Video « Metrology - Trueness and precision »

Time	Text
00 :08	This video will help you understanding what is the trueness as well as the precision of a method.
00 :16	First, let's look at these two targets. Here, the blue points represent the measured values and the red centre of the target is the true value of the sample that we want to reach by repeating the measurement.
00 :36	Often, at the first look, you would say that the best situation is the situation on the left, but, as it will be explained in this video, this is wrong. In the situation on the left, the results are clearly wrong and they cannot be used. On the other hand, on the situation on the right, even if the results could be improved, you will see that this situation is much more favourable and therefore it is much better to use the results on the right.
01 :05	So, this video will help you to understand the difference between these two situations and, by going further, what the trueness and the precision of a method mean.
01 :14	Now, let's look at these measurement results. In that case, the x-axis represents the concentration that is measured. The yellow peak on the left represents the true value of the sample that we intend to reach with our measurements. On the right of the graph is represented the result of the measurement. It could be a single measure or, as illustrated on this graph, several measures which are represented by the points. In the case of a repetition of the measurement, the mean value of the measure would be estimated as well as the standard deviation which corresponds to the distribution of the different measures.
02 :00	So, on this type of data that we get, the accuracy is defined as, in the case of a single measure, the difference between the measured value and the true value of the sample. In the case of several measures, the trueness is the difference between the mean value of these measures and the true value of the sample. Therefore, if this difference is too important, an error will appear and the method will be classified as biased. There is a video which explains what the bias of a measurement is and how it is possible to reveal it, as well as the corrective actions that could be taken.
02 :49	Hence, the bias of a measurement is mostly due to systematic errors in the manner to perform the experiment, in the protocol itself or in the way the laboratory will perform it.
03 :02	The second important point linked to these results of measurement is the notion of precision. The precision concerns only the case of a repetition of the measurement on the same sample. So, in that case, it is possible to estimate the mean and the standard deviation. Well, the standard deviation will represent the precision of the method. Roughly, it represents the dispersion of the measures around the mean. Higher is the dispersion, less precise is the method. Obviously, the aim is to get the standard deviation as low as possible.
03 :36	Furthermore, the precision is linked to the notions of repeatability and reproducibility. Both terms are linked to the precision but they concern different manners to get the measurement result.
03 :55	First, let's look at the repeatability. In that case, the measures are performed on the same sample, with the same material, by the same person and with a time between each measure relatively short (like some hours or some days). If one of these conditions is not respected, so, measures are not performed by the same person or the material has been changed (for example, the UV lamp could be changed or the standard solution) or there are several weeks or months between each measure; in that case, we talk about reproducibility. Of course, more the conditions of the repeatability are respected, more it is easy to get a good precision.
04 :35	Usually, the repeatability and the reproducibility represent the random errors which are linked to this distribution curve.

04 :50	The precision is a very important point in the result of a measurement. Here is a graph which will illustrate it. The top line represents a conformity value, for example a concentration of a toxic molecule in the food or a nutritional quality of a meal. Each circle on the figure represents the mean value of the measures performed on the same sample and the barres on each side of the circle represent the 95% confidence interval which is an assessment of the precision. Therefore, there are four different cases: - The extreme cases, which are easy to deal with. On the left of the figure, there is a mean value and its confidence interval which are clearly above the conformity limit, therefore it is easy to say that the sample is not conform and to reject it. On the right of the figure, this is the same situation but in that case the mean value is under the conformity line, so it is easy to say that the sample is conform and it is possible to accept without the fear to be wrong. - It is more difficult to deal with the intermediary cases. In the figure, there is a mean value which is just above the line of conformity and another one just under, but in both cases, the confidence interval crosses the line of conformity. Often, the mean value which is under the line will be preferred but other measurements will be performed on the sample to follow its quality and to be sure that it is conform. In the case where the mean is just above, the sample may be rejected but again, some other measurements will be performed on this sample to follow its quality. In conclusion, the precision of a measurement is a very important parameter and more precise is the method, easier it will be to deal with extreme cases and to conclude if the sample is conformed or not.
06 :57	To sum up, let's go back to the target that I've shown at the beginning of the video but this time with the four possible cases according to the trueness and the precision of a method.
07 :12	In this figure, from the right to the left, the method is getting more precise and, from the bottom to the top, it is getting more accurate. It is easy to see that the ideal case is the one on the top left of the figure which is a method precise and accurate. Here, the mean value of the measures is closed to the true value, which is represented by the red circle of the target, and the measures are very close to each other, which means that the method is precise. Then, there are three other possible cases.
07 :51	On the top right, the mean value is around the red circle, so it's close to the true value, therefore it is an accurate method. But the measures are far from each other, therefore the method is not very precise. The case in the bottom right is the worst. Indeed, in that case, the method is not precise but also not accurate because the mean value is far from the true value. Finally, on the bottom left, this is the case that I presented at the beginning of this video. Here, the method is very precise, but not accurate. Usually, this is the most difficult case to deal with because, often, as a student you think that because this method is precise, it means that it is accurate. But, as I have explained in this video, the precision and the accuracy of a method are two different parameters and it is necessary to assess both of them to get validated measurements.