



Measuring ≠ Knowing

‘Measuring is knowing’ remains a dubious expression. My thesis supervisor used to think it motivated us to collect data, as much data as possible. It seemed only of secondary importance that we afterwards struggled to complete the thesis in time. Even today I regularly hear in the lab: “Yes, folks, measuring is knowing!”, especially when they are using some high tech device. Why is no one criticizing this phrase?

The expression also is eagerly repeated in the social sciences, especially to emphasize that many data have been collected. The meaning, however, is not yet entirely clear. Statistics are needed, the models are too limited in scope, the marketing mix is incomplete or the sociologist has not had enough time to properly interpret the development. Even the Director General of Statistics Netherlands (CBS – Centraal Bureau voor de Statistiek, a department of the Ministry of Economic Affairs), who has a PhD in theoretical physics, recently quoted this expression. [1]



What is the importance of the formula ‘measuring = knowing’? A positron is an electron with positive charge. We agree on that: ‘positron = positively charged electron’. Both sides of the =-sign describe not-identical matters, which render a cognitive meaning for us. The same is true for ‘1 m = 100 cm’, ‘S = k log W’ and ‘morning star = evening star’. Nevertheless, only a few concepts are so closely connected with each other. The connection often fails, for example in ‘Planck is ill’, and ‘ π is a rational number’, and what about ‘the symmetry is broken’?

The expression became popular in the Netherlands through the saying on the facade of the Kamerlingh Onnes laboratory: “Through measurement to knowledge” [2]. Stated this way, it sounds different. The description is clearer, it typifies the nature of scientific work more accurately. Not until you have done your measurement, you can take steps leading to better understanding. In brief, measurement leads to knowledge, or: ‘measuring → knowing’. But, let’s review this. Is this actually correct?

What is knowledge anyway? That seems to be a profound question, but perhaps not quite as much as one might first think; knowledge is the totality of assumptions and facts nearly everyone agrees on. Of course there are idiosyncratic physicists with deviating opinions. That is acceptable and not a hindrance. Knowledge still remains that which is generally accepted. Does the majority determine what knowledge is? No, in science it is the other way around, a minority structures our concepts of knowledge.

That does not sound very pleasant, but in physics those who are most powerful determine (the content of) our knowledge. Physical facts are determined by the best mass spectrometer, the strongest source of neutrons, the most precise satellite and the LHC. Who can improve on these if there is no alternative? Are we able to doubt the results? We accept the numerical values given by the experts even though these are only temporary ones. The measurement values lead to assumptions, creating a situation, which could be typified as ‘measuring → speculating’.

We live in a world in which all kinds of things are measured, big data is hot. But what is measuring actually? What enables us to measure anything? An apparatus is needed, a measurement instrument that indicates quantitatively what we are looking for, a voltmeter yields a measure of voltage difference and a dB meter registers sound levels.

We actually already understand some of what we are looking for, only a numerical value is missing.

Measurement requires an assumption. It makes no sense to use an oscilloscope to discover gravitational waves, or a thermometer to attempt to measure radioactivity. Observation is not possible without a set of hypotheses. We already assume a result before we measure, i.e. ‘speculating → measuring’.

We live in a world of raw data and it will always remain that way. So, we don’t know anything at all? Are we merely surrounded by data on Majorana particles, the vacuum, magnetic monopoles, the Big Bang? Just numbers? No, fortunately we have physicists (such as Hawking, Guth and Dijkgraaf) who can produce elegant and coherent stories which we listen to with pleasure and which we try to comprehend. And then what? Well, we get to work again, we go on measuring and continue to measure. The only thing we do is ‘measuring & speculating’.

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References

- 1 *Nederlands Tijdschrift voor Natuurkunde* **80-11** (2014) 395.
- 2 Laesecke, Arno, *Through Measurement to Knowledge: The Inaugural Lecture of Heike Kamerlingh Onnes (1882)*, *Journal of Research of the National Institute of Standards and Technology* **107-3** (May–June 2002) 261 - 277, doi:10.6028/jres.107.021.