

How many 'sciences' are there?

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“All science is either physics or stamp collecting.”¹ — Ernest Rutherford (1962)

“Anthropology, or true science of Man [is] the last gradation in the Grand Hierarchy of Abstract Science.”² — Auguste Comte (1874)

Introduction

How many 'sciences' are there? Science is thought by many people to be the most global-universal practise we have available to humanity nowadays, other than perhaps football (soccer) teams, the Olympic Games and the United Nations. It is supposed to be neutral to gender, race, ethnicity, class, network, status, ideology, political system and religion. Since most people generally hold that there is more than one science — that science is plural, not singular, that there are multiple *scientific methods* and not just a single, uniform *scientific method* — this article is my attempt to answer the simple question above by giving a basic guide of how to estimate the approximate number of sciences.

As orientation lessons on the history and philosophy of science (HPS) often begin, there are two questions we must ask: which science(s) and whose science(s)? The first question is mainly what I am focused on in this paper. But the second question is likewise important because people hold various opinions about what constitutes 'science' and what does not. To some scientists, other scientists do not actually count as 'scientists' because they are considered not scientific enough (i.e. their field is not really a 'scientific' field according to others' perception).

It would thus be impossible for me to give a definitive answer here about how many sciences there are from an objective perspective. Instead what I propose to do is to look at what several people and organisations consider to be 'science,' to ask a few questions about their views and then to offer my own interpretation near the end, including a brief summary. This way the reader will not think I am imposing my personal way of defining science as authoritative compared with their own. For some brief background context, the way I will approach the question of how many sciences there are is in light of training and work done in the Russian Federation on the topic of HPS, science studies (*naukovedeniye*) and different sociology of science traditions.

Organising and Categorising the Sciences

Let us start at a globally-widespread institution that believes in the unity of knowledge still today and in the concept of 'unity-in-diversity' — the foundational meaning of the

¹ Quoted in J.B. Birks “Rutherford at Manchester”.

² 1874 translation of *System of Positive Polity*, Vol. II, pages 347-356, cited in Urbanowicz, Charles F. 1992. “Four-Field Commentary”, *Newsletter* of the American Anthropological Association, Volume 33, Number 9: p. 3. http://www.csuchico.edu/~curbanowicz/Pub_Papers/4field.html

'university.' We may consider the Pontifical Academy of Sciences, which does not speak *ex cathedra* about science and thus does not claim to be an infallible institution regarding how many sciences there are. There are 9 Pontifical Academies distinguished as follows:³

1. Astronomy
2. Chemistry
3. Earth and Environment Sciences
4. Life Sciences
 - 4.1 Botany
 - 4.2 Agronomy
 - 4.3 Zoology
 - 4.4 Genetics
 - 4.5 Molecular Biology
 - 4.6 Biochemistry
 - 4.7 Neuroscience
 - 4.8 Surgery
5. Mathematics
6. Application of Science,
7. Philosophy and History of Science (Epistemology)
8. Physics
9. Other Disciplines

What I find most interesting in the list is the inclusion of "Application(s) of Science" as a separate scientific branch of knowledge, as well as multiple fields being classified under 'Life Sciences.'

We can also look to those who study science scientifically. The field known as 'science studies' (or *naukovedeniye* in its original Russian), offers us 'scientific' insights into what qualifies as scientific fields. In some recent cases, this has been visually 'mapped' according to various branches of knowledge. The Knowledge Mapping Laboratory of the University of California, San Diego identifies 14 main branches (see Image 1 below):

1. Humanities
2. Social Sciences
3. Health Professionals
4. Brain Research
5. Medical Specialties
6. Infectious Diseases
7. Biotechnology
8. Biology
9. Earth Sciences
10. Chemistry
11. Physics
12. Math

³ http://www.vatican.va/roman_curia/pontifical_academies/acdscien/own/documents/pasdisciplines.html

13. Aeronautical/Chemical/Mechanical/Civil Engineering
14. Electrical Engineering/Computer Science

Here it must be noted that in the Anglo-American tradition, 'humanities' does not count as a 'scientific' field, whereas in the German-Russian tradition, there is a 'science of humanities' or 'humanitarian science.' In any case, we can identify several main types or branches of science, similar but different from the above example, some of which can be grouped under joint or collaborative labels.

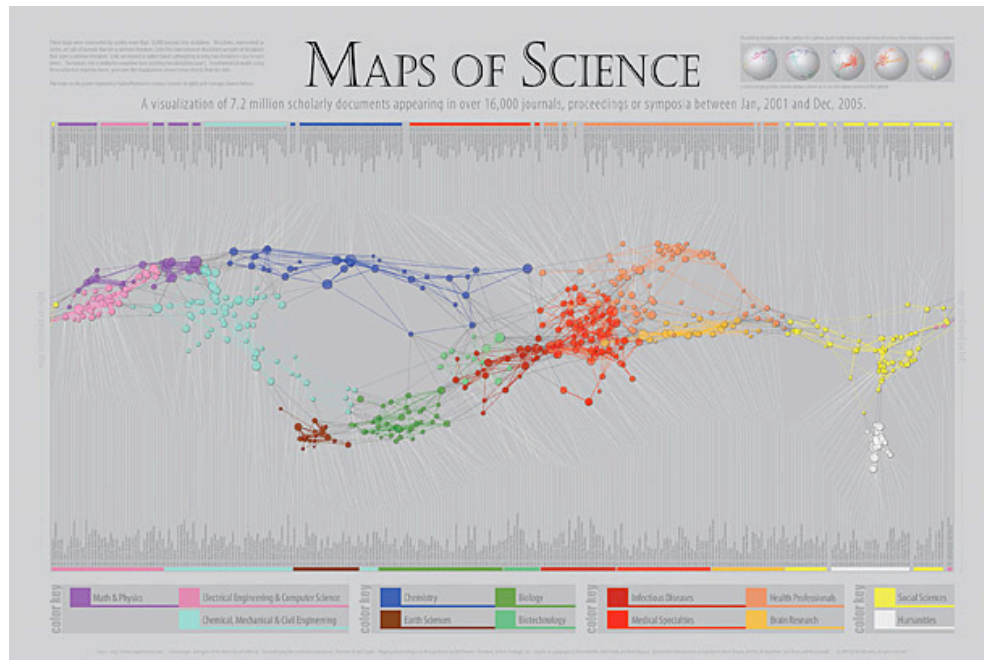


Image 1. Maps of Science

A bit closer to home for me, still on the higher education, academic level, I looked at how my *alma mater* divides the realms of science. The University of British Columbia's Science Departments⁴ — ranked among the Top 20 in the world by the *Times Higher Education* rating system — use the following 8 names:

1. Botany
2. Microbiology & Immunology
3. Chemistry
4. Physics & Astronomy
5. Computer Science
6. Statistics
7. Earth, Ocean & Atmospheric Science
8. Zoology

⁴ <http://science.ubc.ca/departments>

Of note in looking at this division of scientific kinds, is that engineering has its own independent Faculty at UBC, outside of the Faculty of Sciences, as does Medicine. Likewise, the Faculty of Sciences is distinct from the Faculty of Arts, which therefore excludes fields in the Social Sciences, such as economics, politics and cultural fields from being called 'sciences.'

Turning to a broadly available view of 'science,' Cynthia F. Kirkeby runs a website called ClassBrain.com which claims to be "tailored to the informational needs and skill levels of the various age groups."⁵ The site speaks of 10 Kinds of Scientists (2006). Basically, scientists to Kirkeby are those who study the fields denoted by their professional names; astronomers study astronomy, biologists study biology, chemists study chemistry, and so on.

Looking at a more common, less academic source to see what the so-called average educated person might consider to be 'science,' Wiki Answers responds to the question: "How many types of science are there?"⁶ It claims there are 30 scientific fields. This list defines as independent scientific fields some 'sciences' that in Kirkeby's model and in the above approaches would instead be considered as scientific subfields, rather than autonomous disciplines.

But now that we have reached a view of 30 sciences, can this be said to be an exhaustive list? Could there possibly be more than 30 kinds of science? Should we grant that all of the fields listed at Wiki Answers are 'scientific,' including Ufology? Or what about SETI (the search for extra-terrestrial intelligence) — is that properly considered as a scientific field? What about 'origins of life' (OoL) — is that a scientific field, or rather more closely related to philosophy or even theology or worldview studies? If some academic fields are best not called 'sciences,' then what are the proper grounds for rejecting certain fields as scientific while accepting others?

Usman Malik gives a detailed summary (2010) of what he counts as 612 branches of science and various scientific studies.⁷ Malik's list includes commonly known fields such as Aeronautics "study of navigation through air or space," Archaeology "study of human material remains," Cardiology "study of the heart" and Cartography "the science of making maps and globes," as well as less known fields such as Ethonomics "study of economic and ethical principles of a society," Gigantology "study of giants," Magirics "art of cookery," Magnanerie "art of raising silkworms," Sarcology "study of fleshy parts of the body," Philematology "the act or study of kissing" and Urbanology "study of cities."

In two of these cases, the term 'art,' which is normally reserved for a 'non-scientific' (in the Anglo-American tradition) meaning, was used. How many of Malik's 612 branches

⁵ http://www.classbrain.com/artaskcb/publish/article_219.shtml

⁶ http://wiki.answers.com/Q/How_many_types_of_sciences_are_there#ixzz1syz4Rbmb

⁷ <http://www.cssforum.com.pk/css-compulsory-subjects/everyday-science/everyday-science-notes/36223-list-branches-science-their-studies.html>

of science are taught in most university settings and is that what qualifies a field as 'scientific' or not? Does the systematic and thorough study of something, virtually anything, thereby qualify it as a 'scientific' field of thought and research?

Malik's taxonomy of sciences also includes some terms that people might wish to distinguish from being 'scientific,' such as Ideology, "science of ideas; system of ideas used to justify behaviour", Philosophy "science of knowledge or wisdom," Hierology "science of sacred matters", and Thaumatology "study of miracles." Do most people count these latter fields as 'sciences,' as 'alternative fields of knowledge,' or even as not constituting legitimate knowledge worth studying at all?

A Social-Philosophical View of Science

The so-called 'science demarcation game' was part of the 'Science Wars'⁸ of the 1990's and 2000's, brought on by natural scientists questioning the scientificity of social sciences and literary studies. The latter fields had been engaging in an on-going analysis of scientists and scientific practise, including the subfield of sociology of science (SoS), which followed natural-physical scientists around to see what they were actually doing and engaged in interviews and dialogues with them, thus in a sense 'demystifying' scientific behaviour and attitudes.

Likewise, SoS for several decades has studied the personal and collective meanings of science and scientific knowledge to people; how the public, how civil society, how individuals view science and its value to humanity. This inevitably led to some challenges to the positivistic, pseudo-neutral and objectivistic approaches to science that are still to be found today in some philosophies of science. It has thus put scientists on the defensive regarding their legitimacy, their credibility and their appropriate value to society and a reaction was to be expected.

The 'Science Wars,' along with HPS, science studies and SoS have informed the background for this short survey paper about how many sciences there are and what distinguishes them from non-sciences. Personally, I have found it helpful to distinguish roughly 10 kinds of sciences, based on my work in these 3 fields. But as I said above, it is likely that readers will have their own chosen number of sciences as they designate and assign knowledge fields into their personal 'map of science.'

Approximately 10 kinds of sciences in my view are listed below. It should be noted immediately that several subfields overlap within the 10 kinds of science shown. For example, Social Sciences are by definition Human Sciences, which are also by definition Behavioural and Life Sciences. Environmental Sciences are also Biological Sciences, Life Sciences and Physical Sciences. Likewise, Formal Sciences (1) could be seen as an alternative to Informal Sciences (2-10), which is not intended, since most sciences can be studied 'Formally' or based on formal causes, in addition to just using material or efficient causes. With those brief qualifications, here is my list of sciences:

⁸ <http://www.cf.ac.uk/socsi/contactsandpeople/harrycollins/science-wars.html>

1. Formal Sciences – Mathematics, Logic, Theoretical computing, Information theory, Systems theory, Statistics, Applied linguistics, etc.
2. Physical Sciences – Physics, Chemistry, Geology, Cosmology, etc.
3. Life Sciences – that which studies life and also distinguishes life from non-life
4. Biological Sciences – Evolutionary Biology, Developmental Biology, Genetics, Genomics
5. Environmental Sciences (Earth and Ocean sciences) – Botany, Geology, Ecology, etc.
6. Behavioral Sciences – Ethology, Zoology, Cognitive Sciences, Psychiatry, etc.
7. Health Sciences – Medicine, Diseases, Ophthalmology, Veterinary, etc.
8. Human (Anthropic) Sciences – that which studies human beings and/or does not deal with non-humans, Psychology; Media, Technology and Communications
9. Social Sciences – Sociology, Anthropology, Culturology (Cultural Studies), Philology (Literature and Linguistics), Politology (Political Sciences), Education (Pedagogy), etc.
10. Applied Sciences – Engineering, Agriculture, Social Work, Computer Science, Urban planning, etc.

It is deemed worth distinguishing those fields that study living things in contrast with non-living things even though there is still not a clear, consensus definition of what exactly it is that differentiates 'life' from 'non-life.' The most important feature, which is also a controversy in the list as I see it is with regard to so-called 'final causes,' or teleological studies, which are limited mainly to #8-10, with heated discussion still about #6 and #7 and even sometimes #3-5. This demarcation of scientific 'kinds' is defended by Ludwig von Mises, who wrote (1957, 240): "The field of the sciences of human action is the orbit of purpose and of conscious aiming at ends; it is teleological." The non-human or natural-physical sciences are defined by the apparent absence of teleology.

Likewise, one might ask why then it is important to distinguish Human (Anthropic) sciences, especially if only two fields are labelled: Psychology and Media, Technology and Communications. I find this distinction worth making in the face of 'species egalitarianism' of the variety that Charles Darwin promoted and which Peter Singer and a considerable number of other people are currently promoting (Fuller 2006) — the notion that human beings are only different in 'degree' but not in 'kind' from (other) animals. In other words, I distinguish psychology and media, technology and communications as particular studies of human beings, rather than fields that are interested in (other) animals, the latter is reserved for the sciences of zoology and ethology.

This indicates something about the particular ideological presuppositions that I bring to the table in defining 'science' and 'how many sciences there are.' It is my belief that anyone who tries to do this will find their ideologies are inevitably present and must be taken into consideration. The contention is that we cannot escape ideology when defining for ourselves the total number of 'sciences' because the exercise itself is ultimately reflexive and extra-scientific.

Given the above list of sciences, it is also possible to speak of various categories of sciences, rather than identifying types or kinds, which are denoted by scientific fields and disciplines. These categories distinguish the object or subject of study from the methodology used to approach it.

1. 'Experimental/experiential sciences' are based on experiments or experiences in the present, in contrast with 'historical sciences,' which are based on studies of the past and of inferring past events from evidences found in the present;
2. 'Empirical sciences' are based on empirical or quantifiable evidence that is observable by the senses, while 'theoretical sciences' are based on theories mentally constructed that may or may not begin with observations, but which are aimed at applying to or aiding our understanding of reality in a variety of fields;
3. 'Fundamental sciences' or 'basic sciences' deal with fundamental or basic elements, objects, relations, forces or laws, which often refers to physics, chemistry and sometimes biology in contrast with engineering, computer programming or other 'applied sciences,' that are directly related to human-artefacts (cf. technology) and our life-world interactions with them;
4. Similarly, there are categories called 'exact sciences' and 'inexact sciences,' which focus on the level of precision, accuracy and ability to reproduce or repeat experiments or experiences in a scientific field; this distinction can also be described as 'pure sciences' and 'impure sciences,' based on the purity of objectivity or lack of subjectivity;
5. A frequent distinction between scientific categories is made between so-called 'hard sciences' and 'soft sciences,' the one which is more empirically and quantitatively rigorous and involves objects of study in nature that are deemed entirely separate from humanity, while the other is more theoretical and qualitatively focused and highlights topics of study that focus on humanity and human communities and individuals, thus involving 'reflexivity' (more below) or a 'double hermeneutic.' Here I wish to add the linguistic emphasis that just because a science is considered 'harder' does not make it more 'difficult,' indeed, the more complex sciences are in fact the 'softer' sciences, based on their higher number of potential variables;
6. 'Open science' is a term that relates to the level of accessibility people have to data, information and research conducted by scientists (e.g. open access journals) and 'closed science' is a term that relates to knowledge or information that is accessible to only a small number of scientists and scholars, with barriers that could be based on business, military or political interests;
7. A distinction in attitudes between 'deep science,' in which scientists are trained as specialists and are competent in knowing what they are doing and thus independent and autonomous from social criticism, and 'shallow science,' where "non-specialists should have more of a say" and are involved with "which science is done and how" was made by Steve Fuller (2004, 9), the latter idea which takes the label of 'Protoscience' in his book *Science (The Art of Living)* (2010);
8. Finally comes a distinction made by anthropologist-sociologist Michael Burawoy, current President of the International Sociological Association, who distinguishes between 'positive science,' which is a remnant of positivism, where the scientist

is an objectivist and an 'outsider,' an approach mainly practiced in the natural-physical sciences, and 'reflexive science,' which relies on inter-subjectivity with those (persons) we study, where the scientist or citizen is a subjectivist and a 'participant,' an approach mainly practiced in human-social sciences (Burawoy 1998). Burawoy claims "reflexive science as an ideal typical counterpart to positive science" (12).

There are, of course, other options people might choose to distinguish as independent categories, e.g. technical sciences, speculative sciences, proto-sciences or science fiction. Nevertheless, this list is included to show that scientific fields or disciplines differ by the way knowledge, evidence, ideas and information are treated and studied, gathered, distributed and produced.

One brief side-note: A deep rift between creationism, intelligent design theory and evolutionary theory in debates about origins and processes of change-over-time is also defined as that between 'operations sciences' and 'origins sciences.' Whereas origins sciences analyse an object or topic after-the-fact or try to reverse-engineer it to understand events that happened in the remote past, operations sciences deal with operations or experiments that are or can be done in the present. This origins science vs. operations science dichotomy, however, has been widely questioned by many critics of ID and of creationism and may therefore be more appropriately seen instead to fall within category 1) listed above.

Let me also add a short word of caution regarding the term 'historical sciences,' which is a debatable category. I am not entirely convinced that the term 'historical sciences' makes much sense or whether other alternatives, such as chronological sciences, geographical sciences, musical sciences or worldview sciences should be added alongside it for balance. Regardless of my hesitancy, however, many people consider history as a kind of science, in addition to being a unique category involving certain methods and theories. Let me therefore withhold judgment about whether or not 'sciences of history' or 'historical sciences' are appropriate terms of use.

Is Less Science Actually More Science?

It may be that less means more when it comes to doing good science, in keeping with the simplification principle of William of Ockham. One might therefore argue that there are only three kinds of sciences, as does the Physics Portal at South Carolina State University.⁹ They indicate three branches of science:

1. Formal
2. Natural
3. Humanistic

With six subfields:

⁹ <http://www.cnrt.scsu.edu/~psc152/A/branches.htm>

1. Mathematics
2. Logic
3. Physical Sciences
4. Biological Sciences
5. Behavioural Sciences
6. Social Sciences

An image is offered below regarding connections between the main fields and subfields. Perhaps this is an appropriate way that the number of scientific fields can be divided which keeps the number of sciences at a manageable level?

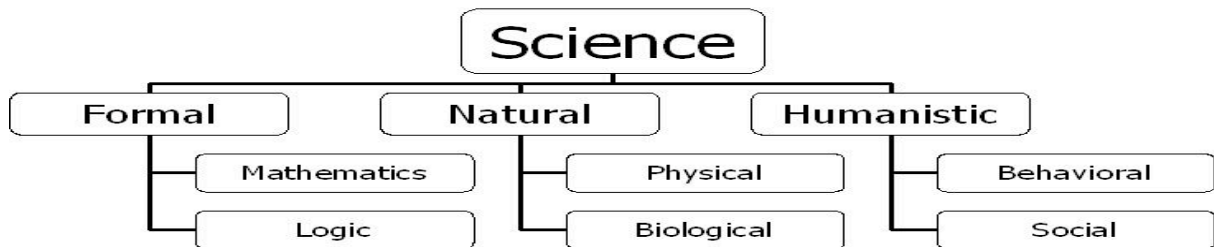


Image 2. Branches of Science

There are several reasons one might wish to reduce or restrict rather than to elevate or unleash the number of sciences in existence today. First, it protects against making things into 'sciences' that actually do not or should not qualify. In other words, it secures the rigour of studying one particular field (or a few related fields) for many years, preparing for and taking examinations, writing assignments for course-work and later articles for peer-reviewed publications, participating in conferences and symposia, listening to and speaking with experts in the field, presenting ones ideas and theories before unfamiliar and oftentimes quite critical committees of one's peers and elders, being mentored by leaders and mentoring younger scholars, to finally be rewarded with the (high and/or low status) title of 'scientist.' Becoming a scientist in this sense means achieving a particular social status and partly validates the university's *raison d'être* as the main institution that bestows the title of 'scientist' upon its graduates while it acts as guardian of scientific knowledge.

Second, reducing or restricting the number of sciences helps to clarify that there is a basic, even simple hierarchy or order in nature and human society, which offers us a way to understand the world that can be organised and studied according to various

institutionally — or 'school'¹⁰ — defined fields that follow specialised formal and professional principles. If there are too many sciences, the unity in the diversity is lost, the hierarchy becomes flattened or disfigured, the university becomes fragmented and detached from the purpose of studying science for the betterment of human life, the guiding principles are abandoned, the categories become jumbled and disassociated, the interrelations among knowledge spheres become confused or forgotten and post-modern relativism of knowledge and science reigns supreme. This situation has been termed as the 'multiversity' where talk of 'unity in diversity' is no longer possible.

Third, less science means more when it limits the possibility of people exaggerating what scientific method(s) is/are capable of doing or proving. The latter happens when some people turn science into an ideological position or worse, into a capital-S Scientific Worldview, in which scientists become like priests or shamans, as gatekeepers of progress and salvation through science and technology. In order to properly limit the reach of scientific knowledge, less science becomes more powerful in that it protects the authority to deem certain topics, fields, questions or 'schools of thought' as 'unscientific' when they do not pass the standard of rigour or professionalism expected of the few, but legitimate sciences. Doing this, however, also means opening up discussion about the borders and boundaries of science, as well as notions of scientific consensus and integrity, which at times and in some cases are sorely lacking.

Fourth, less science means more because it allows for more careful, thoughtful and deliberate consideration regarding the sovereignty of scientific fields based both on internal standards and external recognition. This means that it opens the way for fields of knowledge both that are proudly scientific and those that are proudly non-scientific or extra-scientific, the latter which are nevertheless still important for human life, self- and community-understanding. Thus, less science means more for itself and also for others because it validates the non-scientific sense of value and worth in human life, which ultimately determines the *telos*, direction, governance and regulation of science as a social activity.

In the comments section below, people are invited to give their own answer, to respond to or to debate with my contributions in this article: Is less science actually more science?

Conclusion

There are of course many other ways that people have identified and categorised the various sciences and fields of knowledge than those presented here (e.g. the Dewey Decimal System or the Chinese Library Classification). The aim of this paper has been to present a few of the options that are currently available for organising and categorising scientific knowledge and for identifying the limits of science. It is hoped that this principle concern will provoke readers to conceptualise and to seek to imagine their own

¹⁰ Here 'school' is meant in the Eastern sense of a 'school of thought,' as a kind of 'paradigm' of knowledge that develops around one person or small group of scientists or scholars, who spread and develop a core approach or 'research program' which others may be attracted to and choose to follow.

'map of knowledge' for the purpose of exploring the 'unity in diversity' of knowledge in the electronic-information age.

One might wonder what other domains are not usually classified as 'science,' but which nevertheless deal with knowledge production, consumption and human activity. We could speak of Law, Philosophy, Theology, Worldview or Religious Studies, Fine Arts, Theatre, Sports, or Journalism.

Does secretarial science count as science? Is gastronomy a science? Are there not as many different kinds of science as there are kinds of work or labour? When we hear of someone's activities, "She's got that down to a science," do we mean that the person therefore qualifies as a 'scientist'? Do some fields require people to take the title of 'scientist' in order to validate them and the field or to help represent their supposedly proper status in society more than others? Again, there seem to be more questions than answers on the topic of how many sciences there are in the world today. And the biggest challenge seems to be that we can't arrive at a wholly 'scientific' answer to this question, which means that we must look beyond the limits of science even to help define science's domain.

My tentative conclusion then is to speak as simply and jargon-less as possible. It may be that in the western analytic tradition, perhaps surprisingly, there are best said to be only two kinds of sciences: Natural Sciences and Alternative Sciences. After the invention of 'methodological naturalism' in (United States) American philosophy of science – which says that only academic fields studying 'nature' qualify properly as 'sciences' – identifying 'Alternative Sciences' may be the next best (Anthropic) option to help ensure the survival of non-naturalistic academic realms of knowledge.

Then again, the division into only two kinds of sciences — Natural (orthodox) and Alternative (heterodox) — could be considered as a variety of 'scientism' — as an exaggeration of the power of science taking precedence above other realms in today's universities.¹¹ This could be seen as trying to attribute the term 'science' to only a certain few (privileged) fields, to the exclusion of outcast others. Perhaps if instead we conceptualise three major realms of knowledge¹² as Sciences (both Natural-Physical and Human-Social), Philosophy and Theology (or Religion or Worldview), we can overcome the felt need to classify realms as 'scientific' that are in fact not scientific, while at the same time evaluating and even uplifting human knowledge and life experiences that matter to most people?

The final conclusion is therefore intentionally kept open. I have no final conclusion or definitive number of sciences to profess. The reader must solve the mystery of how many sciences they recognize and acknowledge. This is said with the caveat that how one

¹¹ Perhaps this is best exemplified in the simple statement by Bertrand Russell: "What science cannot tell us, mankind cannot know."

¹² This prospect is displayed in a forthcoming paper by Sandstrom (2013) based on the Dutch philosophical tradition of Abraham Kuyper and Herman Dooyeweerd.

organises and orders the sciences into a mutual dialogue reveals much about their/our philosophy of knowledge and human society.

What are the proper relationships that are or can be built between various sciences and disciplines in the university today? Can we still seek a unity of knowledge and humanity amidst great diversity, specialisation and individualisation in the 21st century? These questions are among the challenges for the new university and educational landscape to help us discover.

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