Camera View: “Ankur’s Challenge” (Two disks)

Date of filming: 1998-Jan-09

David Brearly High School, Kenilworth NJ, “Ankur’s Challenge”

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Notes:

* R1 is Professor Maher
* Ankur's Challenge – How many towers can you build four high, selecting from cubes available in three different colors, so that the resulting towers contain at least one of each color?
* This episode took place on January 9, 1998. The student participants in this episode are Ankur, Michael, Brian, Jeff, and Romina. At the time, they are in the tenth grade and are from the David Brearly High School in Kenilworth, New Jersey. This session is after school and is part of an after school enrichment program sponsored by Rutgers University that met on a regular basis on Friday afternoons.
* Prior to Ankur’s Challenge, the students were working on a problem that they did in fourth grade. The question was: how many towers can you build five tall selecting from red or yellow that have exactly two red cubes. This is where the tape begins.

**\*Disc TWO** of Two

| **Line** | **Time** | **Speaker** | **Transcript** | **Picture** |
| --- | --- | --- | --- | --- |
| 1 | 00:00:01 | Ankur | I'll prove it to you. |  |
| 2 | 00:00:04 | Jeff | Wait, I'll be back in a second. |  |
| 3 | 00:00:04 | Romina | What is eight plus six? Eight, nine, ten, eleven, twelve, thirteen, fourteen. Thank you. |  |
| 4 | 00:00:07 | Brian | Oh my God. I'm telling you. |  |
| 5 | 00:00:09 | Romina | You guys I got eighty-four. |  |
| 6 | 00:00:11 | Michael | Eight-four what, total? |  |
| 7 | 00:00:12 | Romina | Total. |  |
| 8 | 00:00:13 | Jeff | And wait, what was your number? |  |
| 9 | 00:00:13 | Romina | Hold on. But I got, you guys, it makes sense. |  |
| 10 | 00:00:15 | Jeff | What was your number? |  |
| 11 | 00:00:16 | Ankur | We had eighty-one total. |  |
| 12 | 00:00:17 | Jeff | I mean, your other number? Thirty-nine? |  |
| 13 | 00:00:18 | Ankur | Thirty-nine. |  |
| 14 | 00:00:19 | Jeff | And we got thirty-six? |  |
| 15 | 00:00:21 | Romina | You guys, cause the other... did we include the all x's, the all one's, and the all o's and the other one? |  |
| 16 | 00:00:25 | Jeff | No, we have to add the three because we had to do that for the pizza. Like the plain... |  |
| 17 | 00:00:26 | Romina | Because look at what I did, look... |  |
| 18 | 00:00:28 | Ankur | No, but we added to the pizza but we didn't add it to the tower problem. |  |
| 19 | 00:00:30 | Romina | You guys, you guys you know how we have our x to the y system? Oh, I'm just talking to myself. |  |
| 20 | 00:00:35 | Jeff | No, we were... |  |
| 21 | 00:00:35 | Ankur | Can I tell you right now why it's not eight-four? |  |
| 22 | 00:00:37 | Romina | Hold on can I tell you why it could be eight-four? |  |
| 23 | 00:00:39 | Ankur | Can I tell you first? |  |
| 24 | 00:00:40 | Romina | No, I don't want to, no, okay, go ahead. |  |
| 25 | 00:00:42 | Ankur | Cause look... |  |
| 26 | 00:00:43 | Brian | We don't have to have a brawl like we do in history. |  |
| 27 | 00:00:43 | Ankur | there's four spots, right? So for the first one, there's three colors... |  |
| 28 | 00:00:47 | Romina | But Ankur, do you agree, hold on, do you agree that you other thing works? |  |
| 29 | 00:00:49 | Ankur | Just cut me off. | 00:59:30 Ankur tries not to laugh as Romina, who agreed to listen to his explanation, cuts him off during the first point. |
| 30 | 00:00:51 | Romina | Ankur, I'm just doing your other thing. |  |
| 31 | 00:00:51 | Brian | Where do you think you've been for the last sixteen years of our life? |  |
| 32 | 00:00:55 | Romina | I know. |  |
| 33 | 00:00:56 | Ankur | She's like, 'okay, I'll let you explain'. I start to explain. |  |
| 34 | 00:00:58 | Romina | Okay, go, go, go. |  |
| 35 | 00:01:00 | Jeff | Go. |  |
| 36 | 00:01:00 | Ankur | There could be three colors for the first one, three colors for the second one, three colors for the third one, three colors for the fourth one. Right? |  |
| 37 | 00:01:05 | Romina | Yes. |  |
| 38 | 00:01:05 | Ankur | Multiply them and you get eighty-one. Now there's no way there can be eighty-four now. |  |
| 39 | 00:01:11 | Romina | But there could be because you have to add the three. |  |
| 40 | 00:01:13 | Ankur | But.. |  |
| 41 | 00:01:15 | Jeff | He's including them. Three colors, three colors, three colors, three colors. |  |
| 42 | 00:01:18 | Romina | But it works. It just works, I don't know why. |  |
| 43 | 00:01:21 | Ankur | What do you mean it just works? |  |
| 44 | 00:01:22 | Romina | Hold on. Look at. I am not saying that I am right. I'm not saying that I'm right. |  |
| 45 | 00:01:23 | Jeff | You prove what you thought, prove what you think. |  |
| 46 | 00:01:26 | Romina | Okay, you have the thirty-six, right? |  |
| 47 | 00:01:28 | R1 | Here. Here. [R1 hands her paper.] |  |
| 48 | 00:01:29 | Romina | Okay, you have the thirty-six. |  |
| 49 | 00:01:31 | Ankur | Thirty-six what? What you have? |  |
| 50 | 00:01:33 | Jeff | Uh-hum. |  |
| 51 | 00:01:33 | Romina | And then you're going... yeah, and then you are going with the x, y deal, right? And say you can't work 'em in all at the same time so you figure one of them might be dropped. Cause that's what we did we worked them in all at the same time and one of them has got to be dropped the other ways we do it. So then it would be two to the fourth because there's two colors, right? And for each one you have to multiply that... |  |
| 52 | 00:01:49 | Ankur | What's the fourth one? |  |
| 53 | 00:01:50 | Romina | That's how high it is. That is like your x to the y system. And that equals sixteen. And then there's colors. |  |
| 54 | 00:01:56 | Ankur | Two to the fourth equals sixteen? |  |
| 55 | 00:01:58 | Jeff | Yeah. |  |
| 56 | 00:01:58 | Romina | Two times two. |  |
| 57 | 00:01:59 | Jeff | Is four times two is twelve, times two is sixteen. Two to the three is sixteen. No, two to the four is. |  |
| 58 | 00:02:07 | Ankur | Yeah, eight, yeah, is sixteen. Okay. |  |
| 59 | 00:02:09 | Jeff | Okay. |  |
| 60 | 00:02:08 | Romina | Okay and then you multiply that by three. I was getting, okay. |  |
| 61 | 00:02:11 | Ankur | Why by three? |  |
| 62 | 00:02:12 | Romina | Because three different colors. Right? So one of them is going to be dropped out one time, and then the other one and then the other one. So that's three. So what's that? I didn't do this... |  |
| 63 | 00:02:20 | Ankur | Sixty-four. |  |
| 64 | 00:02:21 | Romina | Sixty-four. |  |
| 65 | 00:02:22 | Ankur | No. |  |
| 66 | 00:02:23 | Jeff | Six times three is eighteen.. |  |
| 67 | 00:02:24 | Ankur | Forty-eight. |  |
| 68 | 00:02:26 | Jeff | Carry the one [inaudible]. |  |
| 69 | 00:02:27 | Romina | And add that to the thirty-six, eighty-four. |  |
| 70 | 00:02:32 | Ankur | But we've use this method all the time. |  |
| 71 | 00:02:34 | Romina | Well, I'm just saying that could be.. |  |
| 72 | 00:02:36 | Brian | So, things are subject to change over a lifetime. |  |
| 73 | 00:02:38 | Romina | But I could, I could |  |
| 74 | 00:02:39 | Jeff | So we are saying that we have to go back and reprove all of the other problems that we did because we did this wrong? |  |
| 75 | 00:02:42 | Romina | I could be completely wrong, you guys. Chill out, I could be completely wrong. I'm just saying, couldn't work like that? |  |
| 76 | 00:02:46 | Ankur | There's probably a mistake in there, somewhere. |  |
| 77 | 00:02:47 | Jeff | Couldn't you say.. wait, wait, whoa... |  |
| 78 | 00:02:50 | Romina | There's three doubles, in there. |  |
| 79 | 00:02:52 | Jeff | Yeah, and those are the three of each one. That double, that double, and that double. |  |
| 80 | 00:02:57 | Romina | Out of this? So there's three doubles in there. So then there's eighty-one, there. |  |
| 81 | 00:03:02 | Jeff | What are you saying? |  |
| 82 | 00:03:02 | Romina | And then there's these doubles, because those go over there? |  |
| 83 | 00:03:04 | Jeff | No, we are counting these as the three doubles that you just subtracted? Not just any [inaudible] |  |
| 84 | 00:03:10 | Ankur | What number does that leave us with [laughing]? |  |
| 85 | 00:03:11 | Romina | I'm just saying... |  |
| 86 | 00:03:11 | Jeff | Eighty-one. |  |
| 87 | 00:03:14 | Romina | Why did...? |  |
| 88 | 00:03:15 | Ankur | I'm kidding. I just... |  |
| 89 | 00:03:16 | Brian | We do not need any fighting like there is in history every time we do [inaudible] project. No cat fights. |  |
| 90 | 00:03:22 | Jeff | [inaudible] |  |
| 91 | 00:03:26 | Romina | What? |  |
| 92 | 00:03:32 | Brian | Dead silence. Nine thirty. |  |
| 93 | 00:03:34 | Romina | So alright could this fit into this as our doubles? |  |
| 94 | 00:03:39 | Ankur | Are you sitting on the bench? |  |
| 95 | 00:03:40 | Brian | Yeah, I am. |  |
| 96 | 00:03:41 | Ankur | Are you really? |  |
| 97 | 00:03:42 | Romina | Ankur, in doing our x and y could this fit into this as our doubles, could we have, could we have two of these? |  |
| 98 | 00:03:46 | Brian | I have to get up at 8:30 tomorrow morning. |  |
| 99 | 00:03:49 | Ankur | I have no idea what you said. |  |
| 100 | 00:03:51 | Jeff | She is saying where are these three doubles in this part? |  |
| 101 | 00:03:54 | Ankur | Somewhere. |  |
| 102 | 00:03:54 | Jeff | Where? |  |
| 103 | 00:03:55 | Romina | Could like, could they fit in there? |  |
| 104 | 00:04:01 | Brian | What's Mike doing? |  |
| 105 | 00:04:03 | Michael | Don't worry about it. [They all laugh] Don't worry about it. |  |
| 106 | 00:04:06 | Ankur | He's gonna [inaudible]. He's going to prove us all wrong. |  |
| 107 | 00:04:10 | Jeff | He's going to be walking around with his tweeds and his Birkenstocks. |  |
| 108 | 00:04:15 | Michael | Don't worry about it. |  |
| 109 | 00:04:16 | R1 | While Mike is busy doing that. Let's give you something to think about. Let me ask you a question. I left you with something to think about the last time do any of you remember what that was? |  |
| 110 | 00:04:25 | Romina | No, we were talking about that yesterday in class... |  |
| 111 | 00:04:27 | Ankur | I think I know where your mistake is. |  |
| 112 | 00:04:30 | R1 | Go head. |  |
| 113 | 00:04:31 | Brian | Dante. |  |
| 114 | 00:04:32 | Jeff | Dante? |  |
| 115 | 00:04:33 | Ankur | Alright, we need the two to the fourth. Just explain that two to the fourth part over. |  |
| 116 | 00:04:36 | Romina | Okay. At one point we did the one where we have all three of them included. At one point you drop them because you know you have x, x, o, o, you know, or x, x, x, o. So you do like two colors, you do two cause they're four high. Like that. And then you multiply by three because you could do that with three different colors like this could be the ones and this could be the x and this could be.. you know? Do you understand why I multiplied that by three? |  |
| 117 | 00:04:56 | Ankur | Alright. |  |
| 118 | 00:04:57 | Romina | Ankur, I don't know, I'm just saying like, I'm working with numbers that's what.... And then you do. |  |
| 119 | 00:05:01 | Ankur | Yeah, I understand. Alright. When you did, x, x, x, o, right?When you multiply it by three, right now this could be x, x, x, one. |  |
| 120 | 00:05:12 | Romina | One. |  |
| 121 | 00:05:13 | Ankur | Or x, x, x... |  |
| 122 | 00:05:16 | Jeff | x |  |
| 123 | 00:05:16 | Ankur | x |  |
| 124 | 00:05:16 | Romina | See that's probably where the doubles would be. |  |
| 125 | 00:05:17 | Jeff | That's where the x's are. |  |
| 126 | 00:05:18 | Ankur | When you multiply it by three. Again. |  |
| 127 | 00:05:21 | Jeff | You multiply those three. |  |
| 128 | 00:05:22 | Ankur | It could be x, x, x, x, again. |  |
| 129 | 00:05:25 | Romina | So that's why I subtracted three for this. |  |
| 130 | 00:05:27 | Ankur | Yeah, and you get eighty-one which is the same as this. That's where your mistake was. |  |
| 131 | 00:05:32 | Romina | That's what I just said ten minutes ago. |  |
| 132 | 00:05:33 | Ankur | Yeah. |  |
| 133 | 00:05:33 | Jeff | I know but before you were yelling and screaming it was eighty-four. |  |
| 134 | 00:05:36 | Ankur | Yeah. |  |
| 135 | 00:05:36 | Romina | I asked you I never said I was right. I told you that I could of have been wrong in the beginning. |  |
| 136 | 00:05:39 | Jeff | We understood that and we agreed and we listened to it and we came up with a logical reason why your answer [inaudible]. |  |
| 137 | 00:05:44 | Romina | I said that ten minutes ago. |  |
| 138 | 00:05:47 | Jeff | Mike, what you get? |  |
| 139 | 00:05:47 | Ankur | Mike. |  |
| 140 | 00:05:51 | R1 | So I guess I heard Ankur said that in order to be convinced, right, he would want to know.. |  |
| 141 | 00:05:58 | Jeff | The other ones. |  |
| 142 | 00:05:58 | R1 | The other side of the argument. So that will give you something to think about, right? Um, actually this isn't what I had planned for you to do. This is Ankur's problem. |  |
| 143 | 00:06:07 | Ankur | My problem? |  |
| 144 | 00:06:08 | Michael | Ankur made it up [inaudible] |  |
| 145 | 00:06:08 | R1 | Remember I asked you to make up a problem because you were finished with the other one. |  |
| 146 | 00:06:12 | Ankur | I made this up? |  |
| 147 | 00:06:13 | Michael | Yeah. Like you... |  |
| 148 | 00:06:14 | Ankur | Did I? |  |
| 149 | 00:06:15 | Michael | when she asked you [inaudible] |  |
| 150 | 00:06:16 | Ankur | Oh [They laugh]. |  |
| 151 | 00:06:19 | R1 | Ankur's problem is a lot harder then this problem. |  |
| 152 | 00:06:22 | Jeff | Yeah, thanks a lot Ankur. |  |
| 153 | 00:06:25 | Romina | [inaudible] |  |
| 154 | 00:06:25 | R1 | But it's a good problem. Don't you think it is a good problem? |  |
| 155 | 00:06:27 | Brian | Yes, I do. |  |
| 156 | 00:06:27 | R1 | I like the problem. So Ankur, you know, why don't you think about the other side and think about your arguments. I know you don't like to write things up. |  |
| 157 | 00:06:36 | Romina | No.. |  |
| 158 | 00:06:36 | Ankur | How did you [inaudible] |  |
| 159 | 00:06:37 | Romina | But we were going to yesterday. But we were sitting there, I'm like okay, let's write something up. |  |
| 160 | 00:06:41 | R1 | What you were suppose to write up? |  |
| 161 | 00:06:42 | Romina | Yeah, I was like what was the problem? |  |
| 162 | 00:06:43 | R1 | Okay, let me help, remind you. And then I will, I was going to give you something else to think about. Okay? Remember you were, um, Brian was working with these and you were looking at something like a plus b quantity squared. And a plus b quantity cubed. | 01:05:27 Brian tries a unifix moustache when no one is looking. |
| 163 | 00:06:59 | Jeff | Yeah, we were working on the.. |  |
| 164 | 00:07:00 | R1 | Remember that? What do you remember Jeff? |  |
| 165 | 00:07:04 | Jeff | That we were looking on, yeah, the cube part. Like making it a cube. |  |
| 166 | 00:07:08 | Ankur | The different parts of the cube? |  |
| 167 | 00:07:10 | R1 | Right. So that was what you were suppose to do... |  |
| 168 | 00:07:10 | Jeff | That was hard. |  |
| 169 | 00:07:11 | R1 | What I am interested in, I don't think...Mike, you might not be listening anyway. Mike and Ankur heard your argument for finding how many of exactly two reds and then you even solved more than that. So I'd really appreciate what this group worked with earlier if you could show that. Because I want to show you something after you do that. |  |
| 170 | 00:07:31 | Jeff | Alright. Do you want me to go up or? |  |
| 171 | 00:07:33 | R1 | Why don't you do that Jeff since you are going to have to leave. And then Romina can probably take over. |  |
| 172 | 00:07:37 | Romina | What, just rewrite this? |  |
| 173 | 00:07:38 | R1 | No, no, the first problem. |  |
| 174 | 00:07:38 | Jeff | No, we are talking about the first problem. |  |
| 175 | 00:07:40 | R1 | Okay? Um. |  |
| 176 | 00:07:45 | Romina | This one? |  |
| 177 | 00:07:47 | Jeff | This one. |  |
| 178 | 00:07:49 | Romina | Okay. |  |
| 179 | 00:07:55 | Jeff | We were stuck on this one and we felt really stupid because they took them like three seconds. And we were having... |  |
| 180 | 00:07:58 | Michael | It's thirty-six. |  |
| 181 | 00:08:01 | Ankur | You found the doubles? |  |
| 182 | 00:08:01 | Jeff | And we were having problems. Thirty-six Micheal? |  |
| 183 | 00:08:05 | Michael | It's thirty-six. |  |
| 184 | 00:08:05 | R1 | Well, we will hear from Mike in a minute, yes. |  |
| 185 | 00:08:07 | Michael | It is. |  |
| 186 | 00:08:08 | Jeff | Well just that we were trying to figure out something and none of us could get anything. So then I said well, alright, well, let's try to find a math kind of connection to it. So we looked at what we had and we had ten, if we got.. I'll be done in a second. |  |
| 187 | Jeff is at the board but we can hear Michael and Ankur's conversation. While Michael and Ankur are quietly talking to each other, Jeff is writing the following on the board:  10001 10000  11000 01000  10100 00100  10010 00010  01001 00001  01100  00110  00101  01010  Jeff, Romina, R1, and Brian are quiet. The conversation between Michael and Ankur is as follows. | | |  |
| 188 | 00:08:28 | Ankur | How about what we originally made. We had a double for each one. |  |
| 189 | 00:08:32 | Michael | Now we have to find 45 that aren’t. |  |
| 190 | 00:08:35 | Ankur | We found 39. Where’s the other six? |  |
| 191 | 00:08:40 | Michael | I don't know. |  |
| 192 | 00:08:47 | Michael | So both of us don't know. I want to know how I got that six. |  |
| 193 | 00:08:54 | Ankur | I believe. [inaudible] |  |
| 194 | 00:08:58 | Michael | No, just for one section. |  |
| 195 | 00:09:00 | Ankur | Oh. |  |
| 196 | 00:09:01 | Michael | I categorized them as all that end in three, all that end in one, all that end in two. I checked the doubles off. There's six in each. |  |
| 197 | 00:09:10 | Ankur | Yeah, okay. |  |
| 198 | 00:09:11 | Michael | So it's actually [inaudible]. So it's didn't we just do five [inaudible] |  |
| 199 | 00:09:13 | R1 | I'm going to need you to write what you did, a write up. [Talking to Romina] |  |
| 200 | 00:09:17 | Romina | On this problem, or the other one? |  |
| 201 | 00:09:19 | R1 | The other problem. |  |
| 202 | 00:09:19 | Romina | The other one. |  |
| 203 | 00:09:20 | Jeff | Alright, on this one. |  |
| 204 | 00:09:22 | R1 | Okay, let's see what Jeff did. |  |
| 205 | 00:09:23 | Jeff | Alright, what we did on this one was that we looked at this. And we had, we were just writing out each thing, and we got ten for if there was two in each thing saying a one was red and two was say, blue. And then we knew that this also had a flipped side where that it could be zero, one, one, zero. We knew that, we took that for granted. |  |
| 206 | 00:09:45 | R1 | One was red and two was blue? |  |
| 207 | 00:09:48 | Romina | Zero is blue. |  |
| 208 | 00:09:49 | Ankur | Jeff, there's no two. |  |
| 209 | 00:09:51 | Jeff | What? |  |
| 210 | 00:09:51 | Ankur | Make the zero blue. |  |
| 211 | 00:09:53 | Jeff | Oh, excuse me, my bad. We took it for granted that there is a flip for each one. And so then, we're looking at this, and there's ten here and so there was.. first... |  |
| 212 | 00:10:04 | Ankur | Certain ones you can't flip, right? |  |
| 213 | 00:10:06 | Jeff | Well first we were looking at this here.. No you could flip all of them just different colors like... | 01:08:49 Jeff explains their first answer at the board. |
| 214 | 00:10:11 | Romina | [inaudible] |  |
| 215 | 00:10:11 | Jeff | Red, red, blue, red, blue and then red, blue, red, blue, blue. It's just a different colors. We looked at this too and there's five and these all flipped too, so ten. So we were looking at this and we say well there's five colors, it's five long, five, and there's one color in each, one color going in to it, one color is taking one space times one equals five, and then plus the flip so that would equal ten. Times two again. So five times one, five spaces times one block is five times two, the flip side. Then we took this and we said alright, well there's two in here. So five blocks times two. These different color taking up two spots would equal ten and plus the flip side would equal twenty. So that gives you thirty and then there's these and these. So that's it. That's your shortcut. |  |
| 216 | 00:11:14 | R1 | Do you have any questions? |  |
| 217 | 00:11:18 | R1 | Now, would that work... |  |
| 218 | 00:11:19 | Ankur | He just proved thirty-two. |  |
| 219 | 00:11:21 | R1 | Would that work if you were doing it with blocks four tall and I wanted to know where two reds? |  |
| 220 | 00:11:26 | Jeff | And then we would have said. If we were doing this with four tall we would have said well we have four blocks times one. |  |
| 221 | 00:11:27 | Ankur | Two of a colors, five tall. |  |
| 222 | 00:11:30 | Michael | So wait, it's not this problem? |  |
| 223 | 00:11:32 | Ankur | No. It's the first problem we did. [Michael and Ankur laugh] |  |
| 224 | 00:11:37 | Jeff | We would do four blocks times one block taking up each one would give us eight. And then we flip it which would be sixteen. And then we would say four blocks, one block, four times four would be four times two would give us eight. Which would be plus eight. And then plus each one filled up would be plus two. Wait. That would be...And how do we usually figure these out? |  |
| 225 | 00:12:04 | Romina | What is it, how many different colors? |  |
| 226 | 00:12:07 | Jeff | Two, four high so... |  |
| 227 | 00:12:09 | Ankur | Two to the fourth. Sixteen. |  |
| 228 | 00:12:13 | Jeff | Times two, sixteen? No, two times two.. |  |
| 229 | 00:12:17 | Ankur | Is four, times two is eight, times two is sixteen. |  |
| 230 | 00:12:17 | Romina | Times two is eight, times two is sixteen. |  |
| 231 | 00:12:18 | Jeff | Sixteen. So then I messed up somewhere. So that wouldn't work for that. Wait, wait, let me just think for a second. |  |
| 232 | 00:12:26 | Romina | Wouldn't be eight? |  |
| 233 | 00:12:26 | Ankur | Why do we need a new way to do it? |  |
| 234 | 00:12:28 | Jeff | Oh, oh, yeah, that's where I messed up. Four times... For the first one, four times one is eight, would equal eight. |  |
| 235 | 00:12:34 | Ankur | Yeah. |  |
| 236 | 00:12:36 | Jeff | And then, then. |  |
| 237 | 00:12:37 | Romina | Four times... |  |
| 238 | 00:12:38 | Ankur | Four times two is. |  |
| 239 | 00:12:39 | Jeff | Yeah, but wait but you could flip them though, couldn't you? I can right? |  |
| 240 | 00:12:43 | Ankur | Yeah. So then there's sixteen. |  |
| 241 | 00:12:44 | Jeff | Yeah, no, we flipped already. Four times one is four times two is eight. Like four times one doesn't equal eight. Four times one times two equals eight. |  |
| 242 | 00:12:55 | Ankur | Oh, okay. |  |
| 243 | 00:12:55 | Jeff | And then we said four times two actually equals eight times two is sixteen. And then we got thirty-two, though. That would be thirty-two. Cause, sixteen...no, it would be twenty-four, sixteen plus eight. I'm still messed up somewhere. |  |
| 244 | 00:13:10 | Romina | Yeah, that, we.... |  |
| 245 | 00:13:10 | Ankur | Now why do we need a new way to count up the total [inaudible]? |  |
| 246 | 00:13:12 | R1 | Well. |  |
| 247 | 00:13:13 | Jeff | Well we were just looking back at. She asked would it work for four. And it should work with four if that works and it's not working with four. |  |
| 248 | 00:13:21 | R1 | Okay, let me try to answer Ankur. I'm trying to understand why that rule works. So what I like to ask you to think about, you have this rule and you sort of believe in it. So this group did some kind of analysis and accounted for all they could find and did get thirty-two for a variety of ways of organizing it. When you try to do it with four spots, it sort of didn't work. |  |
| 249 | 00:13:55 | Romina | Yeah. |  |
| 250 | 00:13:56 | R1 | I want you to think about that I want you to think about it for fives, fours, threes, sixes... |  |
| 251 | 00:13:57 | Michael | [inaudible] all of these and then I'm going to eliminate those. [He is talking to Ankur as R1 is talking] |  |
| 252 | 00:14:01 | R1 | And see if you can make sense of the rule by counting for those pieces. Does that make sense? Do you understand the question? Should it make sense? Should it work out? Just like what you're working out with the, what's left over. It should work out both ways, right? |  |
| 253 | 00:14:23 | Romina | It should. |  |
| 254 | 00:14:24 | R1 | So I'm asking you to do the same thing here. Do you understand, Ankur? Cause you said to Jeff that you weren't going to be convinced unless you worked it out the other way. Well, I'm saying I'm not going to be convinced unless I see it both ways. |  |
|  |  | The two groups split up. Ankur and Michael look over their papers as Jeff, Romina, and Brian look over their papers. The camera focuses on the Jeff, Romina, and Brian. They are talking about the problem. The following transcript is the conversational between Ankur and Michael. | |  |
| 255 | 00:14:42 | Michael | Do you know what I want you to prove? When I'm doing this, I want you to prove.. |  |
| 256 | 00:14:49 | Ankur | There's probably more over here. |  |
| 257 | 00:14:51 | Michael | No, I just want you to prove this is it. |  |
| 258 | 00:14:53 | Ankur | I probably can't. |  |
| 259 | 00:14:54 | Michael | Just do it. |  |
| 260 | 00:14:55 | Ankur | Let's see. |  |
| 261 | 00:14:58 | Michael | Now I'm doing [inaudible] |  |
| 262 | 00:15:29 | Ankur | [inaudible] Six more. |  |
| 263 | 00:15:37 | Michael | Just times.... Just look to see if you find anything else, anything wrong, any doubles, anything |  |
| 264 | 00:16:14 | Ankur | What about these... 1, 1, 2, 2. I found the six…1,1,3…. |  |
| 265 | 00:16:24 | Michael | Exactly, so... |  |
| 266 | 00:16:26 | Ankur | There’s 45 |  |
| 267 | 00:16:30 | Michael | No, show me, write it down. |  |
| 268 | 00:16:34 | Ankur | One, one, two, two. It's looking right at us. |  |
| 269 | 00:16:38 | Michael | I believe that. [inaudible] I'm just making, I'm being a 100% sure. Double check. |  |
| 270 | 00:16:46 | Ankur | Three, four, five, six. Thirteen, fourteen, fifteen, eighteen plus how many do you have? |  |
| 271 | 00:16:55 | Michael | I have..down here? |  |
| 272 | 00:16:56 | Ankur | Twenty-seven. |  |
| 273 | 00:16:57 | Michael | Yeah, twenty-seven or something like that. |  |
| 274 | 00:17:01 | Ankur | Forty-five. |  |
| 275 | 00:17:06 | Michael | Yeah, but listen. Ankur, [inaudible] |  |
| 276 | 00:17:17 | Ankur | Can you explain this? |  |
| 277 | 00:17:19 | Michael | Yeah. [inaudible] Cause I found those doubles over there. |  |
| 278 | 00:17:24 | Ankur | No, I can explain the forty-five. |  |
| 279 | 00:17:27 | Michael | Some of these are two doubles. And I don't want to explain this. |  |
| 280 | 00:17:32 | Ankur | No, they explained the thirty-six and we will explain the forty-five. I can explain the forty-five with just this paper. |  |
| 281 | 00:17:36 | Michael | Right. [inaudible] |  |
| 282 | 00:17:41 | Ankur | I know, I can explain it, I can explain it. |  |
| 283 | 00:17:44 | Michael | I'll double check [inaudible] |  |
| 284 | 00:17:56 | Ankur | You guys are right with thirty-six. |  |
| 285 | 00:17:59 | Brian | What? |  |
| 286 | 00:17:59 | Ankur | You guys are right with thirty-six. |  |
| 287 | 00:18:00 | Michael | We can explain the forty-five. |  |
| 288 | 00:18:02 | R1 | We're going to have them explain the forty-five. |  |
| 289 | 00:18:03 | Romina | With this one? |  |
| 290 | 00:18:04 | Ankur | You know how you got thirty-six? |  |
| 291 | 00:18:06 | Romina | With this? |  |
| 292 | 00:18:06 | R1 | Do you want to hear the explanation Jeff? Do you have to run? |  |
| 293 | 00:18:07 | Jeff | I really have to go. |  |
| 294 | 00:18:09 | R1 | Okay, so you can explain it to Jeff tomorrow. |  |
| 295 | 00:18:09 | Ankur | Yeah. You guys have [inaudible] explain the forty-five. |  |
| 296 | 00:18:10 | R1 | They'll write I up for you. |  |
| 297 | 00:18:12 | Jeff | Oh, they're going to write it up for me? |  |
| 298 | 00:18:13 | Ankur | Are we? |  |
| 299 | 00:18:14 | R1 | Sure. |  |
| 300 | 00:18:15 | Jeff | Alright. Thank you very much. See you all later. |  |
| 301 | 00:18:17 | R1 | Bye Jeff. [Jeff leaves] |  |
| 302 | 00:18:18 | Romina | We could, we could explain the forty-five [inaudible] |  |
| 303 | 00:18:20 | Michael | Exactly. So you should do this the [inaudible] part. |  |
| 304 | 00:18:23 | Ankur | Alright, no, since I... |  |
| 305 | 00:18:23 | R1 | Okay, that would be good if you explain this... |  |
| 306 | 00:18:27 | Romina | I mean, I don't know. |  |
| 307 | 00:18:28 | Brian | With the eighty-four? |  |
| 308 | 00:18:28 | Michael | Are you going to explain the thirty-six? Cause.. I don't know. |  |
| 309 | 00:18:29 | Romina | Well we got the eighty-four and then we subtract the three. |  |
| 310 | 00:18:33 | Ankur | Alright. |  |
| 311 | 00:18:35 | R1 | Why don't I give you all a couple of more minutes to think about how you did the formula. |  |
| 312 | 00:18:36 | Michael | How about this... explain the thirty-six one more time because I was not paying attention. I was.. |  |
| 313 | 00:18:39 | R1 | Do you want to go to the board and do that? |  |
| 314 | 00:18:40 | Brian | That's why [inaudible] |  |
| 315 | 00:18:42 | Michael | Now I want to know. I want you to explain it. Was it a good explanation? |  |
| 316 | 00:18:46 | Ankur | It was a good.. |  |
| 317 | 00:18:47 | Michael | Not on the board cause... |  |
| 318 | 00:18:49 | Ankur | It would be easier with the paper. |  |
| 319 | 00:18:50 | R2 | Yeah, erase what's there. |  |
| 320 | 00:18:52 | Ankur | Romina, it would be easier with the paper because you already have everything written down. |  |
| 321 | 00:18:54 | Michael | I wasn't paying attention. And I could explain the forty-five now. |  |
| 322 | 00:18:56 | Romina | I knew you weren't paying attention. |  |
| 323 | 00:18:57 | Michael | Forty-five is easy. |  |
| 324 | 00:18:59 | Romina | Okay. You have, we have all three colors, right? So then when we add one. |  |
| 325 | 00:19:06 | Michael | What's the one? What's o and what's x? |  |
| 326 | 00:19:07 | Romina | They're three different colors. Like it could be... |  |
| 327 | 00:19:10 | Michael | Don't say, don't say anything more. I understand. |  |
| 328 | 00:19:11 | Romina | We have three different colors and then we, you know that they have to be paired up. Like the fourth color had to be, has to be the same as one of them that's already there, right? |  |
| 329 | 00:19:20 | Michael | The fourth color.... |  |
| 330 | 00:19:22 | Romina | Okay, see |  |
| 331 | 00:19:22 | Michael | ... has to be the same, yes. |  |
| 332 | 00:19:23 | Romina | Yeah cause you have. |  |
| 333 | 00:19:24 | Michael | Yeah. |  |
| 334 | 00:19:26 | Romina | Okay. So what we did, we, well, let's say there's are your different ones. [Someone sneezes] And we came up with six different like possibilities for like the, the match it could be. It would be here and here, the same. Here and here. Here and here. Come on. Which one am I missing? |  |
| 335 | 00:20:02 | Ankur | The second. |  |
| 336 | 00:20:02 | Romina | Okay. |  |
| 337 | 00:20:03 | Ankur | And the last. |  |
| 338 | 00:20:04 | Romina | Yeah, the second one and the last. Okay. Do you agree with me? And then each one, this is either going to be an o or an x. | 01:18:50 Romina completes her set of towers showing only the duplicate colors at first. |
| 339 | 00:20:12 | Brian | Or an x. |  |
| 340 | 00:20:13 | Ankur | Or an x or an o. So each one, there's two of each one. You can't have x and x. |  |
| 341 | 00:20:18 | Michael | Yeah. I get that. |  |
| 342 | 00:20:18 | Romina | You get that? |  |
| 343 | 00:20:19 | Michael | Yeah. |  |
| 344 | 00:20:19 | Romina | So should I...? |  |
| 345 | 00:20:26 | Michael | What are you doing? |  |
| 346 | 00:20:28 | Romina | I'm writing. |  |
| 347 | 00:20:28 | Michael | No. I was talking to Brian. |  |
| 348 | 00:20:29 | Romina | Oh. Okay. So so far we have six. And then we have to multiply the six by the two for all of these so you get twelve. Right? And multiply the twelve times the three to get thirty-six. You multiply it because it's three different colors. |  |
| 349 | 00:20:44 | Michael | Yeah. The one's can be any color. |  |
| 350 | 00:20:45 | Romina | So each one here can be three. |  |
| 351 | 00:20:46 | Brian | Yeah. |  |
| 352 | 00:20:46 | Romina | Yeah. So you multiply that to get thirty-six. |  |
| 353 | 00:20:51 | Michael | Okay. |  |
| 354 | 00:20:52 | R1 | Show us the forty-five. |  |
| 355 | 00:20:54 | Ankur | It's not as simple as that. [They laugh] |  |
| 356 | 00:20:56 | R1 | It's not as simple. |  |
| 357 | 00:20:57 | Ankur | You do it. |  |
| 358 | 00:20:58 | Michael | I'm just... |  |
| 359 | 00:20:58 | R1 | Well, do it together. Do it together. You can help each other. |  |
| 360 | 00:21:01 | Michael | Well talk amongst yourselves because I got to, I got to finish something. |  |
| 361 | 00:21:04 | R1 | We'll wait for you. |  |
| 362 | 00:21:05 | Michael | Well then they're going to be staring at me and I don't like that. |  |
| 363 | 00:21:07 | R1 | No, we won't. Why don't you get your presentation ready and ... |  |
| 364 | 00:21:10 | Ankur | We got to do it up there? |  |
| 365 | 00:21:11 | R1 | Yeah. |  |
| 366 | 00:21:12 | Ankur | I don't like writing. |  |
| 367 | 00:21:14 | Brian | Tough. |  |
| 368 | 00:21:14 | R1 | It's easier for me to understand. Maybe someone will write it for you. |  |
| 369 | 00:21:18 | Romina | I'll write for you. So you don't have to write. |  |
| 370 | 00:21:21 | R1 | Romina will [inaudible]. What do you think? Will you accept? |  |
| 371 | 00:21:27 | Ankur | I decline. |  |
| 372 | 00:21:28 | Romina | But you're going to be aggravated, you're just going to want to do it yourself, anyway. So why don't you just do it yourself. |  |
| 375 | 00:21:34 | Brian | You lazy bum. |  |
| 376 | 00:21:35 | Ankur | That's right. |  |
| 377 | 00:21:37 | R1 | Come on. |  |
| 378 | 00:21:39 | Ankur | I gotta wait for him. |  |
| 379 | 00:21:41 | Michael | You don't have to wait for me. |  |
| 380 | 00:21:42 | Ankur | You have to do this part. |  |
| 381 | 00:21:43 | Michael | Write this exactly. See how it looks on the paper? Write it up there but neater. [They laugh] Write it up there. Do that. |  |
| 382 | 00:21:52 | Ankur | Did you, did you write them out? |  |
| 383 | 00:21:54 | Michael | Don't worry about it. Look at how [inaudible] |  |
| 384 | 00:21:56 | Ankur | That's what you got to write up there. |  |
| 385 | 00:21:57 | Michael | I'm not going to write that up there. I'm.... |  |
| 386 | 00:22:00 | Ankur | You came up with this. |  |
| 387 | 00:22:01 | Michael | I'm just doing it for myself because I want to be 100% sure that is, what is that eighteen? What did we say for that one, eighteen, right? |  |
| 388 | 00:22:11 | Ankur | Three, six, nine... twenty-seven cause you got [inaudible] up here. |  |
| 389 | 00:22:16 | Michael | Twenty-seven, yeah. I just want to make sure, exactly, that it's twenty-seven. Just do what you have to do up there. Just draw it. |  |
| 390 | 00:22:22 | Ankur | Alright, Romina? |  |
| 391 | 00:22:23 | Romina | Yes. |  |
| 392 | 00:22:23 | Ankur | Could you write something for me please? |  |
| 393 | 00:22:25 | Romina | Yes. That exactly without changing a thing? [She goes to the board] |  |
| 394 | 00:22:28 | Ankur | Write.. |  |
| 395 | 00:22:28 | Michael | Well draw a box around it. She's going to write the stuff at the top. |  |
| 396 | 00:22:30 | Ankur | Write this stuff. |  |
| 397 | 00:22:30 | Brian | Are you telling me that you can't? |  |
| 398 | 00:22:32 | Michael | He's lazy. |  |
| 399 | 00:22:32 | Romina | They're going to get so aggravated with me. So... |  |
| 400 | 00:22:36 | Ankur | Alright, wait, I’ll just read it to you. |  |
| 401 | 00:22:37 | Brian | I'll offer you something... [He erases the board] |  |
| 402 | 00:22:40 | Romina | Do I draw a big box or…? |  |
| 403 | 00:22:41 | Ankur | No, just write whatever I read, write going down. |  |
| 404 | 00:22:45 | Romina | Going down? |  |
| 405 | 00:22:47 | Ankur | One, one, one, zero…like that's [inaudible] and then... |  |
| 406 | 00:22:53 | Romina | Yeah, [inaudible] |  |
| 407 | 00:22:55 | Ankur | Two, two, two, zero. Three, three, three, zero. Then like skip just a little like space and then, not that much….Like one, one, zero, one. Try to keep it even – it it will be easier to see [laughing]. I was just trying to get you mad. Two, two, zero, two. You see where this is going.? |  |
| 408 | 00:23:30 | Romina | Yeah, I can. |  |
| 409 | 00:23:32 | Ankur | And then you do the same thing but the zero’s are like in the second. |  |
| 410 | 00:23:38 | Brian | You couldn’t do that? |  |
| 411 | 00:23:40 | Ankur | Not really. |  |
| 412 | 00:23:43 | Romina | And do I have all the zero’s? |  |
| 413 | 00:23:44 | Ankur | Yeah. |  |
|  |  | Brian and Ankur are having a quiet conversation as she writes. Their conversation is inaudible. | |  |
| 414 | 00:23:58 | Romina | Okay. |  |
| 415 | 00:24:01 | Ankur | Alright. Now make, make an entire line going across the bottom, under them. Okay. Say one equals red, two equals blue, you don’t have to write it, and three.... |  |
| 416 | 00:24:13 | R1 | Yeah, write it down. |  |
| 417 | 00:24:23 | Romina | Equals... |  |
| 418 | 00:24:24 | Ankur | yellow and zero equals any one of the three. |  |
| 419 | Romina has written the following on the board:  1 2 3 1 2 3 1 2 3 0 0 0  1 2 3 1 2 3 0 0 0 1 2 3  1 2 3 0 0 0 1 2 3 1 2 3  0 0 0 1 2 3 1 2 3 1 2 3  1= red  2=blue  3=yellow  0=any one of 3 | | |  |
| 420 | 00:24:38 | Ankur | Okay, now, I'm just trying to think this out, I don't know how to say it. Alright now, there’s not going to one of each color in this cause you can just see that, right? Like there’s not going to be…. | 01:23:31 Romina writes for Ankur and Michael. |
| 421 | 00:24:58 | R1 | Brian, do you agree with that? |  |
| 422 | 00:25:00 | Romina | What do you mean by that? |  |
| 423 | 00:25:00 | Brian | I see what he's talking about. |  |
| 424 | 00:25:02 | R1 | Romina? |  |
| 425 | 00:25:02 | Ankur | There’s not going to be like a red….Like for the thirty-six there was a red, a blue, and a yellow. There’s not going to be a red, a blue, and a yellow in any one of these. Could you see that? Can you see why? |  |
| 426 | 00:25:15 | Romina | What do you mean [inaudible]? |  |
| 427 | 00:25:16 | Ankur | Like, remember in thirty six? There had to be a red, a blue, and a yellow in each one? |  |
| 428 | 00:25:21 | Brian | Yeah. |  |
| 429 | 00:25:22 | Romina | Isn’t that what we are suppose to do? |  |
| 430 | 00:25:22 | Ankur | Yeah, but in this one I am proving the forty five. There can't be a red... |  |
| 431 | 00:25:25 | Romina | Oh, you’re proving the forty five. Okay, now you can see. Yeah. |  |
| 432 | 00:25:27 | Ankur | Yeah, so. |  |
| 433 | 00:25:28 | Romina | Yeah. |  |
| 434 | 00:25:29 | Ankur | Can you see why there can’t be a red, a yellow and a blue? |  |
| 435 | 00:25:32 | Romina | Yeah. |  |
| 436 | 00:25:34 | Ankur | Ok, I just wanted to, you don’t see why? |  |
| 437 | 00:28:37 | R2 | No, I want you to explain it. |  |
| 438 | 00:25:39 | Ankur | Explain why there can’t be a red, a yellow? |  |
| 439 | 00:25:41 | R2 | No, I understand there can’t be three in each one because of the reason from before. |  |
| 440 | 00:25:48 | Brian | We already figured that out. |  |
| 441 | 00:25:49 | Ankur | Ok…right now, this isn’t the entire part of the forty-five. |  |
| 442 | 00:25:52 | R2 | Oh, okay. |  |
| 443 | 00:25:53 | Ankur | This is just a section of it. |  |
| 444 | 00:25:54 | R2 | A piece of it, okay. |  |
| 445 | 00:25:56 | Ankur | This is the ones with three of one color and, and then... |  |
| 446 | 00:26:01 | R2 | Something else…. |  |
| 447 | 00:26:01 | Ankur | Something else. |  |
| 448 | 00:26:03 | Romina | Okay. Hold on. Three of one color…… |  |
| 449 | 00:26:05 | Ankur | Three of one color... and another color. |  |
| 450 | 00:26:06 | Brian | Anything besides, all three. |  |
| 451 | 00:26:09 | Romina | Yes, I can see that. |  |
| 452 | 00:26:10 | Ankur | But there’s just one problem in this. When, like... [Ankur goes up to the board.] |  |
| 453 | 00:26:15 | Romina | Told yah. [Romina tries to hand him the chalk] |  |
| 454 | 00:26:16 | Ankur | I don’t need chalk When you look at this half, it could be red, red, red, and red. But you go over here and you do red, red, red and red, then those two are the same. So instead of having... zero really represents not any one of the three but the other two that are not present. Do you understand that? |  |
| 455 | 00:26:44 | R1 | Do you want to change that? You want to change what zero is? |  |
| 456 | 00:26:47 | Ankur | Can you write that? [Ankur asks Romina to re-write the definition of zero] |  |
| 457 | 00:26:51 | Romina | Any one of the three except the one that is present. |  |
| 458 | Romina rewrite the definition of zero. The board now says:  1 2 3 1 2 3 1 2 3 0 0 0  1 2 3 1 2 3 0 0 0 1 2 3  1 2 3 0 0 0 1 2 3 1 2 3  0 0 0 1 2 3 1 2 3 1 2 3  1= red  2=blue  3=yellow  0=any one of 3 except the ones that are present. | | |  |
| 459 | 00:27:01 | Ankur | So it could be red, red, red, blue; red, red, red, yellow. For every single one. |  |
| 460 | 00:27:07 | R1 | So you’re not allowed to ever have red, red, red, red? |  |
| 461 | 00:27:09 | Ankur | No, you’re allowed to have that. |  |
| 462 | 00:27:11 | R1 | No here. |  |
| 463 | 00:27:12 | Ankur | Not in this situation, cause we’re doing three of one color and… |  |
| 464 | 00:27:15 | R1 | What do you think about that Brian? |  |
| 465 | 00:27:18 | Brian | I totally understand what he’s trying to talk about. It's just he keeps saying the same thing |  |
| 466 | 00:27:22 | Ankur | So, alright. So there’s eighteen cause there’s three, six, [he counts silently]. No, I mean twenty four. Twenty four. And then when you, when you… |  |
| 467 | 00:27:38 | R1 | Why twenty four? |  |
| 468 | 00:27:41 | Romina | Cause you have the, hold on, one, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve…times two, right? Am I wrong? |  |
| 469 | 00:27:50 | Ankur | You’re right. |  |
| 470 | 00:27:51 | Romina | Okay. |  |
| 471 | 00:27:52 | Ankur | So there’s twenty four and you can add red, red, red, red; yellow, yellow, yellow, yellow and blue, blue, blue, blue. So that’s twenty seven. And now you got to erase that. [He turns to Romina. Romina goes up and erases the whole board.] |  |
| 472 | 00:28:13 | Ankur | Are you guys still with me or ? |  |
| 473 | 00:27:15 | Romina | Okay, we have around twenty seven, right? |  |
| 474 | 00:27:17 | Ankur | Now, I still got to do… | 01:26:46 Ankur decides to explain at the board after having Romina write. |
| 475 | 00:28:20 | Romina | Do I have to write anything? |  |
| 476 | 00:28:21 | Ankur | Yeah. |  |
| 477 | 00:28:28 | Ankur | Write one, one, two, two; one, one, three, three; two, two, one, one. [She continues and writes the next three columns, see board work below]. Okay now you got to write one, two, two, one; one, three, three, one; three, I mean two, one, one, two; you all see where this is leading? [She continues and writes the next three columns on the board]. |  |
| 478 | 00:29:24 | Ankur | Now go on the bottom and write one, two, one, two; one, three, one, three; two, one, two, one; two, three, two, three; three, one, three, one. And three, two, three. |  |
| 479 | 00:29:49 | Ankur | Now this is the other, two, four, six, twelve, eighteen. And twenty-seven plus eighteen equals forty five. Now these are the ones, these still don’t have three of each color. |  |
| 480 | The board now says:  1 1 2 2 3 3 1 1 2 2 3 3  1 1 2 2 3 3 2 3 1 3 1 2  2 3 1 3 1 2 2 3 1 3 1 2  2 3 1 3 1 2 1 1 2 2 3 3  1 1 2 2 3 3  2 3 1 3 1 2  1 1 2 2 3 3  2 3 1 3 1 2 | | |  |
| 481 | 00:30:06 | R1 | So which ones are these? |  |
| 482 | 00:30:08 | Ankur | Theses are two of one color and two of another color. |  |
| 483 | 00:30:12 | R1 | And you have all possibilities? |  |
| 484 | 00:30:13 | Ankur | Yes. |  |
| 485 | 00:30:17 | R1 | Are you convinced of that? [Asking Brian and Romina] |  |
| 486 | 00:30:19 | Romina | It’s kind of like an extended version of what we did. |  |
| 487 | 00:30:22 | R1 | In what ways is it an extended version of what you did? |  |
| 488 | 00:30:24 | Romina | Because we didn’t actually go through, we just went on the math. Which, that's why I said we could have been wrong because we didn’t actually go through them. This one showed us every single possibility. Very good. So we’re sure. |  |
| 489 | 00:30:40 | R1 | So you’re convinced? You believe, Ankur? |  |
| 490 | 00:30:42 | Romina | Yeah. |  |
| 491 | 00:30:43 | R1 | Ankur believes you? |  |
| 492 | 00:30:44 | Ankur | Yes. |  |
| 493 | 00:30:46 | R1 | What about, what do you think Mike? Any idea what he did? |  |
| 494 | 00:30:49 | Michael | Yeah, I did it, I believe them. Something. |  |
| 495 | 00:30:54 | R1 | So, I'm curious, I'm kind of curious when you started out…um…where do you think…um…your notion of variable got you in trouble? You found duplicates later, Mike. Where did they come in? |  |
| 496 | 00:31:08 | Ankur | We made a mistake when we did the first thing we did. When we showed you this. |  |
| 497 | 00:31:12 | R1 | Right. |  |
| 498 | 00:31:13 | Ankur | When we put the zero’s on top. |  |
| 499 | 00:31:15 | R1 | Right. |  |
| 500 | 00:31:16 | Ankur | It turned out that…even if this was a one, like, could we do…. Explain how you did it [Ankur says this to Michael who gets up and goes to the board]. |  |
| 501 | 00:31:24 | Michael | Do you guys, you don't need that, do you? [He points to the work on the board.] |  |
| 502 | 00:31:27 | R1 | We have it already. |  |
| 503 | 00:31:42 | Michael | We had like the dumbest way. In the beginning we did this, to find the ones that have all three. And this “o” could be like a variable, any three of the numbers, any three. |  |
| 504 | 00:31:58 | Ankur | Are you going to write all that on the board? |  |
| 505 | 00:32:00 | Michael | No, I am not going to write one section of it – just six. |  |
| 506 | 00:32:02 | Ankur | Okay…one more. |  |
| 507 | 00:32:08 | Michael | You could have the variable “one” up here or up here. |  |
| 508 | 00:32:12 | Romina | Yeah…it’s…. |  |
| 509 | 00:32:14 | Michael | Just wait though. We have doubles in here. |  |
| 510 | 00:32:18 | Ankur | Which we didn’t realize until later. |  |
| 511 | 00:32:20 | Michael | Too far ahead. Okay, do you see that? Now there’s like six…no, not six. |  |
| 512 | Michael has written the following on the board:  1 1 1 1 1 1  2 3 0 0 2 3  3 2 2 3 0 0  0 0 3 2 3 2 | | |  |
| 513 | 00:32:31 | Ankur | Yeah, its six…cause there’s six… |  |
| 514 | 00:32:35 | Michael | Okay, watch. There’s six doubles in here. Because the way we thought it, here are like three ways to do it, you would do times three, times.. | 01:31:20 Michael gives an example of how their six duplicate towers were created. |
| 515 | 00:32:41 | Romina | There’s only six up there? |  |
| 516 | 00:32:42 | Michael | I know, watch. |  |
| 517 | 00:32:43 | Ankur | No, but you would times three because the zero could be either one of the three. |  |
| 518 | 00:32:43 | Michael | You would do times three because you could have three different ones in there. |  |
| 519 | 00:32:47 | Romina | Okay. |  |
| 520 | 00:32:48 | Micheal | So six times three, eighteen. But there’s three doubles in there. |  |
| 521 | 00:32:51 | Ankur | But then you could have like two off two…. |  |
| 522 | 00:32:53 | Michael | Wait, let me explain. You could have, let’s take the first one. One, two, three, and this is “o.” Now, what was the other one that I was looking at? We took this one – one, 'o', three, two. If you have a two as this variable and a two as this variable, the variable, it’s the same thing. And you would also have another one. One, two, three…no it would be…. |  |
| 523 | 00:33:27 | Ankur | One, zero…. |  |
| 524 | 00:33:29 | Michael | I think it's this one. |  |
| 525 | 00:33:30 | Ankur | Yeah. |  |
| 526 | 00:33:31 | Michael | One, two, “o” and a three. If this is three and this is three, it's the same thing. [He is referring to the two zero's that are contained in the last two columns – see board work below.] |  |
| 527 | Michael now has the following on the board:  1 1 1 1 1 1 1 1  2 3 0 0 2 3 2 2  3 2 2 3 0 0 3 0  0 0 3 2 3 2 0 3 | | |  |
| 528 | 00:33:37 | Michael | And there’s a total of six in there. And this, this would be only for the ones with the one, the certain color. The second color, we did like instead of a one there, we had a two there. And wherever the two’s were, we’d put a one. Two, two, two. I’ll erase the top row. |  |
| 529 | Michael now has the following on the board:  2 2 2 2 2 2  2 3 0 0 2 3  3 2 2 3 0 0  0 0 3 2 3 2 | | |  |
| 530 | 00:34:05 | Michael | And we ran out of time total because we found all those doubles in there. And I didn’t notice that until late. |  |
| 531 | 00:34:09 | Ankur | And then we did the same thing, put the three’s across. |  |
| 532 | 00:34:10 | Michael | It came out to be three, thirty-six. And to explain it, you guys wouldn't understand me, so we used your explanation. That was best. |  |
| 533 | 00:34:18 | Ankur | That's a lot easier. |  |
| 534 | 00:34:19 | Michael | And since we had some sort of explanation for the forty-five which is still confusing. |  |
| 535 | 00:34:24 | Romina | Yeah. |  |
| 536 | 00:34:26 | Michael | We could still prove it that it's thirty-six….forty-five? What did we get [inaudible]? |  |
| 537 | 00:34:33 | Ankur | Thirty-six. |  |
| 538 | 00:34:34 | Michael | Thirty-six and forty-five. |  |
| 539 | 00:34:35 | Ankur | Thirty-six and forty-five. |  |
| 540 | 00:34:37 | R1 | So suppose you were doing towers five tall, would that same reasoning work? |  |
| 541 | 00:34:44 | Ankur | I really don't care. No one is going to ask me that on the street. |  |