Simulation Using a Random Number Table

Statistics Worksheet · Grade 9–12

Name: ________________________________ Date: __________________

Learning Objectives

- Identify and apply the four steps of designing a simulation using a random number table
- Assign digits to represent outcomes with correct probabilities
- Use simulation results to estimate experimental probability

Problems

1. A simulation is described as the imitation of chance behavior based on a model that accurately reflects the experiment. List the four steps, in order, used when designing a simulation with a random number table.

2. A fair coin is tossed once. You want to simulate this using single digits from a random number table (digits 0 through 9). Assign digits so that heads and tails are equally likely. State your digit assignment.

$$P(\text{Heads}) = 0.5, \quad P(\text{Tails}) = 0.5$$

3. State the TWO assumptions that must be listed in Step 2 when simulating a fair coin-tossing experiment.

4. Using the digit-assignment rule that odd digits represent Heads (H) and even digits represent Tails (T), convert the following sequence from a random number table into a string of coin-toss outcomes. The sequence is: 1 9 2 3 5 0 4 7 6 1

Position	1	2	3	4	5	6	7	8	9	10
Digit	1	9	2	3	5	0	4	7	6	1
Outcome										

5. A 'run of three' means three consecutive identical outcomes (HHH or TTT). Using the trial outcome from Problem 4 — H H T H H T T H T H — determine whether this trial counts as a success (a run of three occurred) or a failure.

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6. You want to simulate rolling a standard six-sided die using single digits from a random number table. Describe how you would assign digits 0 through 9 to the six faces (1 through 6), and explain what you do with any digits that cannot be assigned.

$$P(\text{each face}) = \frac{1}{6} \approx 0.167$$

7. A basketball player makes 70% of her free throws. You want to simulate whether she makes or misses each free throw using single digits 0–9. Assign digits appropriately and state the assignment.

$$P(\text{Make}) = 0.70, \quad P(\text{Miss}) = 0.30$$

8. Twenty-five simulation trials of tossing a coin 10 times were run to find the probability of getting a run of three. The results showed that 20 out of 25 trials contained at least one run of three consecutive heads or tails. Use these simulation results to estimate the probability of getting a run of three when a coin is tossed 10 times.

$$\hat{P} = \frac{\text{number of successes}}{\text{total trials}}$$

9. The table below shows results from 10 simulation trials of tossing a coin 10 times. Each trial is recorded as a string of H's and T's. For each trial, determine whether it is a success (S) or failure (F) — a success means at least one run of three consecutive identical outcomes exists.

Trial	Outcome Sequence	Run of 3? (S/F)
1	H H H T H T T H H T	
2	T H T H T H T H T H	
3	H T T T H H T H T T	
4	H H T H H T H H T H	
5	T T T H H T H T H H	
6	H T H T H T T H T T	
7	H H H H T T H T H T	
8	T H H T T H H T T H	
9	H T H T T T H H H T	

Trial	Outcome Sequence	Run of 3? (S/F)
10	H H T T H H T T H H	

10. Design a complete simulation to estimate the probability that a student who randomly guesses on a 5-question true-false quiz will get at least 4 correct. Show all four steps: state the problem, state the assumptions, assign digits, and describe how you would carry out the simulation using a random number table. Then, given that 14 out of 50 simulated trials resulted in at least 4 correct answers, calculate the estimated probability and compare it to the theoretical probability.

$$P(X \geq 4) = \binom{5}{4}\left(\frac{1}{2}\right)^5 + \binom{5}{5}\left(\frac{1}{2}\right)^5$$

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Simulation Using a Random Number Table — Answer Key

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Answer Key

1. Answer: Step 1: State the problem; Step 2: State the assumptions; Step 3: Assign digits to outcomes; Step 4: Simulate the experiment

- Step 1 – State the problem: clearly describe what probability you want to estimate.
- Step 2 – State the assumptions: identify what outcomes are equally likely and whether trials are independent.
- Step 3 – Assign digits: map digits from the table to each possible outcome according to their probability.
- Step 4 – Simulate: read digits from the table in groups equal to one trial, record outcomes, and repeat many times.

2. Answer: Odd digits (1,3,5,7,9) = Heads; Even digits (0,2,4,6,8) = Tails (or any equal split of 5 digits each)

- There are 10 digits (0–9). Each probability must be 50%, so 5 digits per outcome.
- Assign digits 1, 3, 5, 7, 9 (odd) → Heads.
- Assign digits 0, 2, 4, 6, 8 (even) → Tails.
- Each set has 5 out of 10 digits, giving P = 5/10 = 0.5. ✓

3. Answer: 1) Each toss results in heads or tails with equal probability (0.5 each — fair coin). 2) Each toss is independent of all other tosses.

- Assumption 1: The coin is fair, so P(Heads) = P(Tails) = 0.5.
- Assumption 2: Each toss is independent — the outcome of one toss does not affect any other toss.

4. Answer: H, H, T, H, H, T, T, H, T, H

Position	1	2	3	4	5	6	7	8	9	10
Digit	1	9	2	3	5	0	4	7	6	1
Outcome	H	H	T	H	H	T	T	H	T	H

- Odd → H, Even → T.
- 1(odd)=H, 9(odd)=H, 2(even)=T, 3(odd)=H, 5(odd)=H, 0(even)=T, 4(even)=T, 7(odd)=H, 6(even)=T, 1(odd)=H.
- Result: H H T H H T T H T H.

5. Answer: Failure — no run of three consecutive identical outcomes appears in this trial.

- Check each consecutive group of 3: HHT, HTH, THH, HHT, HTT, TTH, THT, HTH — none is HHH or TTT.
- The longest run of identical results is 2 (HH at positions 1–2 and 4–5; TT at positions 6–7).
- Since no run of 3 identical outcomes exists, this trial is a FAILURE.

6. Answer: Digits 1–6 represent faces 1–6. Digits 0, 7, 8, 9 are ignored (skipped).

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• A die has 6 equally likely outcomes. With 10 digits available, we cannot split them perfectly into 6 equal groups.
• Assign digit 1 → face 1, digit 2 → face 2, …, digit 6 → face 6.
• Digits 0, 7, 8, and 9 do not correspond to any face — skip them and move to the next digit.
• This keeps each assigned outcome at probability 1/6 among valid digits.

7. Answer: Digits 0–6 (7 digits) = Make; Digits 7, 8, 9 (3 digits) = Miss

• 70% of free throws are made, so 7 out of 10 digits should represent a make.
• Assign digits 0, 1, 2, 3, 4, 5, 6 → Make (7 digits = 70%).
• Assign digits 7, 8, 9 → Miss (3 digits = 30%).
• Check: 7/10 = 0.70 ✓ and 3/10 = 0.30 ✓.

8. Answer: Estimated probability = 20/25 = 0.80 (80%)

• Successes (trials with a run of three) = 20.
• Total trials = 25.
• Estimated P = 20 / 25 = 4/5 = 0.80.
• Interpretation: Based on this simulation, there is approximately an 80% chance of getting a run of three or more consecutive identical outcomes when tossing a fair coin 10 times.

9. Answer: S, F, S, F, S, F, S, F, S, F → 5 successes out of 10 trials

Trial	Outcome Sequence	Run of 3? (S/F)
1	H H H T H T T H H T	S (HHH at 1–3)
2	T H T H T H T H T H	F (no run of 3)
3	H T T T H H T H T T	S (TTT at 2–4)
4	H H T H H T H H T H	F (no run of 3)
5	T T T H H T H T H H	S (TTT at 1–3)
6	H T H T H T T H T T	F (no run of 3)
7	H H H H T T H T H T	S (HHHH at 1–4)
8	T H H T T H H T T H	F (no run of 3)
9	H T H T T T H H H T	S (TTT at 4–6 and HHH at 7–9)
10	H H T T H H T T H H	F (no run of 3)

• Trial 1: H H H → run of 3 Heads at positions 1–3. SUCCESS.
• Trial 2: Longest run is 1. FAILURE.
• Trial 3: T T T at positions 2–4. SUCCESS.
• Trial 4: Longest run is 2 (HH appears multiple times). FAILURE.
• Trial 5: T T T at positions 1–3. SUCCESS.
• Trial 6: Longest run is 2 (TT at positions 6–7). FAILURE.
• Trial 7: H H H H at positions 1–4 (contains HHH). SUCCESS.
• Trial 8: Longest run is 2. FAILURE.

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- Trial 9: TTT at 4–6 and HHH at 7–9. SUCCESS.
- Trial 10: Longest run is 2. FAILURE.
- Estimated P = 5/10 = 0.50.

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10. Answer: Estimated P = 14/50 = 0.28; Theoretical P = 6/32 = 0.1875 ≈ 0.19

- Step 1 – State the problem: Estimate the probability that a student randomly guessing on a 5-question T/F quiz scores at least 4 out of 5 correct.
- Step 2 – State assumptions: Each question has two equally likely outcomes (T or F), P(correct guess) = 0.5. Each question is answered independently.
- Step 3 – Assign digits: Use single digits 0–9. Odd digits (1,3,5,7,9) = Correct; Even digits (0,2,4,6,8) = Incorrect. Read 5 digits per trial.
- Step 4 – Simulate: Read groups of 5 digits from the random number table. Count how many are odd (correct) in each group. Record 'success' if count ≥ 4. Repeat for 50 trials.
- Estimated P = 14 successes / 50 trials = 0.28.
- Theoretical $P(X \geq 4) = P(X=4) + P(X=5) = C(5,4)(0.5)^5 + C(5,5)(0.5)^5 = 5/32 + 1/32 = 6/32 = 0.1875$.
- The simulation estimate (0.28) is higher than the theoretical value (0.1875); increasing the number of trials would bring the estimate closer to 0.1875.

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