On the thrust of quantitative methods

In my books I totally agree with Carnap, Galileo, Hilbert, Tukey and many others that we should seek quantitative measurement and statements. Of course, I know that in some quarters of the social sciences, the humanities and philosophy, qualitative methods are fashionable, and words are preferred to numbers.

Thus my views might seem backward-looking. Still, like many scientists, I am thoroughly convinced that the quantitative way to proceed is much better than the qualitative. Why? A typical straightforward answer is that quantitative statements are more precise. That's correct but on its own does not hit the target. In my view, the main point is that precise statements force researchers to elaborate their ideas and to detail what they are doing. As a rule, one can only be precise **and** correct (at least approximately) if one has understood what is going on. Lord Kelvin hit the bull's eye with his famous quote: "When you can measure what you are speaking about, and express it in numbers, you know something about it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts advanced to the stage of science."

In a similar vein Laughlin (2005: 14) writes: "... in physics, correct perceptions differ from mistaken ones in that they get clearer when the experimental accuracy is improved. This simple idea catches the essence of the physicist's mind and explains why they are always so obsessed with mathematics and numbers: through precision, one exposes falsehood." If quantitative lines of inquiry reveal what is wrong or bad, good or viable – what happens if theories, methods, and the corresponding facts are imprecise, unreliable or vague? Quite obviously, it becomes much more difficult - if not often impossible - to reach an evidence-based conclusion, in particular to decide between substantially different ideas. Fittingly, only bad scientists should be happy if the evidence is murky or if a theory is intricate, since it is much easier then to keep or defend some personal view.

Moreover, any subject that has been treated mainly with the help of qualitative, in particular, verbal machinery, tends to become confused. If ideas are primarily expressed in words and observations are broad, scientific work to a larger extent boils down to texts and their skillful interpretation. Given these circumstances, wide reading becomes crucial, quotes and remarks build on each other, inviting rhetoric, speculation, different opinions, and lengthy discussions. Often, opposing intellectual traditions emerge, and their subsequent fight for dominance much more likely leads to confusion than towards a constructive consensus among experts.

That is completely different in the quantitative sciences where people focus on subject-matter problems. Elegant theories, mathematical formulae or scientific devices of all kinds will be adopted throughout if they prove to be useful "on the job", i.e. upon working on some scientific problem. Working together towards a practical solution and making real progress on real problems, it is rather typical that, almost as a by-product, a consensus evolves which embraces the helpful and drops the waste. Perhaps that's why Bacon summarized long ago that "truth emerges more readily from error than from confusion".

There is yet another aspect which is often overlooked: A major advantage of the quantitative method is the fact that many can contribute. A single genius may pave the way, but it takes legions of mathematicians, scientists and engineers to build a comprehensive theory and to implement practical applications. Babbage, Turing and Zuse laid the foundations of today's computer science and technology. However, decades of dedicated work had to be invested to turn these isolated tentative approaches into the omnipresent subject we know today. In other words: given a quantitative starting point, it is often "just systematic work" to improve upon it. Since all crucial elements of mathematical models, experimental procedures, and technological blueprints are explicit, it is straightforward to extend the amount of data being collected and processed, to take more factors into consideration, to calculate the effects of various interactions or functional dependencies, etc. Given a stable foundation, there is a rather systematic way to elaborate the consequences – both theoretically and practically. Thus we have created numerous impressive theories, various science-based industries, and interesting models of complex systems, e.g. the weather, chemical reactions, the economy, networks, the evolution of life and the universe.

Some typical examples

Of course, as economics and weather/climate forecasts show, it can be exceedingly difficult to come up with helpful models, convincing arguments, or a non-trivial theory. Thus, in many cases, we can do no better than qualitatively, and yes, in these cases a good narrative – just words – may be much better than mathematical "scaffolding". If you want to understand the setting that led to WW I, first read a good book by a well-informed neutral historian, and do not start with the military budgets of the major forces one hundred years ago. Well into the 20th century, leading economists also made their points verbally. They knew that - at least in their day - knowledge was so sparse and facts so shaky that it would have been dubious to proceed to quantitative statements on a grand scale. Some did so nevertheless, producing formally impressive work, yet typically irrelevant when applied to the real world. Just recently, when the current recession began, economics and its forecasts were rightly criticized for given just the illusion of precise knowledge.

Qualitative methods have some significance: Before the advent of image-generating devices, physicians had to count on their trained senses to diagnose a pathological change. When even a blood sample took days to be analyzed it was sheer necessity to begin a therapy on the basis of a subjective diagnosis. That's still the state of the art in the case of an emergency and in poor countries where life-saving technology is lacking. Thus, in the short run, we may be forced to resort to qualitative methods, heuristics, and intuitive judgment. Yet in the long(er) run, detailed diagnostics thoroughly based on the natural sciences have held sway. Medicine is not the exception but the rule: the more detailed and advanced our knowledge, the more quantitative arguments, methods, and results can be found.

In Saint-Mont (2011, 2013) I mention the example of the measurement and the theory of intelligence. Although I emphasize the difficulties in accessing such a delicate property, this field may serve as an excellent example of how far we have come with the explicit empirical-quantitative method, quite in the spirit of Galileo (to measure what is measurable and to render measurable what is not yet so):

In the 19th century, intelligence was a very vague subject. People were smart, stupid, clever, creative, sophisticated, educated and so on. Naturally, such qualitative verbal statements are rather broad. In the hands of a distinguished author, like Charles Dickens, say, they could become considerably sharper and describe the peculiarities of a person or a group of persons quite precisely. However, in every-day life the best one could hope for was a rather dim and often biased statement, for example, that some person was intellectually outstanding, i.e., that he possessed considerably more intelligence than others, or a comparative judgment, e.g., that Albert seemed to be brighter than Victoria.

With Binet (1905, see www.psychclassics.asu.edu/Binet/binet1.htm) this changed considerably. Instead of a verbal description, he used rather precise items to test mental abilities, e.g. memory, reasoning, and attention. Since his days, such tests have become more sophisticated and popular; so that, as of today, a large "battery" of validated procedures is applied on a regular basis. Such tests have not only stood the test of time; more importantly, they have stood the test of practice - since they have been useful, e.g., in predicting educational success, they have survived and prospered.

Quantitative tests, first aiming at intelligence, have been transferred to other facets of mental life, personal abilities and traits, but also to pathologies and diseases. Consistently, in the whole field of psychology this empirical-quantitative impetus has led to welcome precision in the diagnosis and treatment of individuals. It makes a real difference if your doctor thinks that you have depression since you tell him that you are not feeling well and exhausted or if there are clear-cut criteria for the assessment of depression, including physical and mental tests.

On the theoretical side there has also been tremendous progress. Although no single, generally agreed-upon definition or model of intelligence has prevailed, we are also far away from a purely operational definition - i.e., that intelligence is just some feature that a certain test of intelligence claims to measure. Quite the reverse is true: There are elaborate ideas on various facets of intelligence (e.g. verbal, mathematical, visual, social) and how these "multiple intelligences" (Gardner 1983) are related. Since there is a high correlation among these abilities (and the corresponding test items) various models on the structure of intelligence typically have had a hierarchical structure. Nowadays "there is a broad contemporary consensus that cognitive variance between people can be conceptualized at three hierarchical levels, distinguished by their degree of generality" (general, broad, and narrow). In particular, it make sense to speak of "general intelligence" (Spearman's g), i.e., a personal trait that manifests in almost all particular mental capabilities.

Conclusions

All in all we see that science has been cumulative and spreading. Galileo's two-tier strategy of "experiment and number" has proved to be extremely successful. It fosters innovative research, bringing about more precise methodology, better data, non-trivial theory, and helpful applications. For an excellent book-length treatment of these aspects, see Bookstein (2014). In the case of intelligence studies, it is nowadays straightforward to observe the brain "making up its mind". Consistently, imaging techniques (computed tomography, magnetic resonance imaging, etc.) are at the forefront of research giving more and more detailed pictures of brains in action.

The general lesson seems to be to apply the classical empirical-experimental and at the same time quantitative-mathematical method to every scientific field, and, if possible, beyond. In Saint-Mont (2013), in particular in the last chapter, I elaborate the thoroughly data and fact-based strategy to (a) general philosophy. As an example, I choose ethics. Although I agree with the standard view that

“that what **is**” does not determine how things **should** be, I also say - contrary to tradition - that human ethics is a result of our biological heritage and cultural traditions. “That what **has been**”, has had a major impact on our rules and values. The present, our mental setup as well as our social organization, have been shaped by the experiences we have had, our history as individuals and groups. Thus our norms are also the result of an evolutionary process. The rules that govern our collective behavior are successful since they, too, are based on operating experience, rather than abstract principles or speculative thought.

In other words, the observation that there is a qualitative difference between facts (the “is”) and values (the “should”) is correct. It is wrong to think that the present state of affairs may determine how things should be (the so-called “naturalistic fallacy”). However, that is not the whole story. There is also the past, which has an immense impact on our beliefs, convictions, values and *weltanschauung*. It is also a profound fallacy to ignore the historic factors that shaped both: the present world we are living in and the way we think about it. Thus, at a second, more penetrating glance, our evaluation system seems to be much more “Aristotelian” (bottom up) than “Platonic” (top down). Ethical standards do not descend from Heaven. Like the law, they are man-made and adapted to a certain environment.

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See also the excellent article on the English Wikipedia, and the references given there:

http://en.wikipedia.org/wiki/Human_intelligence