**COUNTING TECHNIQUES**

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* **ABSTRACT:**

The term ‘counting’ is the fundamental concept of Mathematics. The whole world of Mathematics started with the basic necessity of counting. Our ancestors first used fingers for counting and later started using beans, sticks, buttons, and beads to count. However, they, later on, realized that these methods of counting cannot be used in cases where we are forced to count large and large quantities of numbers. That is when our Mathematicians came out with a way of determining large counts efficiently and accurately with the help of the fundamental counting principle. The fundamental counting principle is one of the most important rules in Mathematics especially in probability problems and is used to find the number of ways in which the combination of several events can occur.

* **INTRODUCTION:**

Counting problems arise throughout our everyday life, as well as in mathematics and in computer science.

For example, we may want to count:

• The number of all possible 7-symbols license plates, xxxxxxx, where symbols include letters A-Z and digits 0-9, but such that the license plate always starts with a letter.

• The number of all possible 7-symbols phone numbers, xxx-xxxx that we can generate for some given area code, for example 206 or 425.

• The number of all possible ways an ALIGN student can choose their courses, such that they satisfy all of the degree requirements.

• The degree of separation between any two persons, A and B, where the degree of separation is defined as the number of people person A would have to engage with to reach person B. For example, if

person A reaches to their friend C, who then reaches to their friend D, who then reaches to their Friend E, who has a direct contact to person B, the degree of separation between A and B would be 4 (A → B → C → D → E → B).

* **DISCUSSION:**

1. **Fundamental Counting Principle:**

The fundamental counting principle or basic principle of counting is a method or a rule used to calculate the total number of outcomes when two or more events are occurring together. This principle states that the total number of outcomes of two or more independent events is the product of the number of outcomes of each individual event. For example, a child choosing among six flavors of ice creams with 3 varieties of cones will have 6 x 3 = 18 different choices of ice creams.

**Example:**

A boy has 4 T-shirts and 3 pairs of pants. Find the total number of possible outfits the boy has.

**Solution:**

The above question is one of the fundamental counting principle examples in real life. According to the question, the boy has 4 t-shirts and 3 pairs of pants. So, the total number of outfits with the boy are: Total number of outfits = 4 x 3 = 12 The boy has 12 outfits with him.

1. **Factorial notation:**

Many counting problems involve multiplying together long strings of numbers. Factorial notation is simply a short hand way of writing down some of these products. The symbol n! reads as ‘n factorial’ and means n(n − 1)(n − 2)··· 2.1. For example 6! = 6 × 5 × 4 × 3 × 2 × 1 = 720 3! = 3 × 2 × 1=6 1! = 1 We also define 0! to be 1.

Note: Many people think that 0! ought to be 0, but this would give rise to problems of dividing by 0. We shall see that the formulae we’ll be deriving make more sense if 0! = 1.

1. **Permutations:**

The word ‘permutations’ means ‘arrangements’. We use it to refer to the number of ways of arranging a set of objects. In other words, we use permutations when we are concerned about ‘order’.

**Example**:

How many different 4 letter arrangements can we make of the letters in the word ‘cats’, using each letter once only.

**Solution:**

We have four positions to fill

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |

There are four choices for position 1. For each of those choices there are 3 letters left, and so 3 ways to fill position 2. So by the counting principle there are 4× 3 ways of filling the first 2 positions. For each of these choices there are now 2 letters left and there are two ways of filling the third position. The remaining letter must then go in the last position. Thus by the counting principle, there are 4 × 3 × 2 × 1 = 4! Possible arrangements, ie 24 of them. Try writing them out as a check.

1. **Combinations:**

Combinations are a technical term meaning ‘selections’. We use it to refer to the number of different sets of a certain size that can be selected from a larger collection of objects where order does not matter.

**Example:**

Each of the two players, A and B, get 26 cards at random. Find the probability that each player has an equal number of red and black cards.

**Solution:**Each player can get 26 cards at random in 52C26 ways.

In order that a player gets an equal number of red and black cards, he should have 13 cards of each colour, note that there are 26 red cards and 26 black cards in a pack of playing cards. This can be done in 26C13 , 26C13 ways.

Hence, the required probability = 26C13 x 26C13 / 52C26

* **CONCLUSION:**

Counting techniques and probability is a core topic in middle school mathematics. The purpose of this unit of study is to increase teachers’ mathematical content knowledge and support quality instruction by examining research findings related to students’ understandings of counting techniques and probability. Counting Techniques and Probability is one unit of study in a series of units of study that the author wrote for the Rhode Island Department of Education. These units of study synthesize important research around big ideas in mathematics while connecting them to state mathematics standards. While the state standards referenced in the units of study are no longer being used, the content and research highlighted remain relevant.