Description: PUP Math – World Series **Location: David Brearley High School – Kenilworth, NJ** **Researcher: Professor Carolyn Maher**	**Transcriber(s): Private Universe Project** **Verifier(s): Sigley, Robert, Sran, Kiranjeet** **Date Transcribed: Spring 2000** **Page: 1 of 5**

Line	Time	Speaker	Transcript
1		*Narrator*	*In January of 11th grade, the Focus Group of five Kenilworth students met after school to work on a problem they had never seen before: the World Series problem.* *In the World Series, assuming two teams are equally matched, and the first team that wins four games wins the series, what is the probability that the World Series will be won in four, in five, in six, and in seven games?*
2		Romina	Why don't we do like- you know how we do like write out the blues-
3		Carolyn Maher	We'll leave you alone.
4		Jeff	Yeah, that's what I'm saying-
5		Romina	So that you can go all 7, because if you go all 4, it's only A, A, A. A, A, A, A, and B, B, B, B. Team A and Team B? Those are the only possibilities for four.
6		*Gina Kiczek*	*We had worked with the students on a lot of different combinatorics problems, in towers and pizza, and extensions of those things. So we decided to see what was possible. Given all of the different ideas that they had built, we wanted to see if they could solve a particular probability problem without having been taught how to do it, without any formal rules or notation or anything being imposed. We just wanted to see what would happen.*
7		Romina	So in 4 games, it would be like 1/2 of a chance? Or would we have to write out, with using all 7?
8		Jeff	See, I think that it's the hardest doing it in 4 games. Definitely hardest. So that wouldn't be one half.
9		Brian	Wouldn't it be the odds of winning 1 game, times odds of winning one game, times odds of winning game, times odds of winning one game?
10		Jeff	That's what I'm thinking.
11		Ankur	It's a 50 percent chance of winning the first game.
12		Brian	All right. So it's like a half times a half-
13		*Gina Kiczek*	*They did the problem in about an hour, and they did it correctly, and I've been studying the tape for about two years. There's a lot of mathematics on the tape. And I'm looking at not only what they did to solve the problem, but I'm trying to look for the origins of those ideas.*
14		Brian	Just remember, the odds get harder to win 2 in a row, like a

			coin flip.
15		Romina	Yeah, that's how you do it. Half times half times half times half.
16		*Narrator*	*Their answer, 1/16, was added to another 1/16 to account for both teams.*
17		Romina	Would we do that for 5 games? That would be-- Yeah, there's going to be a lot.
18		*Narrator*	*Mike worked on his own, using Pascal's triangle, while the other students worked together.*
19		Romina	Would it be, like, say, the probability of something, and then it would be like B, B, B, B. And any ones that have B, B, B, B--
20		Jeff	Yeah, then that would be that number and that number. That's what I was thinking.
21		Ankur	So we've got to do it like that.
22		*Narrator*	*Moving on to 5 games, Romina proposed writing out all combinations, using strings of A's and B's to represent the wins.*
23		Romina	Yeah, I know. I'm just saying, like, each time we look over, like, five, well, we'll see how many. You know?
24		*Gina Kiczek*	*Of course, for a 4 game series, it's pretty easy. You either have 4 wins in a row for this team or 4 wins in a row for that team. And for a 5 game series, it was a little bit more complicated, and they realized that they got 8 different strings. But when they tried to figure out what the probability of that was, they knew it was 8 over something, and it was the 8 over something part that they had a little trouble with.*
25		Ankur	They have 8 ways of winning, but it would be over--
26		Jeff	Oh, 8 over 1-- No, how do we find out?
27		Ankur	Be over the total possibilities of 2...- 2 colors and 5 things.
28		*Gina Kiczek*	*They seemed to have the idea that probability is the number of favorable outcomes over the number of total outcomes, although they never said that, they never had that definition. But it was an intuitive type of thing that they seem to have been doing.*
29		Ankur	Know what I'm talking about or no?
30		Jeff	Yeah, it's got to be over 2. The total possibility's 4 spaces.
31		Ankur	Yeah, 4 spaces.
32		Jeff	Yeah, all right, it makes sense-- And that would be 8 over 2 to the fifth, do you think?

33		Ankur	That's 16.
34		Jeff	And then 8 over 2 to the fifth?
35		Ankur	I guess.
36		Jeff	Which would be 32.
37		Mike	Is there's 32 possibilities for 5 games.
38		Jeff	Yeah. That sounds--
39		Ankur	I think there's more.
40		Brian	For how many games?
41		Jeff	Five.
42		Romina	Hold on. You've got 8?
43		Jeff	5 spaces.
44		Ankur	Total possibilities.
45		Jeff	32 for 5.
46		*Gina Kiczek*	*So then they got to a 6 game series. That was a little bit more difficult to list all the different possibilities for 6 games, but they did it. When they got to the 7 game series, they realized that that was going to be a lot to count.*
47		Jeff	You see doubles in that? I can't even look at it.
48		Romina	You want me to read them?
49		Ankur	For 7?
50		Romina	With "A" winning.
51		Ankur	Did you just randomly write them, or did you do them in some order?
52		Romina	I started in some order, then I-- It's hard though, because you're just, like-- I don't know. Did you write them all out?
53		Ankur	I wrote them out.
54		Romina	Oh, you did?
55		Ankur	I wrote out 10.
56		*Narrator*	*Ankur found out that his winning probabilities for 4, 5, 6, and 7 games added up to 1.*
57		Ankur	It is right. 40 out of 128. The whole thing adds up to 1.
58		Brian	Do they match with them?
59		Ankur	They match.
60		Jeff	Wait, 40 out of 128?
61		Ankur	Yeah, it works.
62		*Gina Kiczek*	*They looked at it in cases-- 4 game, 5 game, 7 game series. They got the probability of each one individually. They saw that they gave them a total of 1. They knew that that was supposed to happen. And they were ready to present their solution, all using representations that were basically retrieved from earlier investigations, and maybe modified a*

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			little bit to fit the situation.
63		Jeff	So basically, what we did was, that could be 2 possibilities, that could be 2 possibilities, that could be 2, that could be 2. And that was like where we went back to the old days, and it was like 2 to the n. So 2 X 2 X 2 X 2. That's how we got 16. And that would be the bottom number. And then in order win the 4 games, these have to be either all A's or all B's. So we got 2 out of 16, for winning at 4 games, which is probability of winning in 4 games. That make sense?
64		Mike	They have something that works for that first one, but does it work for-
65		Jeff	Yeah. We're going to go on. So for the next one, we're going to do the same situation, but this would be 2 to the 5th. So that's going to be out of 32. And 32's the bottom number. And then, I think for these we were just kind of-- we went through them. That's why there are strings of A's and B's on everyone's paper. In order to get these, we went through all the possibilities where there was 5, 5 places, and A or B was in 4 of them. And we went through all of them, and that's how we got that. And then we ended up with 8 of 32 put for that. Now that's not too convincing, because we just went through them. But we went through all the ones that were out of 5, with 4 A's. And that's how we got that. I don't think we have a real, concrete mathematical backing to that.
66		*Narrator*	*At this moment, Mike presented his approach. Mike used Pascal's triangle to explain his strategy.*
67		Mike	I just found, like you take the fourth number of each one. For some reason if you double each number, because you have 2 teams, you get the possibilities for 4 games, 4 games- equals two, right? You've got 8, 20, and 40 like they said. Those last- those 3 games that they won, the first 3 games, if they win that, that would be like there's 3 possibilities- would be- if they win the next game- or if they win- I don't know how to explain this. On the third game...I don't know.
68		Jeff	I guess if we were going to say-- if was out of 8 games, then there would be 35? The probability would be 35 out of-- you know what I'm saying?
69		Ankur	Yeah.
70		Brian	Yeah.
71		Mike	It would be 1, 7--

72		Ankur	Just add the 15 and 20 for 35.
73		Jeff	So I mean, there's got to be something there, because it wouldn't all-
74		Mike	It would be 35 doubled.
75		Ankur	Yeah.
76		Jeff	Yeah. 35 for one team.
77		Mike	But the limits of the problem are you have to win 4 out of 7. Not 4 out of 8.
78		Jeff	Oh yeah, I know.
79		*Gina Kiczek*	*So Michael notices in the triangle that on one of the diagonals, he finds the numbers 1, 4, 10, and 20. And the counts, in each case, the count for a 4 game series, the number of ways you can win a series in 4 games was 2, and the number of ways you could win it in 5 games was 8, and in 6 games was 20, and in 7 games was 40. So he's got 1, 4, 10, and 20 in this diagonal. And if you double them, he said that that's 2, 8, 20, and 40. "So there's obviously some connection," he said. "But I don't know what it is yet."* *So they spent some time looking at that connection. I think initially it's just an interesting insight on Michael's part. He notices a pattern there. And noticing that connection spurred all kinds of activities over the next three sessions. That allowed them to do some pretty sophisticated mathematics.*