Erasmus+ Cultural connections : Enhancing EU heritage, Social Inclusion and Digital Literacy through our Pupils' hearts
Scientific and Creative Thinking Workshop
7-12 December 2025, Ukmerges, Lituania

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SCIENTIFIC EXPERIMENT 9.12

Experiment Title

Dice Games: Probability of Winning vs Losing and Social Awareness

Type of Activity

Hands-on mathematics and social education experiment demonstrating probability, risk, and responsible decision-making.

Grade Level

Ages **11–15** (upper primary / lower secondary)

Learning Objectives

Scientific / Mathematical

1. Calculate theoretical probabilities for simple dice games.
2. Conduct experiments to determine experimental probabilities.
3. Compare experimental outcomes with theoretical probabilities.
4. Represent probability data visually with tables and graphs.

Social / Life Skills

1. Understand risk and expected outcomes in games of chance.
2. Develop awareness of gambling risks and consequences.
3. Reflect on responsible decision-making.

Interdisciplinary Connections

- **Mathematics:** Probability, fractions, percentages, data analysis.
- **Social Education:** Gambling awareness, risk management.
- **Language / Reflection:** Explain reasoning, write conclusions.

Research Questions

1. What is the probability of winning vs losing in a simple dice game?
2. How closely does experimental probability match theoretical probability?
3. How does understanding probability help us make safer choices in life?

Hypotheses

1. *The probability of losing will be higher than the probability of winning.*
2. *Experimental probability will approximate theoretical probability more closely with more trials.*
3. *Understanding probabilities can help avoid risky gambling behavior.*

Materials

- Standard six-sided dice (1 per student or group)
- Tokens or counters (optional for scoring)
- Ruler or calculator
- Observation worksheet
- Graph paper or online spreadsheet

Variables

Type	Variable	Details
Independent	Number of dice rolls	Each student/group chooses number of trials (e.g., 50–100)
Dependent	Outcome	Win or Lose
Controlled	Rules of the dice game	Same for all groups; same dice and surface

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Example Dice Game

Single Die Game:

- Roll one die. Win if you roll a 6, lose otherwise.

Two Dice Game (optional):

- Roll two dice. Win if the sum is 7, lose otherwise.

Experimental Procedure

1. **Determine Theoretical Probability**
   - Single die: Probability of winning = 1/6 (~16.7%), losing = 5/6 (~83.3%)
   - Two dice: Probability of sum = 7 is 6/36 = 1/6 (~16.7%)
2. **Perform the Experiment**
   - Roll dice **50–100 times** per student/group.
   - Record each outcome as Win or Lose.
   - Count total Wins and Losses.
3. **Calculate Experimental Probability**
   - Probability of winning = Wins / Total Rolls
   - Probability of losing = Losses / Total Rolls
4. **Compare to Theoretical Probability**

   - Calculate difference between experimental and theoretical probabilities.
5. **Graph the Results**
   - X-axis: Dice outcome (Win / Lose)
   - Y-axis: Probability (%)
   - Use bars or points to represent both theoretical and experimental probabilities.

Observation Table (Sample)

Trial Number	Outcome (Win/Lose)	Cumulative Wins	Cumulative Losses
1	Win	1	0
2	Lose	1	1
3	Lose	1	2
…	…	…	…

Probability Comparison Table

Outcome	Theoretical Probability (%)	Experimental Probability (%)	Difference
Win	16.7	________	________
Lose	83.3	________	________

Graphing Activity

Instructions:

1. X-axis: Outcome (Win / Lose)
2. Y-axis: Probability (%)
3. Draw **two bars per outcome**: one for theoretical probability, one for experimental probability.
4. Use different colors for clarity.

Graph Grid Sketch:

```
Probability (%)
|
| 100 |
|  90 |
|  80 |        █ (Lose Exp)
|  70 |
|  60 |
|  50 |
|  40 |
|  30 |
|  20 | █ (Win Exp)
|  10 | █ (Win Theo)
|   0 |___________________________
       Win        Lose
```

Results Analysis Questions

1. Did the experimental probabilities match the theoretical probabilities? Explain any differences.
2. Which outcome was more likely to occur?
3. How does this experiment illustrate the concept of risk?
4. How could understanding probability help you avoid gambling losses?

Reflection / Social Awareness Questions

1. If you played a dice-based gambling game regularly, what do the probabilities tell you about expected losses?
2. Why do most gambling games favor the house?
3. How can understanding math and probability help you make responsible choices?

Conclusion Template

This experiment shows that losing is more likely than winning in dice games, both theoretically and experimentally. Understanding probability helps us recognize the **risk of loss**, supporting responsible decision-making and helping to avoid gambling behaviors.

Simulating theoretical probabilities vs **expected experimental probabilities**

1. Theoretical Probabilities

Single Die Game (Win = 6, Lose = 1–5)

- Total possible outcomes = 6 (faces of a die)

- **Win (rolling 6)** = 1 outcome → 1/6 ≈ **16.7%**
- **Lose (rolling 1–5)** = 5 outcomes → 5/6 ≈ **83.3%**

Two Dice Game (Win = sum 7, Lose = sum ≠ 7)

- Total possible outcomes = 6 × 6 = 36
- Combinations summing to 7: (1,6), (2,5), (3,4), (4,3), (5,2), (6,1) → 6 outcomes
- **Win** = 6/36 ≈ **16.7%**
- **Lose** = 30/36 ≈ **83.3%**

Notice: Both simple games have the same theoretical win/loss ratio (~1:5).

2. Expected Experimental Probabilities

- Experimental probability will **approximate theoretical probability**, but small sample sizes will vary.
- Example for **50 dice rolls** (single die):

Outcome	Expected Number of Rolls	Expected Experimental Probability (%)
Win	50 × 1/6 ≈ 8–9 rolls	16–18%
Lose	50 × 5/6 ≈ 41–42 rolls	82–84%

For **100 rolls**, the approximation gets closer:

Outcome	Expected Number of Rolls	Expected Experimental Probability (%)
Win	100 × 1/6 ≈ 16–17 rolls	16–17%
Lose	100 × 5/6 ≈ 83–84 rolls	83–84%

Larger numbers of rolls reduce the effect of random variation, so the **experimental probability converges to theoretical probability**.

Key Teaching Point

Students should observe:

1. **Win is rare, lose is frequent** → illustrates risk in gambling.
2. **Experimental probability varies with small trials** → highlights the law of large numbers.
3. This allows **discussion of real-life gambling odds**, making probability directly meaningful.

Comparison with Real-Life Statistics

- According to studies on gambling and poverty:
    - **10–15% of families with gambling addiction fall into financial ruin**.
    - **Gambling contributes to a disproportionate share of personal bankruptcy cases**.
    - For example, in Europe, 1 in 5 problem gamblers lives below the poverty line, often causing debt, eviction, or family breakdown.
- This mirrors the dice experiment: **the odds are stacked against the player**, so repeated play almost guarantees loss over time.

Connection to Addiction

1. **Random Wins Encourage Repetition**
    - Even though losing is far more likely, occasional wins create a **"variable reward schedule"**, one of the most powerful mechanisms in addictive behavior.
2. **Illusion of Control**
    - Players often believe they can "predict" or influence outcomes, even when probability is fixed.
3. **Escalating Risk**
    - Losses motivate further bets to "recover" previous losses, leading to **losses compounding**.
4. **Social Consequences**
    - Families of addicted gamblers often face financial instability, stress, and social problems, mirroring the lesson from the classroom dice game: **probability works against sustained success in gambling**.

Teaching Integration

- **Mathematics / Probability:** Students calculate odds and compare experimental vs theoretical outcomes.
- **Social Education:** Discuss consequences of poor odds and addictive behavior.
- **Reflection Questions for Students:**
    - How does the probability of losing compare to the probability of winning?
    - Why might people continue gambling even when odds are against them?
    - How could understanding probability help someone avoid the financial and social consequences of gambling?
    - How do rare wins contribute to addiction?

Dice Classroom Example vs Real Gambling Odds

- Classroom dice example: 1 win on 6 sides → **1/6 ≈ 16.7%**. This is useful for teaching probability and risk in a safe, hands-on way.
- Real gambling: Odds are much worse. Examples:
    - **Slot machines**: Return-to-player (RTP) often 85–95%, meaning **you lose 5–15% of your money on average per play**; probability of hitting the jackpot is extremely low (often **0.01–0.001%**).
    - **Lottery (6/49)**: Probability of winning top prize ≈ 1 in 14 million ≈ **0.000007%**.
    - **Roulette (single number)**: 1/37 ≈ 2.7% chance (European roulette).
    - The 16.7% classroom dice example is **intentionally higher** to make

the activity feasible and illustrative in a short lesson. Real gambling odds are dramatically lower, which is why gambling is financially risky.

Why Real Gambling is Addictive Despite Low Probability

- ➔ **Variable reward schedule**: Even rare wins trigger strong psychological reinforcement.
- ➔ **Illusion of control**: Players think strategy or timing can influence outcomes.
- ➔ **Escalating risk**: Loss chasing increases stakes and losses.

Even if your "win probability" is 0.01%, the occasional reward **keeps the brain engaged**, leading to addictive behavior.

Emulating real life gambling probabilities

1. Single Die Probabilities

- Rolling **a 6 on one die** → 1/6 ≈ 16.7%
- To **decrease probability**, require **multiple successful rolls in a row**.

2. Two 6s in a row

- Probability = (1/6)×(1/6)=1/36≈2.78%(1/6)×(1/6)=1/36≈2.78%

This is already **lower than 5%**, a realistic "rare win" for classroom simulation.

- Students roll **one die twice per trial**.
- Win only if **both rolls are 6**.
- Lose otherwise.

This emulates the "rare jackpot" effect of gambling, while still using dice in class.

3. Alternative Approaches (~5% Win)

Method	Probability	Practicality
Roll **6 twice in a row**	1/36 ≈ 2.78%	Slightly low; may need many trials
Roll **6 on one die OR another 6 on second die**	1 – P(no 6s) = 1 – (5/6)^2 ≈ 30.6%	Too high for rare-win simulation
Roll **6 three times in a row**	(1/6)^3 ≈ 0.46%	Too rare for classroom

Best compromise: **two 6s in a row (≈2.8%)**, or **two successes out of 12-sided dice** if you want slightly higher (~5%).

4. Classroom Dice Game Example (≈5% Win)

Game Rules:

1. Each student rolls **one die twice per turn**.
2. **Win** if both rolls are 6.
3. **Lose** for any other combination.
4. Record results over **50–100 trials**.

Expected outcomes (50 rolls):

- Wins ≈ 50 × 2.78% ≈ 1–2 wins
- Losses ≈ 48–49 losses

Optional social twist: Each “loss” costs a token, and “win” earns several tokens to simulate gambling risk/reward.

Student Worksheet: Dice Games – Win vs Lose Probability

Name: ___________________________
Date: ___________________________
Class: ___________________________

1. Experiment Title

Dice Games: Probability of Winning vs Losing

2. Research Questions

1. What is the probability of winning vs losing in a simple dice game?
2. How do experimental results compare to theoretical probabilities?
3. How can understanding probability help us make safer decisions in life?

3. Hypotheses

Outcome	Prediction	Reasoning
Win (roll a 6)	☐ Yes ☐ No	___________________________
Lose (roll 1–5)	☐ Yes ☐ No	___________________________

4. Materials

- ★ Standard six-sided dice (1 per student/group)
- ★ Tokens or coins (optional)
- ★ Observation table
- ★ Ruler / calculator
- ★ Graph paper

5. Dice Game Rules

- Roll **one die**.
- Win if you roll a **6**.
- Lose if you roll **1–5**.
- Repeat for **50 rolls** (or more for larger sample).

This simulates a simple gambling-like game with a **16.7% win probability**.

6. Observation Table

Roll #	Outcome (Win / Lose)	Cumulative Wins	Cumulative Losses
1			
2			
3			
…			
50			

7. Probability Comparison Table

Outcome	Theoretical Probability (%)	Experimental Probability (%)	Difference
Win	16.7	________	________
Lose	83.3	________	________

Instructions:

- Experimental probability = (Number of Wins or Losses ÷ Total Rolls) × 100
- Compare your results to the theoretical probability.

8. Graphing Activity

Instructions:

1. X-axis: Outcome (Win / Lose)
2. Y-axis: Probability (%)
3. Draw **two bars per outcome**: one for **theoretical probability**, one for **experimental probability**.
4. Use different colors for clarity.

Graph Grid:

```
Probability (%)
|
| 100 |
| 90  |
| 80  |        █ (Lose Exp)
| 70  |
| 60  |
| 50  |
| 40  |
| 30  |
| 20  | █ (Win Exp)
| 10  | █ (Win Theo)
| 0   |______________________________
       Win       Lose
```

9. Results Analysis Questions

1. How often did you win vs lose?

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2. Did your experimental probabilities match the theoretical probabilities? Explain any differences.

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3. Which outcome was more likely to occur?

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4. How could this experiment help you understand risk in real-life gambling situations?

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10. Reflection / Social Awareness

1. Why do games with low odds of winning appeal to some people?

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2. How does the low probability of winning relate to financial loss in gambling?

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3. What strategies could help people avoid risky gambling behaviors?

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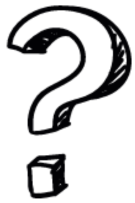
11. Conclusion Template

This experiment shows that losing is more likely than winning in dice games. Understanding probability helps us **recognize the risks** of gambling and make informed, responsible decisions. Experimental probability may vary from theoretical probability, especially with small sample sizes, but overall demonstrates that **the odds are stacked against the player**.

Name:____Date: ________

____________________________Experiment

Write the name of your experiment in the blank space above. Then, complete the rest of this page with information about your experiment.



Question: What are you testing?

Hypothesis: What do you think will happen?

Observations: What happened during the experiment? Draw a picture or record data below.

Conclusion: What conclusions can you draw based on the results of your experiment?

Observation sheet source: WeAreTeachers,2024