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Special issue on “Research and Developments in Probability Education”

Manfred Borovcnik & Ramesh Kapadia (Eds)

**ANNEX: ALL APPENDICES TO  
BUILDING A CONNECTION BETWEEN  
EXPERIMENTAL AND THEORETICAL ASPECTS OF PROBABILITY**

**Seth Ireland & Jane Watson**

To article 

**Movies**

**Movies** on Mixer and Spinner

**Movie** on Whole Class Coin Activity

**Movie** on an Interview

**Appendices**

**A.** Section 1 of Class Test: Probabilistic Intuitions

**B.** Personal Interview Protocol

**C.** Section 2: Attitudes to Technology, Mathematics and Probability

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**Results**

**General Statistics**

**Section 1.** Class Test on Probabilistic Intuitions

**Section 2.** Attitudes to Technology, Mathematics and Probability

**Section 3.** Experience with Technology

**Annex**

**Student Interviews.** Results of the In-Depth Interviews (external file)

## MOVIES

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### Movies on Mixer and Spinner

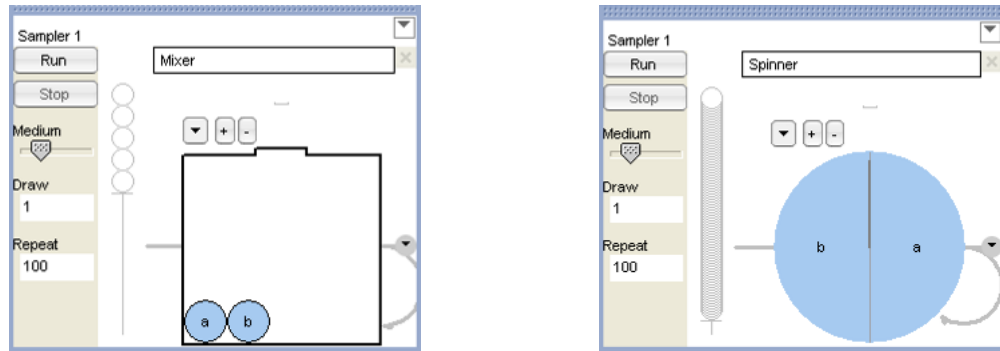


Figure 1. The Mixer and the Spinner in TinkerPlots Sampler (click to see the videos).

### Movie on Whole Class Coin Activity

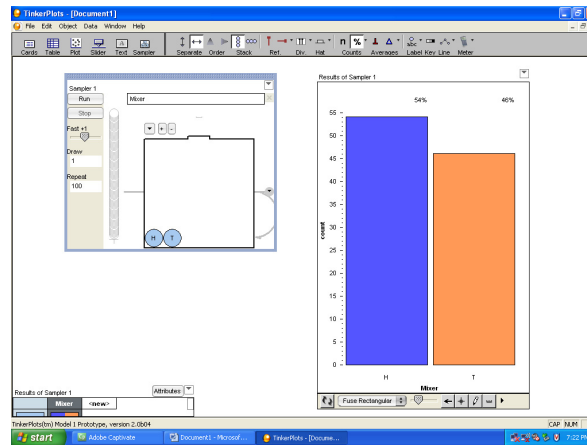


Figure 5. Screen dump of the Sampler whole class coin activity including three graphs (click to see a video).

### Movie on an Interview

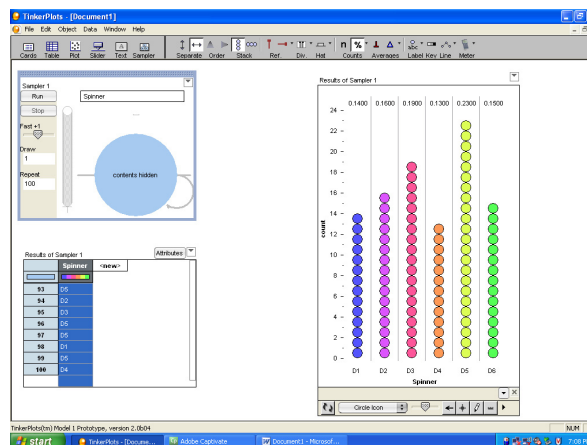


Figure 6. Screen dump of the Sampler personal interview die activity including a table and graph – click to see a video.

**APPENDIX A**[To article](#) [Top](#) **Section 1 of Class Test: Probabilistic intuitions****1. Complete the sentence**

(a) One thing that **will certainly** happen today is \_\_\_\_\_

\_\_\_\_\_

(b) One thing that is **impossible** today is \_\_\_\_\_

\_\_\_\_\_

(c) One thing that **might possibly** happen today is \_\_\_\_\_

\_\_\_\_\_

**2. What things happen in a “random” way?**

3. One day, Claire won Tattslotto with the numbers

1; 7; 13; 21; 22; 36.

So she said she would always play the same group of numbers, because they were lucky.

What do you think about this?

4. Consider rolling one six-sided die. Is it easier to throw?

(1) a one; or

(6) a six; or

(=) are both a one and a six equally easy to throw?

Please explain your answer.

5. Imagine you threw the die 60 times. Fill in the table below to show how many times each number might come up.

Number on Dice	How many times it might come up
1	
2	
3	
4	
5	
6	
TOTAL	60

Why do you think these numbers are reasonable?

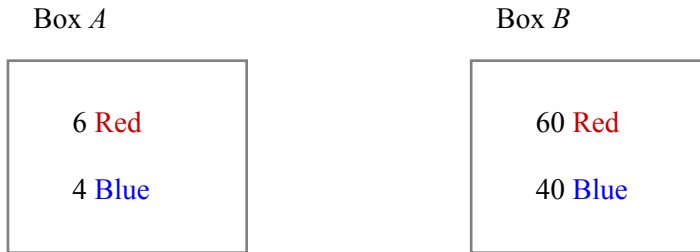
6. A mathematics class has 13 boys and 16 girls in it. Each pupil's name is written on a piece of paper. All the names are put in a hat. The teacher picks out one name without looking.

Is it more likely that

- (b) the name is a boy  
or  
 (g) the name is a girl  
or  
 (=) are both a girl and a boy equally likely?

Please explain your answer.

7. Box *A* and Box *B* are filled with red and blue marbles as follows:



Each box is shaken. You want to get a blue marble, but you are only allowed to pick out one marble without looking.

Which box should you choose? (Circle your answer)

- (A) Box *A* (with 6 red and 4 blue).
- (B) Box *B* (with 60 red and 40 blue).
- (=) It doesn't matter.

Please explain your answer.

8. If you flipped a coin what is the chance you will get a heads?

Explain your answer.

## APPENDIX B

[To article](#) [Top](#) **Personal Interview Protocol**

<b>Issue addressed</b>	<b>Questions</b>
<b>Introduction</b>	
Relaxing	<ul style="list-style-type: none"> <li>• Show Die</li> </ul>
Participants	<ul style="list-style-type: none"> <li>• How did you learn from the lessons? What was easy what was hard?</li> </ul>
<b>Manipulatives</b>	
General	<ul style="list-style-type: none"> <li>• Describe to me the object in your hands?</li> <li>• What other objects are this shape?</li> <li>• Where do we use this object? And how?</li> </ul>
Theoretical	<ul style="list-style-type: none"> <li>• What happens if we toss the die?</li> <li>• What are the possible outcomes?</li> <li>• What do you think the probabilities of these outcomes might be?</li> <li>• Does this mean that all outcomes are “Equally likely”?</li> </ul>
Experimental	<ul style="list-style-type: none"> <li>• What would it mean if they were not “Equally likely”?</li> </ul>
Experimental Concrete	<ul style="list-style-type: none"> <li>• I was playing a game with someone and they said that they never get a 6, they believed the die was loaded. What ways can I find out if it is loaded? Be prepared for responses like “feel if it is heavy on one side,” “check the numbers,” or “all dice are fair, you don’t have to check.”</li> <li>• In probability we make the assumption that the dice is fair. What is meant by fair?</li> </ul>
Experimental & Theoretical	<ul style="list-style-type: none"> <li>• How many rolls do you think you would need to make to be certain it was fair? Why?</li> <li>• GET PEN AND PAPER. DRAW GRAPHS.</li> <li>• If it was a fair die, what would you expect the results to look like after 10 rolls? Why? If I did 10 rolls another 3 times? Would it be different?</li> <li>• 100 rolls? Why? If I did it another 3 times?</li> <li>• 1,000? If I did it another 3 times?</li> <li>• Would the results be different if it was an unfair dice? How?</li> <li>• How fair (equally likely) do you consider a normal dice to be? Why?</li> </ul>

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**Computers**


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Computers & manipulations	<ul style="list-style-type: none"> <li>• Explain to me what is happening on the screen when I run a trial?</li> <li>• How is that similar to what we did in class with the coin?</li> <li>• What does the spinner do?</li> <li>• In your own words how does the simulator represent the die? (Show spinner)</li> <li>• What are the possible outcomes?</li> <li>• What do you think the probabilities of these outcomes might be?</li> <li>• Does this mean that all outcomes as “Equally likely” as the die? Why? (Show mixer)</li> </ul>
Computers manipulations & Theory	<ul style="list-style-type: none"> <li>• What are the possible outcomes? (Why same as before?)</li> <li>• What do you think the probabilities of these outcomes might be?</li> <li>• Does this mean that all outcomes as “Equally likely” as the die? Why?</li> <li>• Of the spinner and mixer, which do you think is a better representation of the die? Why?</li> <li>• How do you think the computer randomly chooses the numbers from 1–6?</li> </ul>
Computer to manipulations	<ul style="list-style-type: none"> <li>• The sampler has been set up the same as this die. It has the same theoretical probability. Let’s run some samples, you tell me when you are satisfied that the die is fair or not. <ul style="list-style-type: none"> <li>○ Start with small samples of 10, 20, 50. Ask for student input on sample size.</li> <li>○ What do you notice about the results?</li> <li>○ What do you think will happen after we added these additional samples?</li> <li>○ Are you satisfied yet?</li> <li>○ How did you come to that conclusion?</li> </ul> </li> </ul>
Experimental & theoretical	<ul style="list-style-type: none"> <li>• Explore simulations with loaded dice. Have students explore how many tosses they need to infer what the theoretical probability might be and how many times they need to test it.</li> <li>• Show correct loadings of the loaded dice and ask where does this (the spinner loadings) fit into the range from theoretical to experimental probability? Why?</li> <li>• Did you prefer working with the dice or computer better? Why?</li> <li>• How fair do you consider the computer simulation to be? Why?</li> <li>• Is the computer fairer then the dice? Why/why not?</li> <li>• Is the simulator “closer” to the real die we have here on the table or “closer” to the concept of a fair die we talked about with equal probability for each number? Why?</li> <li>• In your own words explain how theoretical and experimental probability of a die are related? Can you give me an analogy?</li> </ul>

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## APPENDIX C

## Section 2: Attitudes to technology, mathematics and probability

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<i>Answer this section by placing an '×' on the</i>	No	Maybe	Yes		
• I learn Maths best when it includes hands on activities.	●	●	●	●	●
• It takes me a while to work out computer programs.	●	●	●	●	●
• Computers and technology interest me.	●	●	●	●	●
• Even if a mathematical problem is difficult I can usually solve it.	●	●	●	●	●
• I like 'playing around' with computers.	●	●	●	●	●
• I get anxious when I first 'get stuck' on a mathematics problem.	●	●	●	●	●
• I only study mathematics because I have to.	●	●	●	●	●
• Mathematics can be used in everyday life.	●	●	●	●	●
• Probability is useful in everyday life.	●	●	●	●	●
• I think I will probably get a good mark in mathematics this year.	●	●	●	●	●
• I think I am good at probability.	●	●	●	●	●
• I daydream all the time in mathematics class, my mind just seems to want to be elsewhere.	●	●	●	●	●
• I know more about computers than almost all of the teachers.	●	●	●	●	●
• I am very good at least one computer 'strategy' game. Eg. Age of Empires, Civilisation,	●	●	●	●	●
• If a friend or someone lends an MP3 player or mobile phone I can quickly work out how to use all the	●	●	●	●	●
• I could explain <b>most</b> of these terms and symbols: 1.8 Ghz, .doc, 160 MB, .xls, 6.1 Megapixel	●	●	●	●	●
<b>10. Are you confident in using the following technologies?</b>					
▪ Internet	●	●	●	●	●
▪ Office software (Word, Excel, etc)	●	●	●	●	●
▪ Email	●	●	●	●	●
▪ Blogs	●	●	●	●	●

## APPENDIX D

### Section 3: Experience with technology

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11. Do you have a desktop or laptop computer at home that you have access too?

**Yes/No**

a) How often do you use a computer at home? Please circle your answer

**Everyday / Once a week / Few times a month / Rarely**

b) What programs do you usually use? And what for?

12. Do you have a game consol such as a Playstation or Xbox at home that you have access to?

**Yes/No**

a) How often do you use the consol at home? Please circle your answer

**Everyday / Once a week / Few times a month / Rarely**

b) What game titles do you usually play?

13. a) How often do you use a computer in the classroom? Please circle your answer

**Everyday / Once a week / Few times a month / Rarely**

b) What programs do you usually use? And what for?

14. Have you used any mathematical or probability software previously? If so what?

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**RESULTS**

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**General statistics**

Student	Gender	Grade
#25	0	1
#26	1	1
#22	1	1
#20	0	1
#20	0	1
#06	1	1
#07	1	1
#08	0	1
#09	1	1
#10	0	1
#11	0	1
#12	0	0
#13	1	0
#14	0	0
#15	0	0
#16	0	0
#17	0	0
#05	0	0
#19	1	0
#04	1	0
#21	1	0
#03	1	0
#23	1	0
#24	0	0
#01	0	0
#02	0	0
#27	1	0

	Grade 5	Grade 6	Total
Boys	5	7	12
Girls	6	9	15
Total	11	16	27

Code	Gender	Grade
0	girl	6
1	boy	5

**Section 1: Probability Intuitions**

Student	1.A	1.B	1.C	2	3	4	5	6	7	8	Total
#25	1	1	1	1	2	3	1	3	2	3	18
#26	1	1	1	0	1	2	1	1	1	1	10
#22	1	1	1	2	2	3	3	3	3	2	21
#20	1	2	1	2	1	1	1	3	1	2	15
#20	1	1	1	1	1	2	1	3	3	1	15
#06	1	2	1	2	1	3	2	3	2	3	20
#07	1	1	1	1	2	3	2	3	2	2	18
#08	1	1	1	1	2	2	1	3	2	3	17
#09	1	1	1	0	1	2	2	3	2	1	14
#10	1	2	1	2	1	1	1	3	2	1	15
#11	1	1	1	1	1	3	1	3	2	2	16
#12	2	0	1	0	1	0	1	1	1	1	8
#13	1	1	1	2	1	3	1	3	3	3	19
#14	1	1	1	0	1	1	0	1	2	1	9
#15	1	1	1	2	2	3	4	0	3	2	19
#16	1	1	1	2	1	3	3	3	3	3	21
#17	1	2	1	1	2	3	4	3	3	2	22
#05	1	1	1	1	1	3	3	3	3	3	20
#19	1	2	1	2	2	1	2	3	2	2	18
#04	2	1	1	2	2	3	1	3	2	3	20
#21	1	2	1	0	2	4	3	2	2	3	20
#03	2	2	1	2	1	3	3	3	3	3	23
#23	1	0	1	0	0	0	0	0	0	0	2
#24	1	1	1	1	1	3	3	3	2	1	17
#01	1	1	1	1	2	3	4	3	1	3	20
#02	1	1	1	2	2	3	4	3	3	2	22

Sum score out of 30		%
20+	10	38
10 to 19	13	50
0 to 9	3	12

Code	1A	%
2	3	12
1	23	88
0	0	0

Code	1B	%
2	7	27
1	17	65
0	2	8

Code	1C	%
2	0	0
1	26	100
0	0	0

Code	2	%
3	0	0
2	11	42
1	9	35
0	6	23

Code	3	%
3	0	0
2	11	42
1	14	54
0	1	4

Code	4	%
4	1	4
3	15	58
2	4	15
1	4	15
0	2	8

Code	5	%
4	4	15
3	6	23
2	7	27
1	7	27
0	2	8

Code	6	%
4	0	0
3	20	77
2	1	4
1	3	12
0	2	8

Code	7	%
3	9	35
2	12	46
1	4	15
0	1	4

Code	8	%
3	10	38
2	8	31
1	7	27
0	1	4

Codes	0	1	2	3
1.A	not certain	contextual	certain	
1.B	not impossible	contextual	possible	
1.C	not possible	possible		
2	not random	haphazard	random	
3	irrelevant	numbers, no mention of chance	mentions chance	even chance
4.A				

**Section 2: Attitudes**

Mathematics									Computers							Competence						Probability						
Student	Confidence			use-ful	like	inter-est	Av.	9,08	9,07	9,12	Av.	9,01	9,13	Interest		Confidence			Game-s	Lang-uage	Inter-net	Word	email	Blog	Av.	life good		
	9	9,1	9,1											9,03	9,05	Av.	9,15	9,02								Av.	9,14	9,16
#25	2	2	4	2,7	2	4	4	4,0	5	1	4	4	4,0	1	4	2,5	2	1	4	4	2	2	2,6	2	2	2,0		
#26	5	5	3	4,3	5	5	5	5,0	3	5	5	5	5,0	5	5	5,0	5	5	5	5	5	5	5,0	5	3	4,0		
#22	4	4	3	3,7	5	2	5	3,5	5	3	5	5	5,0	5	5	5,0	5	1	5	5	5	1	3,4	5	5	5,0		
#20	3	2	2	2,3	2	1	1	1,0	4	1	1	2	1,5	4	3	3,5	2	1	4	4	4	4	3,4	3	1	2,0		
#20	2	1	3	2,0	5	2	5	3,5	4	1	4	5	4,5	5	4	4,5	5	1	5	2	5	4	3,4	5	4	4,5		
#06	4	2	4	3,3	5	4	5	4,5	3	2	5	5	5,0	4	4	4,0	4	2	5	5	5	2	3,8	5	3	4,0		
#07	2	1	1	1,3	2	1	1	1,0	4	1	2	4	3,0	3	2	2,5	5	1	4	4	1	1	2,2	3	2	2,5		
#08	3	4	4	3,7	5	5	5	5,0	5	1	2	5	3,5	4	3	3,5	2	1	5	4	5	5	4,0	5	2	3,5		
#09	4	3	3	3,3	5	1	5	3,0	3	1	5	5	5,0	4	2	3,0	4	1	5	5	5	3	3,8	4	3	3,5		
#10	3	2	3	2,7	2	1	1	1,0	4	1	1	2	1,5	5	3	4,0	2	1	4	4	4	4	3,4	2	1	1,5		
#11	5	2	*	3,5	4	5	5	5,0	3	1	1	1	1,0	3	4	3,5	1	1	4	5	4	2	3,2	3	3	3,0		
#12	5	3	3	3,7	4	3	2	2,5	3	4	5	4	4,5	5	1	3,0	3	3	5	5	5	3	4,2	5	4	4,5		
#13	3	3	3	3,0	5	5	5	5,0	5	3	5	5	5,0	5	3	4,0	5	1	5	5	5	3	3,8	3	5	4,0		
#14	1	4	1	2,0	3	1	3	2,0	3	1	2	1	1,5	1	1	1,0	2	1	5	5	4	1	3,2	3	1	2,0		
#15	2	3	*	2,5	5	3	3	3,0	2	1	1	2	1,5	5	4	4,5	3	1	5	4	5	4	3,8	3	3	3,0		
#16	3	3	3	3,0	5	5	5	5,0	1	1	1	1	1,0	4	1	2,5	3	1	4	2	5	1	2,6	5	2	3,5		
#17	5	2	5	4,0	5	1	4	2,5	3	3	2	4	3,0	5	5	5,0	5	2	5	5	5	4	4,2	5	4	4,5		
#05	4	*	3	3,5	5	5	5	5,0	1	1	1	1	1,0	3	1	2,0	5	1	4	2	5	1	2,6	5	4	4,5		
#19	3	3	3	3,0	5	4	1	2,5	3	3	5	4	4,5	5	3	4,0	4	1	4	4	2	1	2,4	3	3	3,0		
#04	5	1	5	3,7	5	2	3	2,5	5	3	5	4	4,5	5	4	4,5	5	4	5	4	5	4	4,4	5	5	5,0		
#21	3	3	4	3,3	5	3	1	2,0	5	3	5	5	5,0	5	4	4,5	5	5	5	5	5	3	4,6	5	5	5,0		
#03	5	2	4	3,7	5	4	4	4,0	3	5	5	5	5,0	5	5	5,0	5	5	5	5	5	5	5,0	5	4	4,5		
#23	5	1	5	3,7	5	1	5	3,0	5	3	5	5	5,0	5	1	3,0	5	1	5	5	5	5	4,2	5	5	5,0		
#24	3	3	3	3,0	4	3	4	3,5	3	1	3	4	3,5	3	2	2,5	2	1	5	3	5	3	3,4	3	4	3,5		
#01	5	3	3	3,7	5	3	4	3,5	4	1	3	4	3,5	3	2	2,5	1	3	5	5	5	2	4,0	5	3	4,0		
#02	4	4	4	4,0	5	3	5	4,0	4	3	5	5	5,0	5	5	5,0	4	3	5	4	5	3	4,0	5	3	4,0		
Av.	3,6	2,6	3,3	3,2	4,3	3,0	3,7	3,3	3,6		2,1	3,4	3,7	3,6	4,1	3,1	3,6	3,6	1,9	4,7	4,2	4,5	2,9	3,6	4,12	3,2	3,7	
Total			15		21		14		13		3						15	4	26	22	23	10				11		
%			58		81		54		50		12						58	15	100	85	88	38				42		
Av. = Average		con-fident		use-ful	like				like		better						Game-s	Lang-uage	Inter-net	Word	email	Blog				posit-ive		

### Section 3: ICT experience

Home				Game consols			School			Mathematics software																		
Student	11A	11B	11C	Usage	%		12A	12B	12C	Usage	%		13A	13B	Usage	%		14a	14b									
#25	0	0	1	access at home	23	88	1	1	*	have game consol	19	73	2	1	use maths software	7	27	0	0									
#26	1	4	2				1	3	1				4	1				3	1	1	1							
#22	1	4	2				1	4	1				3	1				3	1	1	1							
#20	1	1	1				1	1	*				3	1				3	1	1	1							
#20	1	4	1				1	2	1				3	1				3	1	0	0							
#06	1	4	2				1	4	1				4	1				4	1	all are lower order thinking programs	0	0						
#07	1	3	1				0	*	*				3	1				3	1	0	0							
#08	1	2	2				0	*	*				4	1				4	1	0	0							
#09	0	0	2				1	4	1				1	1				1	1	Code result %	4	5	19	0	0			
#10	1	1	1				4	14	64				1	1				*	4	5	28	3	1	3	16	62	1	1
#11	1	3	2				3	3	14				1	1				*	3	5	28	1	2	2	2	8	0	0
#12	1	4	1				2	3	14				1	3				1	2	2	11	1	2	1	3	12	0	0
#13	1	4	1				1	2	9				1	4				1	1	6	33	3	2	1	3	12	0	0
#14	1	*	*				22	100	100				1	*				*	18	100	100	2	1	26	100	100	0	0
#15	1	4	1	1	2	1	1	2	1	3	*	0	0	0	0	0	0	0	0									
#16	1	4	1	0	*	*	0	*	*	3	1	0	0	0	0	0	0	0	0									
#17	1	4	2	1	1	1	1	1	1	4	2	0	0	0	0	0	0	0	0									
#05	1	4	1	1	1	2	1	1	2	3	1	0	0	0	0	0	0	0	0									
#19	1	2	2	Cognitive engagement			1	4	2	Cognitive engagement			3	1	Cognitive engagement			1	1									
#04	1	4	1	1	3	2	1	3	2	3	1	0	0	0	0	0	0	0	0									
#21	1	4	1	Code result %			0	*	*	Code result %			3	2	Code result %			0	0									
#03	1	4	2	2	10	42	0	*	*	2	4	31	4	2	2	7	29	0	0									
#23	1	4	*	1	14	58	1	3	*	1	9	69	3	*	1	17	71	1	0									
#24	1	2	1	24	100	100	1	3	2	13	100	100	3	1	24	100	100	0	0									
#01	1	3	1	0	*	*	0	*	*	3	2	0	0	0	0	0	0	1	0									
#02	0	*	2	0	*	*	0	*	*	3	1	0	0	0	0	0	0	0	0									

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