VISIT MATH

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Statistics and probabilities

Topic	Statistics
Learning objectives	Basic vocabulary of statistics and probabilities
Age group	10-14 years (to be adapted in each country)
Estimated duration	1h
Activities	Being able to estimate the outcome of a random operation
Related visits	Amiens, Lille, Lucca, Pisa

Previous knowledge required

Basic operations, fractions

Step by step: the sequence in the classroom

Step 1: Introducing the topic

Short presentation of the heritage elements in this sequence

Although the concept of statistics seems quite easy to understand – it refers to turning numbers into something meaningful – it is also quite recent. Indeed, the mathematical concept of "statistics" was born in the 18th century to qualify the way of counting relevant items for war: the population, the quantity of guns, the food production, etc. These numbers were then studied and compared with the numbers of the previous months or years to give an objective feedback on the wealth of a country. Nowadays, statistics are found everywhere: the average grade for a test, the number of "likes" for a social media post, the evolution of the temperatures in a country, etc. Probability was studied a bit earlier, as European mathematicians discussed the probability of winning a luck-based game such as dice during the 17th century.

Links between these elements and math topics

Probability is closely linked with statistics, since it can be used to determine if a given series of numbers is "probable" or not. When 17th century mathematicians studied the probability of rolling a die to find a specific number, they would consider that all faces have an equal chance of showing. While rolling four 6 in a row is not probable (1 chance out of 1296), statistics will confirm that it may happen.

These mathematic topics are closely related to percentages: on the one hand, the user aims at finding which part of the population falls under a specific rule. On the other hand, the user wants to know what are the odds of finding the result they are expecting – or what is to be expected.

Being able to understand statistics and probability is also important to develop critical thinking – whether to roughly check if the result to an equation is correct, or to understand all of the data we are sent every day!

Step 2: Class activities

Statistics

Several tools were created in order to give a meaning to the numbers one can find in statistics. For example, you can find the average result of a series of results, calculate an increase or decrease in a trend, etc.

Grandeur

The first thing we can do with statistics is to compare the numbers, in other words, have a look at the percentage of a common phenomenon between two (or more) groups. The groups do not need to be the same size, but the studied criteria needs to be exactly the same.

For example, in the following tables:

Class A total	35
Boys	17
Girls	18

Class B total	23
Boys	12
Girls	11

There are more boys in class A than in class B, yet there is a higher proportion of boys in class B than in class A.

Statistics also help to show an evolution to keep track of data from the past.

Class A 2022 total	35
Boys	17
Girls	18

Class A 2023 total	34
Boys	13
Girls	21

In these tables, the total number of pupils in class A slightly diminished, but the proportion of girls in the class increased by a wide margin.

Application

Compare the proportion of registered members to all the sports listed below between the two years. The total membership has decreased between the two years. **Which club has lost the largest proportion of its members? The smallest? What is the proportion of members in each sport?**

Total number of members in 2022	185
Football club members	56
Tennis club members	65
Karate club members	34
Gymnastics club members	30

Total number of members in 2023	168
Football club members	50
Tennis club members	58
Karate club members	31
Gymnastics club members	29

Average

The average is the sum of all the numbers of a specific data divided by the number of occurrences. If we were to use the data from the Grandeur examples, we can calculate the average number of boys and girls in two years.

Number of boys: (17+13)/2 = 30/2 = 15

There was an average of 15 boys in class A.

Number of girls: (18+21)/2 = 39/2 = 19,5

There was an average of 19,5 girls in class A.

The average is used to know if a pupil has scored enough points in a school year to pass, or to compare with the following concept to help discover inequalities.

Median

A median corresponds to the value of the number in the middle of the series. The median is interesting to compare with the minimum value and the maximum value of a series in order to discover which of the values it is closer to. This is more interesting when analysing larger data than what we did in the previous example.

Let's have a look at the number of brothers and sisters of the children in class A.

Brothers and sisters	0	1	2	3	4
Number of pupils	6	14	10	3	2

In order to find the median number of brothers and sisters of the pupils in class A, we first need to count the total number of pupils: 35. Then, find the median of 35, which is: 35/2 = 17,5, rounded up to 18.

There are 6 pupils with no brother or sister, 14 pupils who have one, 10 pupils who have two, 3 pupils who have three and 2 pupils who have four. In order to best visualize this, you can represent the pupils as follows:

0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3 3 4 4

Next, we need to find the 18th pupil in the table above: the 18th pupil has 1 brother or sister.

This is what it looks like in the previous visualization:

0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3 3 4 4

The median number of brothers and sisters for the pupils in class A is 1.

The average number of brothers and sisters for the pupils in this class would be:

(6x0 + 14x1 + 10x2 + 3x3 + 2x4)/35 = 51/35 or 1,46.

The average number of brothers and sisters is slightly higher than 1 in this example.

Quartile

Just like the median cares about the middle value of the sample of pupils, the quartiles care about the first and third quarters of the sample. They are written Q_1 and Q_3.

To calculate them, divide the number of subjects by 4.

In the case of Class A, this means 35/4 = 8,75, rounded up to 9. Therefore, Q_1 is the number of brothers and sisters of the 9th pupil.

Q_3 is three times Q_1: 8,75x3 = 26,25 rounded down to 26. In this class, Q_3 corresponds to the 26th pupil.

The 9th pupil has 1 brother or sister. Q_1 is equal to 1 in our example, and is therefore equal to the median.

The 26th pupil has 2 brothers or sisters. In our example, Q_3 is equal to 2.

This can be visualized as follows:

0 0 0 0 0 0 1 1 **1** 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 **2** 2 2 2 2 3 3 3 4 4

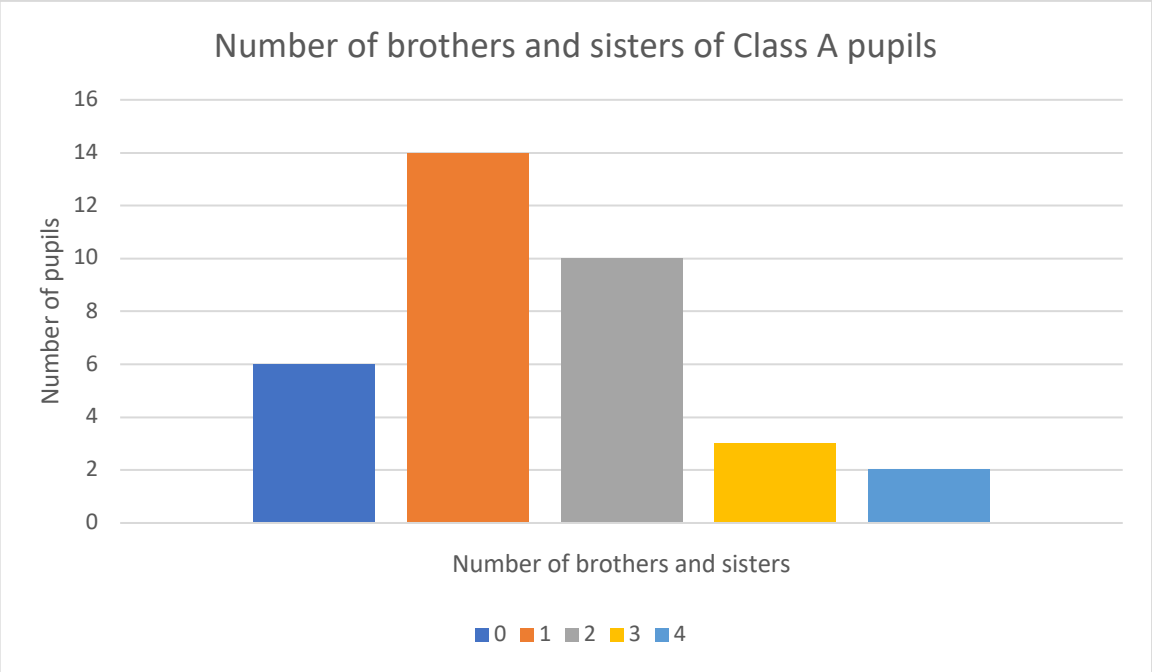
Application

The following table shows how many days a week each pupil eats in school. **Give the average number of times a pupils eats in school, as well as the median and quartiles.**

Number of days	0	1	2	3	4	5
Number of pupils	12	3	5	4	1	10

Graphs

In order to best visualize your statistics, you may organize them as graphs.



In order to create a great graph, you have to abide by a few rules.

1. Be clear (use colours if possible, space out your data and make sure it is big enough)
2. Be precise (set a scale to show your data and stick to it)
3. Verbalize (add a title to your graph and captions to indicate what each part of your graph represents).

There are many ways to create graphs: bar charts (like the one above), histograms, pie charts, scatter charts, etc. Choose the one that best showcases the elements you want to highlight!

Probability

Probability is the expression of the chances to land on a specific result. The probability of an event A is equal to the ratio between the number of elements of A on the total number of possible outcomes. Consider Class A from the previous example, with 35 pupils in it: if we were to pick one pupil at random, then each pupil would have a 1/35 (0,03) chance of being picked. Of course, this means that all issues have the same

chance of happening: there would be no means of pre-emptively knowing which pupil we are about to select.

Some results are also better shown off as percentages. For example, in Class A, we would have a:

- 6/35 chance to pick a pupil with no brother or sister (0,17 chance)
- 14/35 chance to pick a pupil with one brother or sister (0,4 chance)
- 10/35 chance to pick a pupil with two (0,285 chance)
- 3/35 chance to pick a pupil with three (0,085 chance)
- 2/35 chance to pick a pupil with four (0,06 chance)

The total always needs to be equal to 1. Indeed, there is a 1/1 chance to pick a pupil in class A.

Step 3: Homework and development ideas

The math test

Here are the grades obtained by several pupils in a test about statistics. The grades are given out of 20.

15	16	8	10	20	19	17	14	14	15	18	20	7	10	15	14	12	11	17

What is the average grade of the class? What is the median? What are Q_1 and Q_3?

The lottery

Today is lottery day! Although they are not allowed to share the information, one of the organizers has shown you the prizes of the tickets.

0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €
0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €	0 €	1 €
1 €	1 €	1 €	1 €	1 €	1 €	2 €	2 €	2 €	2 €
2 €	3 €	3 €	3 €	3 €	4 €	5 €	6 €	8 €	10 €

Buying a ticket costs 2€. What are the chances of being able to refund the purchase? What are the chances of actually winning some money?

Using the information contained above, what is the average gain? What is the median gain? Are these numbers higher or lower than the price of a ticket? What can you understand from this?

Figure 1 Pixabay

The football teams

The following table shows how many league titles each of these football teams have won. Create a graph that shows the proportion of teams that won the same number of titles.

Awesome Team	**Cool Team**	**Great Team**	**Nice Team**	**Splendid Team**	**Soccer Team**	**Absolute Team**
3	2	5	3	2	1	1
Meh Team	**Yes Team**	**Goal Team**	**Defence Team**	**Super Team**	**Shady Team**	**Easy Team**
3	4	1	1	2	8	2

What is the average number of titles won by these teams? What is the median?

Suppose that teams that have won the same amount of titles cannot play against one another. What would be the odds of Cool Team facing Yes Team? What would be the odds of Absolute Team facing Awesome Team?

Figure 2 Pixabay

References

Porter, T.M. (2023). *Probability and Statistics*. Britannica. https://www.britannica.com/science/probability

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Co-funded by the European Union

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Project code: 1-FR01-KA220-SCH-00027771
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