Scientific Thinking in Medical Education: A Student's View

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"Scientific thinking in medical education", I believe, refers to the question of what role scientific thinking plays or ought to play as an object of medical studies.
This questions presumes that medicine is indeed a science. There being many sciences, one is faced with the initial task of defining the way in which medicine is a science.
In order to answer this question, I shall use the method of categorisation which has been in use since Aristotle, according to which a science must be defined as to

- its purpose,
- its object and
- its method.

Aristotle (1) defined a science according to whether it saw its goal or purpose in its object, it itself, or whether it was free of purpose as an effective, active or observational science. Medicine was for him an active science.
We still agree with Aristotle that medicine is an active, practical science. A physician does not practise medicine for the sake of its scientific nature, but rather in order to help the sick. The help meant here could also be defined as acting on a scientific basis. But taking action refers to a concrete situation, an individual case, in medical practice an individual person, who cannot be completely subjugated to general truths.

With that we come to the object of medical practice, ie. the things medicine deals with.
The terms illness and health will serve to define these objects, since we are interested in healing people who are ill. In most cases of somatic illness, it will suffice to limit oneself to a pragmatic course of action, for which purpose precise definitions of our terms are not necessary. This does not, however, serve to clarify the definition of medicine as a science.
I should like to limit myself to three examples culled from the voluminous discussion on the definitions of illness and health.

1) The definition of "health" issued by the WHO. According to this definition, health is a condition of bodily, psychological and social well-being. Illness is then a disturbance of this condition.
Any definition of illness will have to take into account how the patient him/herself experiences the matter. A definition such as this one can, by the same token, never suffice, since it would allow practically anyone to claim to be ill at any given time. In addition to the subjective experience of illness there are objective aspects of health and illness that are simply not covered by how one feels.

2) Grundmann (2), in an introduction to pathology often read by students of medicine, has consciously chosen a different path. He writes, "We define illness differently: it is the result of a change in biological processes that has a negative effect on the organism." In the next sentence, however, Grundmann has to rein in this statement. "Such a change is not the illness itself." At a later point he writes, "When a person is ill, the entire person is ill."
Instinctively I would tend to agree with this definition as well as with the qualification. Instinct and feelings, however, can have no more than an heuristic value in the eyes of "The Sciences". We are forced to inquire what phrases such as "the illness itself" and "the entire person" are supposed to mean.

3) Karl Jaspers (3) reveals the basic difficulty in defining the term illness in the following example. Writing on "the idea of illness in somatic medicine", Jaspers begins with the assumption that illness is a "deviation". A deviation from what? Obviously from "health", which cannot, however, be defined as some statistically average condition. Jasper continues: "If one considers this and imagines what medical thinking involves, one must come to recognise that a physician who thinks scientifically is almost never referring to an average condition when he refers to a 'deviation', but rather to an ideal definition. He does not presuppose a standard definition of health, but he is guided by a standard idea. (...)
The more one grasps of the precise interrelationships between organs, structures and functions, the more lucid this idea becomes. (...) Health is initially a term with a rather indistinct defintion and with a tone of finality similar to life, ability, etc. The deeper one's grasp of the goal oriented interrelationships in the life of the body becomes, the more one is able to proceed

from a hazy teleology to a finer one, whereby the notion of health as a standardized biological term gains in clarity, although never reaching absolute clarity."

Jasper's brief text touches upon three different approaches to a definition of health. He begins with the presupposition that the idea of health carries an ideal definition, then suggests that it works in us as a standard idea and finally comes to call it a standardized biological term that never reaches absolute clarity.

Two sources, presumably Jasper's main ones, will serve to elucidate these points.

1. Kant's treatment of the notion of an idea in his "Critique of Pure Reason" and
2. Max Weber's application of these thoughts of Kant in the field of sociology.

Kant (4) understands an idea to be a necessary term defined by reason that does not allow us to make any empirical assumptions about real objects. This means that we can talk about ideas and that under certain circumstances we must even presuppose their existence; they cannot, however, be grasped in the same way that one may comprehend an empirical object.

An example of this is the world. This is nothing but an idea. We certainly do go about understanding things within the world (which presupposes the world), but we do not understand it as a whole. The same is true of humans as a whole, and presumably of health as well; in both cases Kant would say we are dealing with ideas, not with terms and definitions.

Max Weber (5) applied Kant's perspicaciously analysed method for expanding our understanding beyond the realm of understanding one's own terms to the sciences of sociology and history. His notion of ideal types defines neither an average reality nor a concrete individual case. Any concrete historical case must deviate from the corresponding ideal type, and in so doing becomes understandable by virtue of its contingency and individuality.

All of this has little to do with the methods of natural science. We return to Jaspers.

It is quite clear to him that health is an idea in the Kantian sense and can therefore never be clearly and completly defined. For this reason, he chooses to apply the "ideal type" method developed by Max Weber to try to understand the idea of health. He does in the end maintain that medicine is a natural science, even though it requires value judgements unlike, say, physics.

The difficulty thus seems to inhere in the fact that health cannot be completely understood by applying the methods of natural science alone, and that reason still has not found a communicating link between the basic concepts of natural science and the humanities, although the two have been bridging the gap somewhat of late.
This situation does not, in any case, allow for a clear definition of the objects of medical science.
To summarize thus far, medicine is an active science without a clearly defined object.
The third characteristic of a science remains to be considered: its method.

Let us begin with a look at the catalogue of the scientific disciplines upon which medicine is based and look for differences in their method. These include: physics, biology, psychology, sociology and history.
Mathematics as a formal aid to interpretation and the orientation offered by philosophy apply to the whole field. For this reason I shall not consider these two subjects (which are indeed basic to medicine) any further in this investigation of methodical differences since they evince not a differentiating character, but rather an integrative one.

If one ignores the "problem of the observer" in physics, its scientific character, supported by the principle of causality, proves to be well established. Working from general theorems and preconditions consistent with its system, physics draws conclusions about individual instances based on the pattern of cause and effect - the chain of causality. This method allows one to make "preconditions" of events as well as to "explain" them, that is, to establish prognoses and carry out dialetical analyses according to the Hempel-Oppenheim method. The applicability of this method is generally agreed to establish proof of the truly scientific character of this science.

Causal explanations are also to be met within the field of biology. Beyond the cause-and-effect chain, however, biologists are also interested in an "ends-and-means" chain. It is assumed that the elements in a biological system fulfill an "end" that serves the entire system. In contrast to physics, this gives meaning to the purposive "why-what for?" in biology. Thus the causality

principle is replaced by the homology principle, the causality chain by the finality chain and the causal explanation by the so-called functional explanation. The Hempel-Oppenheim model remains fully in force for this method; the marriage of ends to means allows one to predict and explain an occurence within the framework of the model (6).

At this point I would like to emphasize once again the contrast with physics.

Teleological statements can only be meaningful within hierarchically structured systems such as are commonly applied in biology (7). (The fact that biological systems must also surely be subject to heterarchical organisation need not enter into this discussion.) (8) The question "why-what for?" makes no sense in the context of physics, just as it would be senseless to speak of a hierarchy of forms of energy. At the very most, one could speak of a descending hierarchy of the vehicles of energy in the sense of increasing levels of entropy. Such considerations are, however, not the concern of physicists, but, significantly, of economists, students of politics and, increasingly, biologists.

Teleology itself and statements like "the whole is greater than the sum of its parts" were for a long period distasteful to scientists. Cybernetics then rehabilitated these notions. This gave rise to the term "emergence" to define the phenomenon of it not being possible to comprehend a system's performance capability by adding together the performance capabilities of its component parts.

In psychology and sociology (from the field of medicine we can add psychosomatics, which has already made several integrative contributions) the idea of emergence is clearly in place. To illustrate this I would like to refer to the first chapter of the third edition of the "Lehrbuch der Psychosomatischen Medizin" by Thure von Uexkuell (9).

Von Uexkuell and Wesiack attempt therein to grasp the so-called vegetative plane using the feedback mechanism as a model. The animal plane is seen as the emergent quality of the vegetative.

This is the next higher level of integration, which is said to be more complex than the feedback mechanism. Von Uexkuell and Wesiack then construct the functional feedback model to fulfill the perceived need.

The human plane, an even higher and more complex level of integration, requires the authors to construct the situational feedback model. In so doing, they emphasize the increasing role of historicity the higher the level of integration. The theory of evolution offers an explanation of the variety of methods within medical science of which we have offered a brief description. This concept is indeed embedded in this sort of variety, requiring as it does variations and mutations in order for natural selection to lead to further development. In and of itself, this way of grasping science has, however, already left the world of Hempel-Oppenheim behind. "Once the nexus of cause and effect has been relaced by the interplay of mutation and selection, predictions about the future are only possible in the form of descriptions of trends and no longer as prognoses as understood by the Hempel-Oppenheim model". (10)

A kind of intuitive integration of these variegrated elements has already developed within medical practice in the confrontation between doctor and patient. The physician sees the illness and the person who is ill. This total view of things is becoming something of a rarity due to increased specialisation, which is also true of our medical studies. Students are confronted by a plethora of specialised subjects. Their days are full. They are bombarded by isolated bits of knowledge. No time is left to them to reflect on the basic situation of being a doctor.
This deficit can only partly be made up for by a heavier emphasis on practice during one's studies: learning by actually working with patients and applying the case method.

A further requirement would be to become consciously aware of the limitations of the methods applied in medical practice. All conceptions about knowledge have their limits. Not until one reflects upon these can one develop an awareness of their significance as integrated elements in a larger picture.

In closing, I would briefly like to touch upon a basic difficulty standing in the way of a holistic understanding of a person suffering from an illness.

Let us return to Kant's treatment of ideas again. The idea is a necessary concept of reason, which states the unity of an object of pure reason which cannot be perceived. This is always the case when the knowing subject is a part of the object of knowledge. The basic situation of the knowing subject is that it can never become the objective object of its own knowledge, in spite of the fact that the subject's own unity, in the sense of being a necessary term of reason, is an absolute prerequisite for each and every act of knowing on its part. This prerequisite, which Kantian terminology would label an idea, does not in fact empower one to make any statements about the empirical actuality of any person. Referring to the case at hand: since illness is the illness of a person, the sick person's statement about his/her illness must be heard if it is to be understood completely which statement lies outside the field of scientific objectivity.

The same difficulty arises in conjunction with the ascending series quoted above, from "feedback" to "functional feedback" to "situational feedback". As helpful to our understanding as they may be, they are not as completely operatonal as the notion of the feedback mechanism. Whereas the "feedback mechanism" can be subjected to a thorough logical analysis, this is not true of the "functional feedback model" and the "situational feedback model". Seen in this way, they remain mere metaphors for what were defined as the animal and the human planes.

The failure of our dual logic or probability theory logic with its true/false scheme in analysing so-called "autoreferential systems" (8; 11; 12; 13) is revealed by an example of the logical implications.

The specific achievement of autoreferential systems is reflection, that is, the creation of an image of their environment while retaining the ability to differentiate between themselves, the image-creating relationship and what they have created an image of. This process is in part circular and not transitive.

And there lies the rub. A deductive conclusion is based on the structure of its logical implication. The principle of transitivity holds absolutely for such implications, at least in the case of dual value calculations. Thus we cannot use deductive conclusions to describe circular processes.

Put in a different way: the logic of substances, with its classic axioms of identity, forbidden contradiction, excluded third propostions as well as the law of sufficient grounds, upon which transitivity of implications is based, can only perceive circular processes as meaningful if they can be reduced to purposeful events, for example, if they can be fitted together to a chain that can be interpreted teleologically or causally. What such an interpretation succeeds in grasping is, however, only a calculable result which is thus a special case of reflection and in no way the process of reflection itself.

As long as comprehensive understanding of an autoreferential system remains outside the limits of our logic we will have to get used to a scientific pluralism that does, however, have one important advantage for medicine, namely that it prevents it from falling prey to reductionism.

The implications for medical studies are that the patient will have to become the central theme of our education to a much greater extent than heretofore, and that philosophical reflection covering the field as a whole - at present non-existant - is necessary, especially in view of the great mass of material to be learned.

The splitting up of specialised knowledge into separate subjects should be ordered and integrated with a view to the reality of the individual patient. Such an integrated view of the subject matter can only be achieved through work on concrete cases. Responsible work within the individual disciplines is only possible if the limits of their methods are known.

The role of scientific thinking in medical education should be to make us aware of these limits.

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