Transdisciplinarity: two preliminary issues

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Abstract

Any discussion about transdisciplinarity presupposes some sort of recognition of the scientific disciplines and some agreement on how they are or should be grouped or classified. This article supplies a demarcation criterion to distinguish science from non-science and discusses the way the sciences should be grouped. The first issue can be summarized by the question: (how) can scientific disciplines be distinguished from non-scientific ones? To answer this question it is necessary to sketch what in philosophy of science is called a "demarcation criterion" to distinguish between scientific and non-scientific activities. Secondly, does it make sense to recognise groups of sciences and which disciplines should be placed in each group? Does it make sense to use categories like social, hard, soft, exact, applied sciences and so forth? To answer these questions it is necessary to assess the plausibility of some of the categories traditionally used to classify the sciences. The purpose of the article is to provide an initial (yet philosophically grounded) orientation in an area in which many academics seem to wander, and sometimes to accept simplistic answers.

Keywords: Demarcation criterion, groups of sciences, natural sciences, social sciences, human sciences, groups of sciences, general sciences, special sciences, transdisciplinarity, (Theory of) modal aspects, multi-modal sciences

Disciplines: Philosophy, Philosophy of science, (Basically, all sciences are interested)

1. Introduction

Recently, a colleague from the same faculty came to my office. He was trying to sort out what he considered a rather intriguing puzzle. He had to sketch an overview of the place of his field of study among other disciplines. He knew that his subject needs to "borrow" from several other sciences. He was told that we have science only when we have an accepted paradigm. But he could not see such a paradigm in his newly emerging discipline. Was his discipline a real science? If so, in which "recognised" group would it fit? A few weeks later, another young colleague wrote to the School of Philosophy asking similar questions.

It was in those circumstances that I realised that issues concerning scientific status, the paradigms, inter-disciplinary dialogue and so forth constitute a big question mark for many academics. This is not surprising: such issues cannot be solved from inside any particular discipline[2]. On the one hand, issues of demarcation and classification of the sciences are typical philosophical tasks. On the other hand, as Stoker (1971:41) puts it, when it comes to

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[2] In this article I use the terms science(s), discipline(s) and scientific discipline(s) as synonyms.

such issues, all the parties involved should have a say. Philosophy should not try to impose decisions, but should listen to the other sciences. This topic might therefore be regarded as one inviting to transdisciplinary research or at least as a preparation to discuss transdisciplinarity more directly in a next step.

The present article is an attempt at clarifying some background issues about transdisciplinarity and at giving them philosophical foundations. Any discussion about trans-*disciplinarity* presupposes an identification of the scientific *disciplines*. It also presupposes some agreement on how these disciplines are or should be (distinguished and then) grouped. This article, therefore, 1) supplies a demarcation criterion to distinguish between science and non-science and 2) discusses the way the scientific disciplines should be classified in groups. Admittedly, one might think of many other "preliminary issues" to be discussed in relation to transdisciplinarity, but I will have to limit my scope to these two. I will not be able even to answer all the possible questions related to these two topics, but I would like to try and construct something useful for an introductory orientation.

The questions are many: when can we say with confidence that we are busy with scientific work? How many disciplines can be regarded as scientific? What do they have in common? Is there also something unique and different for each "science"? To which broader group of sciences does my field of study belong? Is there an accepted "paradigm" in each science, or do we simply have different "schools" competing with each other? Do we find competing paradigms in all the sciences or especially in the social and human sciences?

To answer this type of questions, I will also need to criticize ideas, definitions or prejudices that may be very familiar to us but that still need to be re-considered critically. I hope this exercise will provide a useful introduction to these topics and perhaps even show that philosophy does have some "practical" value (something which is not often taken for granted!). It is also fair to anticipate that my philosophical point of view is a reformational and Dooyeweerdian one.

Our inquiry starts, in the next section, from the issue of the criterion of demarcation to distinguish between science and non- (or pre-) science. When can one say that a certain discipline is scientific? In philosophy of science this is known as the problem of finding a "criterion of demarcation between science and non-science". It is important to notice that the question is not which disciplines can be regarded as *natural sciences*. We are asking which disciplines (or ways of thinking, research or activities) can be regarded as scientific, in distinction from non-scientific activities, research and so forth.

The debate has of course a long history, but not a very successful one, in the sense that not much consensus has been achieved. Some have even reached the point of considering abandoning the problem, after noticing that 2.400 years of attempts have not brought about any solution (cf. Laudan, 1980:275). The easiest shortcut, at this point, is often to avoid asking questions about the scientific status of one's discipline. After all, if it is taught at universities it surely must be scientific? Yet is a discipline supposed to be scientific because it is taught at university, or is it supposed to be taught at university because it is scientific? How can an academic institution discern between proper scientific work and what Storkey (1981) calls "the surrogate sciences"?

In the next section a historical survey will be presented to evaluate several demarcation criteria proposed in philosophy of science to answer these questions. Their lack of tenability should

lead the reader to understand why certain answers should not be accepted too quickly. A more positive proposal is provided in section 3.

2. How many sciences do you count?

2.1. The experimental criterion

I once asked a colleague and friend from the department of physics how many disciplines he could regard as scientific. He answered: "only physics, but not all of it"! He explained that we deal with science wherever there is experiment, and some parts of physics are not experimental. This does not always mean that what is not regarded as scientific is considered useless. But the risk of over- (or under-) estimating certain fields of study is obviously present. At universities, all this is linked to important decisions concerning for example funding, the appointment of lecturers and so on.

What about my friend's idea that we have scientific studies when we have experiments? First of all, one should realise that if this is true, experiments are not possible only in physics. There are psychological experiments concerning perception, memory and so on. There are sociological experiments, dealing for example with people's reactions under certain pressures. Galileo's famous law of inertia was based on a logical experiment, often called a "thought experiment". One can devise a pedagogical experiment to test the validity of a teaching method. If we adopt an experimental criterion to identify the sciences, we should count more sciences than just physics.

However, we should also notice that, apart from the experiments mentioned above, there may be gastronomic experiments, investment experiments, photographic experiments and so on. In other words, there are both scientific and non-scientific types of experiments. One might reply that science is characterised by scientific experiment. But as long as we do not know what precisely "scientific" means, we will not be able to identify what exactly distinguishes a scientific experiment from a non-scientific one. We have only shifted the question from "what is science?" to "what is a scientific experiment?"

To this objection one might reply that experiments are only one part of the scientific method. Could we broaden the picture and say that disciplines are scientific when they follow the scientific method? Let us analyse this possibility in the next section.

2.2. The methodological criterion

"You have science whenever the scientific method is used". This seems to be a conviction of many academics. This idea often implies that only the natural sciences are "proper" sciences and in fact the scientific method is the method of those sciences. The other "fields" may become scientific by adopting *the* one and only scientific method.

The history of philosophy of science shows a tendency to "sanctify" one method and to downplay all the others. Not even Feyerabend, in his *Against method* (1975), escapes the temptation to absolutise one method. In fact, while he pretends that all methods (scientific or not!) are valid, he ends up saying that only one method is superior to all, namely the "anthropological method" (1975:26, 66, 190, 252). So the motto "anything goes" is just a pretext to promote one specific method.

(Un)fortunately there is no scientific method which is applicable to all sciences (natural, social, human etcetera). In addition, even the method of the natural sciences undergoes change. It is sufficient to consult brief essays (e.g. Hatfield, 2005) on the topic to realize the big transformations which occurred from Antiquity, through the Middle Ages and still during the Modern Age. Of course we will always have someone arguing that all past methodological developments lead linearly to the present method. But is this "cumulative" view credible? And what precisely is the present scientific method?

Some of the procedures or characteristics of this method, like repeatability, can be attributed to non-scientific activities as well. Experiments, as we have seen, can be scientific or non-scientific. The consistency-condition has been successfully criticized (e.g. by Feyerabend, 1975:35ff.). As one scratches the surface of descriptions and definitions of the scientific method one notices all sorts of empiricist, rationalist and pragmatist "axioms", conflicting with the supposed objectivity and neutrality of the method.

Someone might argue that not only the method of the natural sciences but all scientific methods *together* show the difference between science and non-science. In this case, however, we end up with a maze of demarcation criteria, differing from field to field. So-called quantitative, qualitative, hermeneutical, exegetical, immanent, transcendent and transcendental methods would then be lumped together. Yet they would not help us identifying what distinguishes science from non-science but only what partially distinguishes certain sciences from others.

As a matter of fact, philosophers of science have rarely proposed "method" as a demarcation criterion: the strategy is more "popular" than academic. However, two specific methods have been proposed as demarcation criteria: verification and falsification.

2.3 Verification (or falsification?)

For some there is science wherever there is verified knowledge. The criterion of verification was popular in positivism. Science is different from opinion because science can verify its claims. However, the history of this idea shows that it was gradually abandoned. Can one verify something hundred percent? The answer had to be negative and gradually the verification concept had to become more and more "modest". In Carnap's article *Testability and meaning*, for example, verification was gradually "reduced" to confirmation (Carnap, 1936; 1937). Later on, confirmation was gradually toned down to probability (Carnap, 1951).

In addition, the problem is similar to the experiment-issue: there are both scientific and non-scientific types of verification. An official verifies the identity of an applicant, a judge verifies the proofs supplied by the defence and similar operations occur every day in parliaments, churches or families. As long as we do not know how to distinguish between scientific and non-scientific, verification will be a flimsy criterion to use.

Popper (1963:42 ff.) tried the opposite road: science does not try to verify but to falsify. Scientific theories and statements can be falsified (i.e. proven false), while non-scientific theories cannot. For example, astronomical statements can be refuted, but astrological predictions can always be "saved" by one or the other justification. However, Kuhn (1970:14-15) pointed out that it is impossible to achieve "conclusive disproof" (complete falsification). Is falsification, then, not a relative tool, exactly like verification?

And, one might add, are there not again two types of falsification, a scientific and a non-scientific one? Yes, just like verification, falsification is used every day in professional

meetings, police cases and family discussions. In other words, falsification may lead to the formulation of both scientific and non-scientific theories, statements or solutions. A sound criterion for demarcation should be sought elsewhere.

2.4 Puzzle-solving and the checklist-criterion

Some may remember that Kuhn's (1970:7) own proposal was that one has science when there are "puzzles" to be solved (a pragmatic approach). So for example astronomy generates continuous puzzles while astrology does not. Or even if the latter generates some occasional puzzles they never constitute the type of problem that can lead to a revolutionary re-construction of astrology itself. Feyerabend (1970:200), however, noticed that even a gang of robbers can be faced by "puzzles" to solve, and may decide to solve them in "revolutionary" ways for example to accomplish a robbery! In other words, Feyerabend noticed that there can be both scientific and non-scientific types of puzzles to be solved. Each new proposed criterion of demarcation demolished the previous one and then was quickly refuted in its turn.

Some propose a list of characteristics of science and think that we have science when a number of those characteristic traits are present (Stoker, 2008:9). This seems to offer a more nuanced approach. We have science when we have verification, plus systematised knowledge, plus objective recording of data, disclosure of methodologies and so forth.

But instead of providing a more refined criterion, usually this approach produces considerable confusion. For example, in a list of seven crucial characteristics of science, how many of them should be met, to know that we are dealing with science? All of them or only a majority of them? Perhaps just a few of them? In addition: how systematised, verified and so on must a theory be, in order to be considered scientific? Obviously verification, systematisation and so forth can be achieved to different degrees. To what extent, then, should a theory be "systematised" before it can be called scientific? Should we decide on a percentage? In addition, if we have already observed that criteria like "being verified", or "based on observation" and so forth, can be both scientific and pre-scientific, can we solve the problem by simply adding them together? The sum of several untenable criteria cannot create a sound criterion.

In my opinion, this approach achieves only uncertainty because in practice one will always be confronted with theories, ideas, programmes which meet only in part the requirements of the list. At this point one is likely to hear several erudite suggestions concerning the "graduality" of the border, the grey areas, the fog surrounding the bridge between science and non-science.[3] But personally, I regard them as *ad hoc* adjustments to evade the problem. I can accept that there is graduality between science and non-science, but this should not prevent anybody from proposing a reliable criterion of demarcation.

2.5 Paradigms in the sciences

After the appearance of Kuhn's work *The structure of scientific revolutions* (orig. 1962) the paradigm concept became very popular in academic circles. It is however not easy to use it properly. Generally speaking, academics know that there are different views among scholars,

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[3] See Van Woudenberg (2011:182), who does not propose or endorse any specific demarcation criterion but is sure that "the science/non-science divide is vague and blurry".

even in the same discipline. However, some detect such differences especially outside of the natural sciences. On the contrary, in the natural sciences there would be "maturity", which is due to the acquisition of a unifying paradigm. Maturity, some suggest, is measured precisely by this unifying factor (cf. Lowenstein, 2004). In this, they are in line with Kuhn. Yet, together with Kuhn, they are wrong.[4]

Confronted with the question whether paradigms could be present outside of the natural sciences Kuhn did not deny the possibility that one day e.g. sociology could reach the paradigmatic phase, which would bring to an end the dissensions over fundamentals which are so evident in its present phase. Yet the presence of several schools within sociology (and many other sciences) was to Kuhn the proof that a common paradigm was missing and therefore the "mature" (i.e. "normal") phase of science had not yet been reached.[5]

Nevertheless, Feyerabend (19870:207-208) correctly observed that, for example, if one looks at physics during the 19th century, at least three different paradigms are present within the discipline. Let us be straightforward: the idea of a single paradigm reigning undisturbed over a scientific community for a period is simply not in tune with the history of science. In all disciplines, at all times (not only during revolutions) there are different approaches, paradigms and schools fighting over fundamentals and sometimes even struggling to communicate with each other. Strauss (2009:5-7) has compiled a basic list of a few schools operating at present within the main disciplines, from mathematics to theology. He makes evident that in all the sciences competing paradigms and schools are present without exception.

In addition, paradigms have never caused the end of debates over "fundamentals", as the case of Franklin's paradigm for electrical studies demonstrates, and they have never created general consensus (Stafleu, 1979:26). They have rarely ever achieved a period of uncontested dominion. The usual situation is that one paradigm is adopted by the majority of scholars in a certain field, but normally there are minority views as well, and these views can be sometimes compatible, sometimes rival, sometimes conflicting with the majority's view. This situation should not be surprising. Actually the very opposite (i.e. total consensus) would be surprising. If one considers that, according to Kuhn (1996:41), paradigms imply "quasi-ontological commitments" and that such commitments, I would add, are prompted by worldviews and deeper types of commitments, it would be very surprising that a huge variety of positions may lead to uniform consensus. No, in this case Feyerabend was right: paradigms tend to proliferate. I would not agree with his idea that it is necessary to support their proliferation. I would however say that it would be futile not to recognise it once it occurs.

The situation is aptly described by Dooyeweerd (e.g. 1959:20-63; 1979; 1984, 1:169-495). Although he does not use the paradigm concept, he deals with the different ground motives directing the development of science and culture in the West. In a sense, they can be regarded as macro-paradigms or "macro-motives" (Visagie, 1996). Dooyeweerd saw quite

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4 Popper too cultivated the illusion that "dogmas and fashions" are characteristic of disciplines like sociology, psychology or theology, which he could even call the "lunatic fringe" (1970:57-58).

5 Later on Kuhn modified his view by saying that paradigms are also present in the phase preceding mature science (1996:178-179). The phase of paradigm-acquisition would then concern the acquisition of a certain type of paradigm. In any case the human and social sciences would lack the broad consensus produced by such special paradigms.

clearly that ground motives capture the commitment of the majority of people in a certain context. Yet an older "paradigm" does not always gradually disappear after a new one emerges. On the contrary, different ground motives usually co-exist in a certain epoch and in a certain context.

Summing up, a variety of paradigms are present in all disciplines, most often simultaneously. Their presence does not indicate that a science is still immature or that it is degenerating, on the contrary it may indicate its vitality.

It would take too long to consult the whole list of attempted solutions to the problem of the demarcation criterion, which frequently has led to disillusion. In the next section I will rather propose a criterion that seems to hold water.

3. A plausible demarcation criterion?

3.1 What is unique about science?

To find a credible demarcation criterion we have to find out what all the scientific disciplines have in common and what distinguishes them from non-scientific activities, knowledge, research, and so on. Together with Strauss (e.g. 2001:29-30; 2009:145), I would argue that we should consider *modal abstraction*. Let us start from introducing the theory of modal aspects elaborated by Dooyeweerd and Vollenhoven since the 1920s.

The basic ontological ingredients of our world (Hart, 1984:201; 203-210) are entities and modalities (in relation). The modalities are the fundamental modes of existing and also the ways of observing the world in which we live. According to present research (which is always open to improvement) the modal aspects are fifteen. In the following scheme they are placed in ascending order of complexity and their fundamental "core" is defined.

Figure 1: Modal aspects related to scientific disciplines

Aspects:	Core-meanings:	Special sciences:
Certitudinal	belief, commitment	theology
Ethical	care, love	ethics
Legal	justice	law
Aesthetic	harmony	aesthetics
Economic	management of resources	economics
Social	social relations	sociology
Lingual	symbolic signification	linguistics
Historical	formative power	history
Logical	rational distinction	logic
Sensory	feeling, sensation	psychology
Biotic	life	biology
Physical	energy	physics
Kinematic	movement	phoronomy
Spatial	space	geometry
Numeric	quantity	mathematics

Source: adapted from Dooyeweerd, 1979:214 ff.; Strauss, 2009:82-102.

What characterizes scientific thought is that it chooses one (or a few) of these modalities as "gateways" to a field of study. This modal aspect is then "abstracted" (lifted up) from the coherence in which it is normally situated and the researcher follows that particular "channel"

to study some concrete reality. For example, the biologist may be interested in plants, but not particularly in their cost, their beauty and so on. In his research, he normally follows the biotic aspect. The mathematician follows the numerical aspect, while the economist follows the economic aspect.

This provides us also with a rough sketch to see the difference between scientific and non-scientific attitude of thought. In our non-scientific attitude, we do not think along one particular modality, but we "keep them together". When I think that it is late and I must catch the bus in five minutes I "keep together" spatial, social, economic considerations, and ethical, juridical, numerical and more aspects.

Is there not abstraction even in pre-scientific thinking? Yes, but it is not *modal* abstraction. It is another type of abstraction which can be called *entitary* abstraction and is in fact linked to entities. A small girl combing a doll can learn to abstract the different parts of the "body": the hair, the face, the legs and so on. In this way she can "lift up" different parts of the body, focus on them and distinguish them from other parts and entities. In this case, however, no particular modal aspect is detached from the others as is the case with modal abstraction. Only different entities are identified and abstracted.

I understand that this is just a brief sketch and many questions might arise. We will have to leave most of them unanswered and just be content with this brief introduction. Nevertheless, we can start noticing a few implications of our approach.

4. A few implications of this approach

The first implication is that, according to this approach, the status of "science" is not restricted to the natural sciences, perhaps with the appendix of the ("softer") social sciences and the even more impalpable humanities. All the disciplines abstracting one aspect or a combination of aspects as their "gateway" for the study of reality can be regarded as scientific.

A second implication is that most of the time it is inadequate to define the field of study of a science by indicating an "object" of study, or a "part" of our experience (for examples plants, animals, human behaviour, banks, society, the churches or the Bible).

As soon as we define, for example, psychology as "the study of human behaviour", we are confronted with the problem that several other sciences could be said to study human behaviour as well. What about history, which studies the events generated by human behaviour in the past? What about ethics or sociology, studying the behaviour of individuals or groups? Economics too studies human behaviour, at least in relation to money, resources and so forth.

The definition of a scientific field of study should identify the *unique field* of a specific discipline, not something which is in common with other disciplines. The same problem is encountered when we say that sociology studies "society", or that biologists study the environment or that theologians study the Bible. There are several other disciplines which are interested in society (e.g. history, politics, ethics) or in the environment (e.g. economics, theology, law, physics) or in the Bible (virtually all the disciplines, when conducted from a Christian perspective).

One might reply that while for example economics might *occasionally* study the exploitation of natural resources and thus the environment, biology has in the environment its *constant*

object of investigation. It should be observed, however, that such a focus of biology does not involve all the modal aspects. When studying the environment, biologists are not interested in its economic aspect, or in its legal, certitudinal or numerical aspects. Biology studies the plants (or the brain, or genes, or whatever else) from the biotic point of view. To make it simpler we can say that it studies "reality" or "the world" through that modal aspect. Theology studies the world (be it the environment, history or social institutions) via the certitudinal point of view. Economics studies the world (e.g. minerals, families, laws) via the economic point of view.

The impression that certain sciences are about certain "things" derives from the fact that things (entities, institutions, events etcetera) are usually *qualified* by certain modal aspects. This is quite a complicated topic,[6] but to keep it simple we can make a few examples. Works of art are qualified by the aesthetic aspect, a church is qualified by the certitudinal aspect and animals are qualified by the sensory aspect. Now, certain sciences will more often insist on objects which are qualified by the particular aspect which is their "point of entry" to the world.

It should be remembered, however, 1) that no science is limited to those specific objects. In addition, as already observed, 2) those objects are never studied in all their modes of existence by a single science. As a consequence 3) other sciences study the same objects from other points of view, and they are not, therefore, an exclusive field of study. The only exclusive trait of a science is the specific modal aspect (or the selection/combination of aspects) through which it observes the world. Finally, it is important to note that 4) sciences do not only study "objects" or "facts" but need to include the laws, the norms, the orderliness characterising and holding for the specific objects. Modal aspects include this normative side in their law-side. It is by contrast simplistic to refer to a field of study as being constituted by "things" or objects. [7]

Having said this, we should however grant that *some sciences* are particularly focused on certain entities, processes or phenomena and at the same time seem to amplify the range of modal aspects that they need to "access" for their particular purposes. In some cases the focus on entities seems particularly intense and the modal perspectives "used" by certain sciences seem to increase. This introduces a discussion on the groups of sciences (e.g. natural and social sciences) to be undertaken in the next section.

5. Different groups of sciences

5.1 Colloquial yet problematic distinctions

We are familiar with several types of distinctions between and classifications of scientific disciplines. We hear that there are natural sciences, exact, hard, soft, practical disciplines and

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6 For a useful introduction see Clouser (2005:260ff). A qualifying aspect is usually the highest aspect (see Figure 1) in which an entity functions as a "subject". For example, for plants this aspect is the biotic (they have biotic properties, they grow etc.). In the following aspects plants do not function as subjects (e.g. they do not think or socialize) although they function as objects (they can be objects of thought and are used in social life as presents, for celebrations etcetera).

7 For one more example, it is not plausible to say that history has "the past" as its *object* of study. In fact, history does not study *whatever* happened in the past but only what is significant according to a historic-cultural perspective (i.e. modality).

so forth. Some of these categories are colloquially acceptable, but they often contain disputable implications or may suggest wrong connotations. For example, what is so hard about the so-called "hard sciences"? The terminology seems to suggest that this group is more "reliable" than the "soft" sciences. This sounds like a positivist prejudice which considers empirical experience as more reliable than (e.g.) rational investigation.

Another problematic distinction is the one between theoretical and practical (or pure and applied) sciences. Sometimes the distinction is drawn within the same discipline. For example "practical theology" includes disciplines like pastoral counselling and homiletics, while church history and dogmatics would be part of the theoretical side of theology. While sciences like theology would be both practical and theoretical, there would be sciences which are only theoretical or only practical. This time, the prejudice seems to come from the pragmatist party: theory and practice must be clearly distinguished. Yet a possible disputable implication might be that theoretical disciplines are less "practical" (therefore less useful?).

The distinction between theory and practice needs to be considered carefully. The contrary of "practical" is not "theoretical" but *unpractical*. In fact, a theoretical elaboration is something to be achieved in practice (after hard work) and might have very practical (i.e. useful) consequences. Upon further reflection, one should realise that there is no science which is not "practical", and no science which is not theoretical.

Finally, a third problematic type of distinction is the one devised by Rickert: untenable but (I suspect) still very much in use on our campuses. According to Rickert (1986) one should distinguish between the sciences studying something universal and the sciences studying the individual. For example, physics and biology are busy with universal phenomena: water always boils at a certain temperature, animals grow by following certain fixed phases and so on. History, on the contrary, is busy with unique individuals like Julius Caesar or with unique events like the American Revolution.

Rickert's intentions were commendable: he wanted to supply an alternative to the positivist view, thus creating a space for the humanities and social sciences. He attempted to do this by showing that the social sciences follow a different method (compared to the natural sciences) but they are nevertheless sciences. The problem, however, is that ever since Aristotle (1961:981a, 30; 1003a, 15) it was clear that scientific knowledge can only deal with the universal. There is no science of "this cow" or "this plant". No science would be interested in Emperor Nero or the French revolution if they could not fit in (historically relevant) categories like "dictators", "Roman emperors" or "revolutions". Science is of course not entirely cut off from the individual, but only in so far as it points towards the universal or typical.

The distinctions and groups mentioned above are rather "informal", in the sense that they are used colloquially, without big ambitions. We should now pay some attention to the more traditionally academic distinctions: are they acceptable?

5.2 Traditional groups of sciences

The most traditional classification contains categories like:

Natural sciences	Social sciences	Humanities	Applied sciences

We all know what these terms mean and it is not blasphemous to refer to these categories. Yet the following remarks are necessary to be(come) aware of the problematic sides of such

definitions. For example, the distinction between natural sciences and humanities might aim at proving that different methods may be used in the different fields and in this sense it would be acceptable. However, if its aim is contrasting "proper" science with "pseudo" science it is untenable, at least according to our criterion of demarcation.

We may start by noticing that the above scheme is based on a rather sharp distinction between nature and humankind (or culture). Based on our previous discussion, one might ask: are the natural sciences really about "nature" in distinction from humankind? Is genetics not about human beings? Is chemistry not about human nature as well? Then why should this sharp distinction between natural and human be fundamental for classifying the sciences?

A second question concerns the extension of the groups of sciences. Should mathematics and geometry be regarded or not as natural sciences? If the answer is "yes", why do they use theoretical rather than empirical approaches? If the answer is "no", how is it possible that the sciences of the first two modal aspects of "nature" (see Figure 1 above) are not considered natural sciences? In addition, should psychology be included in the *natural* sciences or not? Should it be included even if it looks beyond "nature" to study *human* (individual or social) emotional life? Or should it be excluded even though it includes animal behaviour in its scope?

Moving to the second group, do we speak of *social* sciences because they are supposed to study "society"? Is this the common denominator of (e.g.) history, economics or law? Do they really focus on social relationships? Should one rather say that they "support" (the quality of) social life? But then is not pharmacy doing the same? What distinguishes the social sciences from the human sciences? A rapid journey to the internet shows that some sciences (e.g. history) are classified as "social" and as "human" at the same time.

The term "sciences" tends to disappear when we move to the third group, the "humanities": does it mean that only nature and "society" can be studied objectively while in philosophy or theology we deal with subjective interpretation? Are the social sciences not busy with "human" phenomena, products, events and so forth? Does the difference lie in method? But then, should not the adjectives "social" and "human" be replaced by others, referring to the specific methods rather than to the field of study?

Concerning the category of "applied" sciences, we can ask the same question formulated above in connection with the category of the "practical" sciences. Namely: does anybody know of a science which is not applied or applicable to something at least in some sense?

The purpose of these questions are to highlight the fact that such classifications are questionable, lack precision and are based on several prejudices. This is probably why we hear so many "judicious" admissions that in some cases "the categories overlap". Neuro-biology is said to be part of the natural and social sciences at the same time. Mathematics is an exact science but not a hard science. Psychology can be defined as a social, cognitive and behavioural science at the same time. The categories seem to multiply as the cultural, cognitive, information or cultural sciences may be added to the list. In the end, each discipline seems to create a category in itself and each category seems to contain only one science with its sub-disciplines. Detached from any structural order (like the modalities above) the sciences seem to proliferate *ad infinitum*, under the impetus of "industrial needs" or the constructivist freedom of the postmodern Man.

Is it possible to look for more reliable distinctions and groups? A few categories are sketched in the next section.

6. More acceptable distinctions?

6.1 Special sciences

Keeping in mind the theory of modal aspects we can start by distinguishing between two categories: special and general sciences.

The special sciences are those that study reality through a particular point of view constituted, as we have seen, by a specific model aspect. From the list of modal aspects above, it is easy to recognise the modalities referring to mathematics, physics, biology, logic, law, economics, and so on. It might be less obvious to "place" disciplines like the agricultural or engineering sciences. On this point Hart (among others -1984:177) shows that such sciences are related to the historical or cultural modal aspect. Such sciences are related to cultural formation.

One should not imagine that the special sciences are enclosed within the walls of a single perspective on reality. On the contrary, there are frequent contacts with other perspectives and other disciplines. There remains however a guiding thread, a fundamental trajectory while input from other disciplines/modalities is received. For example, mathematics is very important for physics and input from other modalities (and sciences) can lead to new discoveries and even new paradigms. Yet mathematics remains a side-perspective for physics.

This point can be illustrated by referring to Dooyeweerd's theory of modal aspects (Dooyeweerd, 1984, 2:79-330). Each modal aspect is irreducible to others, yet it can be identified only in connection with all the others. These connections between modal aspects are called "analogies". For example when we speak of the growth of economy, we borrow from the biotic aspect the idea of growth and we analogically "transfer" it in the domain of economics. There "growth" has a new and specific meaning, which is "shaped" by the economic modality. In a sense the boundaries between the two modalities might be "crossed", but it does not mean that those aspects are blurred, combined or unified.

Stoker even used to speak of "intermediary sciences" (1971:42). He suggested that, depending on the emphasis, one may speak for example of social-psychology or psychological-sociology; theological-philosophy or philosophical-theology (1971:42-43).It might be argued that these sciences, although accessing several modalities, always retain a primary perspective. For example, education might look at psychology but only *in so far as* it serves educational purposes. There would therefore remain a central perspective accompanied by some side-perspectives.

Do we also have disciplines which "combine" more than one aspectual perspective without adopting a "leading" modality? The difference would then be that these sciences access several "gateways" without distinguishing between a primary perspective and several secondary ones. In this case one might speak of "multi-modal sciences". For example, could we say that in the discipline of governance (related to disaster risk management - Van der Waldt, 2013), the perspectives of law, economics and sociology are *equally* needed? The same might be true of political studies, where state-relations are studied from several (modal) points of view. Skillen (1988:48) calls politics a "multifunctional" discipline.

The question is obviously important for transdisciplinary studies. Although it may not be easy to give a clear answer to the above question, I think the possibility of a multi-modal approach is confirmed when we consider the general sciences.

6.2 General sciences

The general sciences are normally philosophical disciplines. Philosophy is the science that is supposed to provide a sort of over-arching perspective both by informing and by listening from the special sciences. The core disciplines of philosophy should especially be regarded as "general": ontology, epistemology and philosophical anthropology are in this category. Philosophy of art, of language and so forth can be regarded as "special philosophy". This means that philosophy has virtually at its disposal all the modal aspects as points of entry to its fields of investigation. This is not surprising if we consider the breadth of the field of study of this discipline, think for example of philosophy of history, of art, of science, of economics and so on.

This does not mean that the modal perspectives are explored all together, at the same time by a single philosopher. This would be impossible or equivalent to pre-scientific knowledge. Philosophers abstract these perspectives according to their needs and particular interests, not simultaneously. This would bring them back to pre-scientific thinking. Nevertheless, in philosophy several modal perspectives are added to each other. Each modal aspect should not be reduced to another aspect, incorporated by or "blended" with another aspect. The core-meaning of each aspect (see Figure 1) does not allow for such operations. Yet the different modal perspectives can be abstracted (i.e. selected and "lifted up") and subsequently "added" to each other. If this is possible for philosophy I would say that it should be possible for the special sciences as well. Storkey (1993:48) argues that, from a reformational point of view, transdisciplinary cooperation is welcome and necessary. In fact, if each science can only provide a perspective on a certain phenomenon, problem or entity, such cooperation becomes indispensable. This topic would lead to discussing transdisciplinarity more directly. But as far as our reflections on "preliminary issues" are concerned, we can stop here.

6.3 Further proposal: nomic and normative sciences?

Two other categories correspond more or less to the distinction between natural sciences and humanities. In fact, although according to Strauss it would be futile to create a big gulf between the two, he himself points out one basic difference (Strauss, 2001:33). In this sense, a distinction (not a separation) looks plausible.

Although both groups of sciences deal with universal forms of normativity, the natural sciences deal with laws while the humanities deal with norms. The difference is the following: laws do not require human positivization, while norms do. For example "justice" is a norm that must be implemented in a society. Just policies do not just "occur" automatically but need human positive formation. The law of gravity, by contrast, does not need human implementation: if I jump from a roof I have no other option than falling down. Laws cannot be ignored, bypassed or disobeyed, while norms can be twisted, "emptied", transgressed.

On this basis, it is therefore possible to speak of the first five aspects as related to the nomic sciences while the post-physical aspects can be related to the normative sciences. The difference is not about the universality or individuality of the object of study.[8] Both laws and norms are universal in scope, in the sense that they apply to all the subjects within a certain domain. It is possible, however, to note that *modal* laws and norms have a broader domain than *entitary* laws and norms. The former apply to all the subjects functioning within a modal

[8] See the discussion on Rickert in section 5.2 above.

aspect, while the latter apply to all the entities for which they are valid. In other words, the modal law of non-contradiction applies to all prepositions (discourses, texts and so forth) while the laws regulating the reproduction of reptiles apply only to reptiles.

6.4 Other groups?

Can one imagine further groups of disciplines? I can recall a couple of attempts performed in reformational philosophy, based on the fact that each aspect is foundational to the successive ones.

Van der Laan (1966:25) speaks of "mathematical sciences" (those related to the first five aspects) because the numeric aspect is foundational to the others. Then he proposed the label "cultural sciences" (from history upwards). It seems awkward, however, to call biology a "mathematical science" and one should also notice that in this scheme the logic aspect (science) is completely left out.

Much more recently Basden (2011:5) suggests grouping the fifteen modal aspects in groups of three. Admittedly, he is neither trying to create a fixed order nor to propose new groups of sciences. Nevertheless, one might ask what the consequences of this procedure would be for the classification of sciences. Once again, I do not think one can be satisfied with the scheme. Basden argues, for example, that while the "social, economic and aesthetic are aspects of our living together, the final three aspects - juridical, ethical and pistic/faith are especially important in the health of society" (2011:5). In this case the difference does not seem to be particularly relevant or useful for our topic.

The difficulty of grouping together sciences referring to various/different modal aspects (already noticed in section 5.2) lies in the fact that each aspect is "primitive", irreducible to others and there is no "common denominator" between (groups of) modal aspects. I am therefore skeptical about the possibility of creating formally correct and precise groups of sciences within the categories already discussed in section 6. I remain open to the possibility but I suspect we will have to be happy with a few colloquial definitions and categories, without big ambitions.

7. Conclusion

With this, an orientative answer has been supplied to several questions concerning the possibility of a demarcation criterion and the groups of sciences. Although not all the possible questions arising from these issues can be answered in a single article, I trust I have sketched an introduction to these problems, a simple "map" which is however philosophically supported. I hope such insights will be of some help to fellow academics who might have struggled with the problems discussed in this article. I trust it is by now quite clear that this preliminary discussion naturally leads to the theme of transdisciplinarity. But this must be the topic of another article.

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