then that was the twelfths.
- 11.0.308 Alan: Since whites are doubles, they're forty-eighths
- 11.0.309 Erik: So, in other words we doubled everything.
- 11.0.310 Alan: Yeah. You basically just added, like, there originally were just two oranges, now there are four oranges and an extra purple. Now there are six, there are six browns.
- 11.0.311 T/R 1: So let's see, on this model here we had an orange and a red, and then on that model there we have two orange and a

Description: Building large models to show equivalence: A generalization (side view) Date: 1993-10-11 Location: Colts Neck Elementary School Researcher: Professor Carolyn Maher	Transcriber(s): Yankelewitz, Dina Verifier(s): Yedman, Madeline Date Transcribed: Spring 2009 Page: 19 of 23
---	---

- purple and in this orange here we have four orange and two purple. All of these represent one, is that a surprise?
- 11.0.312 Alan: It could have been two purples changing into a brown.
- 11.0.313 T/R 1: It could have been two purples changing into a brown
- 11.0.314 Alan: Yeah.
- 11.0.315 T/R 1: That's true.
- 11.0.316 Alan: And
- 11.0.317 T/R 1: I guess my question is what you called one in each of these models? Are they related in any way? The lengths? All of these you called one, are the lengths related to each other, if you study each of the models you built. You see this one here you called the orange and red one, isn't that right, and here you called one two orange and purple, right?
- 11.0.318 Alan: So basically it's just doubled. That's
- 11.0.319 T/R 1: What do you mean by that "basically it's doubled", Alan? That's an interesting idea. In what way is it doubled?
- 11.0.320 Alan: Um, ok, it's doubled because it now it has four oranges and two purples or a brown, so
- 11.0.321 T/R 1: But the first one doesn't have any purples.
- 11.0.322 Alan: Well, that's because this had nothing to do with the first problem because of the first question, but
- 11.0.323 T/R 1: I'm not sure I understand what you're saying.
- 11.0.324 Alan: Had there have been sixths.
- 11.0.325 Erik: I know.
- 11.0.326 T/R 1: We didn't have sixths, we had twelfths here.
- 11.0.327 Alan: Mmm hmm.
- 11.0.328 Erik: I think I know what he's saying.
- 11.0.329 Alan: Right, there you have twenty-fourths and the whites are forty-eighths this time. Now, up there, there are no purples, because they weren't put on. But had they have been, on the bottom, which they are, they are twelfths, because
- 11.0.330 Erik: Purples? In that
- 11.0.331 Alan: Purples are twelfths.
- 11.0.332 Erik: In that model they became twelfths, but over there they would be the sixths. Like Amy said, if
- 11.0.333 Alan: Right, because if you double each of them, it would come out to twice the number.
- 11.0.334 Erik: Exactly!
- 11.0.335 T/R 1: James?
- 11.0.336 James: Uh, I think um, that um, because there are two oranges and two purples I agree with Alan that it's double but why the

Description: Building large models to show equivalence: A generalization (side view) Date: 1993-10-11 Location: Colts Neck Elementary School Researcher: Professor Carolyn Maher	Transcriber(s): Yankelewitz, Dina Verifier(s): Yedman, Madeline Date Transcribed: Spring 2009 Page: 20 of 23
---	---

- 11.0.337 Alan: red's there, it's two reds make a purple and that, that means the two oranges and the red make two oranges and a purple. Yeah, cuz if you took the two oranges out of that model and a purple, and then two more oranges and a purple, and you put them on top of each other, they'd be equal. But if you put em side to side you'd have four oranges and two purples, or the two purples could be a brown. So it's basically doubled, each of the length is doubled.
- 11.0.338 T/R 1: I wonder if the rest of you see this, I'm saying, this is an orange and it's not a purple, it's an orange and a red, right? Now, how does this get doubled to be this? I see there are two oranges, instead of one orange, I see the one orange length got doubled, instead of one orange there's two, right? Isn't that true? But how did the red get doubled?
- 11.0.339 Alan: The red-
- 11.0.340 T/R 1: I'm confused, how did the red get doubled here?
- 11.0.341 Alan: The red
- 11.0.342 T/R 1: I see the orange got doubled here because there are two oranges, right? From one orange to two oranges, I don't know how did the red get doubled? I don't see that. Jessica? Kimberly.
- 11.0.343 Kimberly: Well, they used a purple and the red, two reds make a purple, so now if they have a purple, they doubled the red.
- 11.0.344 T/R 1: Is that what you were going to say?
- 11.0.345 Jessica: Yeah.
- 11.0.346 Alan: I was going to say something different
- 11.0.347 T/R 1: So you're telling me that instead of the one orange and one red, we have two oranges and two reds in this model. But they just called it a purple rather than two reds. Do the rest of you see that? [mmm hmm] Ok, so this model is doubled of this, now you have to convince me that this model is double of this, so instead of two oranges and a purple, what should we have now if it's doubled? Don't look. What would you expect we would have then if it's doubled? Danielle.
- 11.0.348 Danielle: Um, four oranges and two purples.
- 11.0.349 T/R 1: Let's see. Do we have four oranges and two purples?
- 11.0.350 Erik: One, two, three, four, yup, or four oranges and one brown.
- 11.0.351 T/R 1: Or four oranges and one brown.
- 11.0.352 Alan: Yep

Description: Building large models to show equivalence: A generalization (side view) Date: 1993-10-11 Location: Colts Neck Elementary School Researcher: Professor Carolyn Maher	Transcriber(s): Yankelewitz, Dina Verifier(s): Yedman, Madeline Date Transcribed: Spring 2009 Page: 21 of 23
---	---

- 11.0.353 T/R 1: Ok, this is the question I ask you. If I were to make another model, Andrew's hand is up, Andrew knows my question, what do you think my question is, Andrew?
- 11.0.354 Andrew: If you were gonna make another model, what, um, the doubles be?
- 11.0.355 T/R 1: Ok, what would my one look like in terms of rods? Brian!
- 11.0.356 Brian: Um, forty-eight.
- 11.0.357 T/R 1: What would I call one? Imagine in your head what I would call one?
- 11.0.358 Brian: Forty-eight? Cuz there would be, well, cuz there would be forty-eight whites equal up to one and then.
- 11.0.359 T/R 1: Well, we have forty-eight whites going up to one here, don't we?
- 11.0.360 Brian: Oh!
- 11.0.361 T/R 1: In this model.
- 11.0.362 Erik: So we have to double that?
- 11.0.363 Alan: But, no!
- 11.0.364 T/R 1: I don't know, I'm asking you, that's my question, Andrew what do you think?
- 11.0.365 Erik: Well you're saying what-
- 11.0.366 Alan: No, it can't
- 11.0.367 Andrew: Well, the whole would be eight orange rods and
- 11.0.368 Alan: It can't be done
- 11.0.369 T/R 1: Eight orange rods, I'm listening.
- 11.0.370 Erik: Eight orange rods and two browns
- 11.0.371 Andrew: And two browns.
- 11.0.372 T/R 1: And two brown rods.
- 11.0.373 Alan: You can't double that. You can't double that model because if you did, then you wouldn't be able to third it.
- 11.0.374 Erik: You wanna make a bet - all you had to do is train it - you just train it!
- 11.0.375 Alan: Right because if you doubled that it would be eight oranges and two browns, now is there any rod that could third that?
- 11.0.376 Erik: Well if you use a train
- 11.0.377 Andrew: Yeah
- 11.0.378 53:00 Erik: If you use a train, just like in Andrew's theory.
- 11.0.379 Alan: Well, if you train the rod, but that would make it not equal.
- 11.0.380 Andrew: It would probably be-
- 11.0.381 Alan: Up there, it's just plain, except for the whole.
- 11.0.382 Andrew: It would probably be three browns would be the thirds and three dark greens would be the fourths.

Description: Building large models to show equivalence: A generalization (side view) Date: 1993-10-11 Location: Colts Neck Elementary School Researcher: Professor Carolyn Maher	Transcriber(s): Yankelewitz, Dina Verifier(s): Yedman, Madeline Date Transcribed: Spring 2009 Page: 22 of 23
---	---

- 11.0.383 Alan: Right, but that would be using more than one rod to make another rod to fit, fit the same thing.
- 11.0.384 Erik: Yeah, so you can do that! Just like, you, Andrew said, you can use a train to make a third and a fourth. Cuz he, like, I, I overheard, they said that if you can use a train to make a whole why can't you use it to make a third and a fourth?
- 11.0.385 Andrew: Yeah.
- 11.0.386 T/R 1: David?
- 11.0.387 Andrew: And a half
- 11.0.388 Alan: But then it wouldn't be equal.
- 11.0.389 Erik: Yeah they would! Cuz the third could be, like in that model, Andrew used the two browns, that's equal!
- 11.0.390 Alan: But in that model, the three browns don't have anything attached on so it's totally equal
- 11.0.391 Erik: So? They just doubled it!
- 11.0.392 Alan: But if you added something on
- 11.0.393 Erik: We just doubled, we doubled that model to equal that model.
- 11.0.394 Andrew: Yeah, and I doubled the brown - two browns,
- 11.0.395 Erik: Yeah, exactly.
- 11.0.396 Andrew: So in the next model
- 11.0.397 T/R 1: David, what do you think? Did you want to say something?
- 11.0.398 David: Um, I agree with Erik
- 11.0.399 T/R 1: What part of what Erik said?
- 11.0.400 David: Well, Alan didn't think that you could uh third it, but like Erik said that you can train it and put the other blocks onto the other one
- 11.0.401 Alan: What I meant, what I meant is, you can't third it just using one rod.
- 11.0.402 T/R 1: Ok, Alan.
- 11.0.403 Erik: Exactly. You can't third it using one rod, but you can third it using trains.
- 11.0.404 T/R 1: Ok, so
- 11.0.405 Alan: You could double that, but you would have to use two rods to make it
- 11.0.406 T/R 1: Ok, so you think you can double it and you think you can imagine - can you make one bigger than that?
- 11.0.407 Erik: If you doubled that, it would be sixteen oranges [laughter] and, sixteen oranges and four browns!
- 11.0.408 T/R 1: Ok, the question I want to leave you all to think about, I'd like you to uh, first I'd like to thank you for the wonderful

Description: Building large models to show equivalence: A generalization (side view) Date: 1993-10-11 Location: Colts Neck Elementary School Researcher: Professor Carolyn Maher	Transcriber(s): Yankelewitz, Dina Verifier(s): Yedman, Madeline Date Transcribed: Spring 2009 Page: 23 of 23
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models you built, but the question I'd like you to think about is, uh, is there, is there a biggest model?

11.0.409 Erik: Thirty-two oranges! [laughs]

11.0.410 T/R 1: Is there a biggest model? And if you don't have enough, uh, rods, you could imagine, we could write to Cuisenaire and we can have them ship us buckets and buckets and buckets and buckets

11.0.411 Erik: Or we could combine all our stuff.

11.0.412 We could start by that but my question to all of you is there a biggest model? Why or why not? And I'd like you to write to me about, about that. Would you do that? Would you write to me? Maybe Mrs. Phillips can let you combine and build together, that might take a little while and a camera. Ok, I think we have to stop, I'll see you in two weeks, and if you could

11.0.413 57:00 [end of class]

11.0.414 58:22 Erik: I wonder how many oranges

11.0.415 58:17(F) Alan: No, I wonder how many oranges it would take to get from here to California