The Transdisciplinary Approach: A Critical Appraisal from an "Islamic Perspective"

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Abstract

This paper argues that the transdisciplinary approach, contrary to the views of some of its advocates, is not a methodology but a meta-method. In the first part I shall briefly discuss the similarities and differences between science/knowledge and technology to explain important epistemic implications of placing this approach in the latter category. Next, I shall critically examine the views of Basarab Nicolescu, one of the most prolific proponents of a particular reading of this approach. Part three discusses the function of the transdisciplinary approach as a meta-method. In the fourth and final part I shall try to introduce some examples from the intellectual econiche of Islamic culture in a bid to shed further light on this approach's potential as a meta-method. The conclusion, which I draw from my own critical examination, is that the transdisciplinary approach can be used in an effective way, provided that its users adopt an appropriate philosophical framework. Such a framework, I contend, could be provided by critical rationalism.

Keywords: Transdiscilinary approach, critical rationalism, science and technology, methodology, methods, and meta-methods

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Introduction

The transdisciplinary approach is a relatively new concept. It seems that its title and general idea was first suggested by Jean Piaget in 1970.[1] Since then, many writers have used it, developed it further, and applied it to research projects in various fields.[2] However, even a casual observer can detect differences (some rather sharp and substantive) as well as nuances in how those who write about this approach have discussed it.

To make effective use of this approach, we have to better understand its main characteristics and functions. To this end, the first section explains the differences between science/knowledge and technology in order prepare the ground for the third section, where I shall introduce the transdisciplinary approach as a meta-method. In the second section I shall deal at some length with the views of Basarab Nicolescu, who holds that the transdisciplinary approach is a methodology. I shall try to show that his views, which are informed by a rather dubious philosophy of science, suffer from serious defects. In the fourth part I briefly touch upon some examples from the intellectual econiche of Islamic culture in a bid to shed further light on the transdiciplinary approach's potential as a meta-method that could be used in various fields of research. The paper ends with a brief conclusion.

But before embarking upon my critical exploration, I need to clarify an important point. The term *Islamic perspective* simply means the perspective adopted by a Muslim (i.e., a person whose world outlook and universe of moral values are [at least partially] shaped by Islamic ideas and ideals). My perspective is further informed by critical rationalism.[3] The adjective *Islamic* does not imply anything sacred, divine, or infallible, for all man-made constructs are fallible and imperfect and thus in constant need of further improvement.

Science and Technology: Similarities and Differences[4]

Science/knowledge and technology are both socially constructed, although distinct, entities. Science, or more generally knowledge, responds to human cognitive needs. Technology, on the other hand, serves two main purposes: human

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non-cognitive needs (e.g., cars, cutleries, chairs, democracies, banks, and many other technologies) and facilitators for human cognitive needs, none of which can directly respond to human cognitive needs (e.g., telescopes, laptops, universities, books, and many other inventions that facilitate the pursuit of knowledge). Some technologies, of course, could play both roles, mobile phones being a case in point.

Science/knowledge is objective (i.e., publicly accessible and assessable)[5] and consists of our best conjectures about reality, all of which are expressed in terms of statements. Conjectures can only be regarded as proper knowledge-claims if they are criticizable (either by empirical or analytic-rational means or both); tautologies and analytic statements are empty, for they tell us nothing about reality. Our conjectures provide us with knowledge about reality in two ways: *via negativa* and *via positiva*. The first category refers to all of our falsified conjectures, for they tell us what reality is not like. The second category refers to all conjectures that, despite our best efforts to expose their defects, have remained corroborated. They tell us, in a provisional and temporary manner and until better conjectures are found, what reality is like. In any case, knowledge is and forever remains conjectural.[6]

Knowledge or science claims, which are general or universal, differ from both data and information. Knowledge also differs from intuitions, flashes of insight, inspiration, epiphanies, and private and personal experiences. These "existential states" are not knowledge, and yet their role in producing knowledge is vital.[7]

Although scientists are immersed in local cultures and traditions and carry their cultural and metaphysical baggage, as well as value systems, along with them, they do their best, in their bids to understand different aspects of reality, to keep their conjectures free of such external influences in order to depict reality itself as faithfully as possible. The aim of science/knowledge is to move ever closer to a true representation of reality, regardless of the scientists' personal or cultural preferences. The only exception to this is when knowledge about these preferences *is* the goal of the research in question. This aim is achieved by the critical assessment of knowledge claims in the public arena. In this sense, science/knowledge is therefore value-neutral, or at least strives to be so.[8]

In the case of technology, on the other hand, being impregnated with the values cherished by its inventors or end-users is not only a virtue but also an indispensable characteristic. Technology ought to be user-friendly, whereas science/knowledge claims ought to be true (i.e., faithfully represent reality regardless of people's preferences).

Science/knowledge conjectures seek to transcend particular contexts, whereas technology is context-sensitive. For instance, it may not be possible, without the proper fine-tuning, to use a technology devised to respond to the needs of people living in a particular environment or context to work properly in other contexts. Science/knowledge is cumulative, whereas technological know-how is, to some extent, tacit and non-cumulative. Since part of technological know-how is transferred through a sort of master-disciple relationship, in many cases if the know-how is lost it is lost forever, or at least its retrieval would be extremely difficult.[9]

The criterion for judging advances in science/knowledge is approaching the ideal of the truth about reality. In technology, such pragmatic considerations as more effective practical problem-solving provide measures for progress. Technology, contrary to the view of Martin Heidegger[10] and a number of other writers, has no "essence," but only "function." Different kinds of technology are individuated according to their functions. Users of technology can add or omit specific functions in order to tailor them to the purpose(s) they have in mind. While for science/knowledge the final arbiter is always reality, for technology the users' tastes and preferences (which together form an important part of their networks of meaning) are just as important as the constraints imposed by reality on the function(s) that each technology can possess.

Each specific technology is identifiable as such only for those who share a network of meaning or a collective intentionality in which that particular technology, with its characteristic functions, is recognized. For an indigenous inhabitant of a remote tribe in the Amazon's forests, a laptop is only a thing and not a laptop. This is a case of what philosophers define as the difference between "seeing" and "seeing as."[11]

Science strives to discover the fundamental laws of nature. Scientific laws only define the limits beyond which technology cannot operate. For example, the law/principle of energy conservation implies the impossibility of constructing a perpetual motion machine, and entropy states that a machine with a 100 percent efficiency is impossible.[12] Technology rely on what is known as technological/phenomenological laws,[13] those that are "derivable" from fundamental laws.[14]

A Critique of Niclosecu's Views

As briefly stated above, the transdisciplinary approach means different things to different writers. According to Nicolescu, its various explanatory accounts

can be roughly divided into two main camps. One camp, represented by writers like Michael Gibbons and Helga Nowotny,[15] maintains that this approach is not a methodology but a method that concentrates "on the joint problem-solving of problems pertaining to the science-technology-society triad."[16] The other camp, headed by Nicloescu and his colleagues, distinguishes three varieties of transdiscilinarity, namely, theoretical, phenomenological, and experimental.[17]

Nicolescu suggests that the first camp represents the phenomenological manifestation of transdiciplinarity, whereas the theoretical manifestation of this approach is a methodology under which many different methods could be used.[18] He classifies his own view as a theoretical approach and therefore considers it to be a methodology. In addition, he states that experimental transdisciplinarity is concerned with "a great number of experimental data already collected in the framework of knowledge production, but also in many fields like education, psychoanalysis, the treatment of pain in terminal diseases, drug addiction, art, literature, the history of religions etc."[19]

In what follows I mostly limit myself to Nicolescu's views,[20] which are fairly representative of his latest thinking on the issue. My focus in the section is to show why his philosophy and philosophy of science suffer from serious shortcomings. Nicolescu claims that transdiscplinarity's most important achievement has been the formulation of a methodology that is, more or less, universally accepted and adopted by many researchers. He claims that this methodology has an axiomatic nature that resembles the axioms of modern science. The main axioms of these two methodologies are, according to him, as follows.[21]

Table 1. Axioms of Modern Science vs. Axioms of Transdisciplinarity

Axioms of Modern Science	Axioms of Transdisciplinarity
There are universal laws of a mathematical character.	**The ontological axiom:** There are different levels of the object's reality and, correspondingly, different levels of the subject's reality.
These laws can be discovered by scientific experiment.	**The logical axiom:** The passage from one level of reality to another is ensured by the logic of the included middle.
Such experiments can be the perfectly replicated.	**The epistemological axiom:** The structure of totality of all levels of reality is a complex structure: every level is what it is because all of the levels exist at the same time.

Despite his critical attitude toward the positivistic approaches to science, Nicolescu, apparently inadvertently, subscribes to (at least) some positivistic thesis. For example, with regard to science's second axiom, he maintains that these laws "can be discovered by experiment." But this is clearly a positivistic creed. Critical rationalists had argued long ago that "all observations are theory-laden" and demonstrated that experiments and observations can only help researchers critically assess theories and conjectures.[22] In other words, they cannot help us discover anything. Both induction and abduction, as methods for discovery, are not only ineffective but also impossible.[23]

In explicating his own proposed axioms for transdisciplinarity, Nicolescu further reveals his positivistic tendencies, despite the fact that the positivist philosophy of science has long been discredited by such philosophers as Karl Popper.[24] He suggests: "Axioms … have their roots in experimental data and theoretical approaches ...."[25] However, experimental data are mute and contain no axioms, for axioms are constructed (as conjectures) by investigators and researchers. Data is then interpreted in the light of those axioms whose validity we accept without argument.

Having introduced the axioms of modern science and his own axioms of transdisciplinarity, Nicolescu goes on to further elaborate his conception of these axioms' content. But in doing so, he reveals more of the flaws in his own philosophical views. For example his third axiom, which is supposed to be epistemological in nature, is formulated in a way that makes it a continuation of his ontological axiom. Of course, in all fairness it should be pointed out that in 2011 he renamed his third axiom "the complexity axiom" and changed its formulation slightly, as follows: "The structure of the totality of levels of Reality *or perception* is a complex structure: every level is what it is because all the levels exist at the same time."[26] But this new formulation, if anything, is even more confused since it apparently tries to posit the complexity of an objective reality. The use of the connective *or* rather than *and* in the above formulation implies that Nicloescu equates something that ought to be essentially objective with something that is, by definition, subjective.

For another example of carelessness when dealing with sensitive theoretical issues, one need look no further than how he refers to the use of experiments in science. Nicloescu claims that "such experiments can be perfectly replicated." But this is inaccurate and misleading, for what is "replicated" when scientists repeat certain experiments are new phenomena that only *resemble* the original phenomena (which were produced in the original experimental setup) within certain limits of accuracy. However, the "replicated" phenomena are *not* identical with the original phenomena, and the new experimental set-ups are not identical with the original setup.[27]

Nicolescu differentiates between what he calls "real" and what he dubs "reality": "*Real* designates that which *is*, while *Reality* is connected to resistance in our human experience."[28] This distinction presumably alludes to Kant's distinction between the noumenon and the phenomenon. Elaborating on his first axiom, Nicloescu further claims there is a *discontinuity* in the structure of reality's levels because each level has its own specific set of laws. His guiding analogy in making this claim is the difference between classical and quantum laws.

Here it seems that a more cautious epistemic approach is required. First, it is necessary to differentiate between the laws of nature and the laws of science, the latter being our best conjectures with regard to the former. Nicolescu does not appear to have been particularly clear about this distinction. The fact that the laws we have discovered so far imply "discontinuity" at the level of phenomenal reality can, at most, allow us to *conjecturally* and not categorically posit "phenomenal discontinuity."

Having introduced his distinction between the "real" and "reality," Nicolsecu goes on to suggest that transdisciplinarity is "the possibility of knowledge [about reality] *beyond* disciplines."[29] In his bid to develop a new way of acquiring knowledge about reality, which, in his view, is not restricted by the boundaries of any particular discipline, Nicolescu moves to re-introduce the idea of unity between object and subject, an old idea upheld by mystics like Ibn Arabi and Eckhart,[30] idealist philosophers like Hegel,[31] and realist theosophists like Mulla Sadra.[32] They all believed that genuine knowledge of reality could only be achieved when such unification is achieved. Muslim philosophers have even coined a term for this "type of knowledge": *knowledge by presence*.[33]

But as critical rationalists have explained, such a state of unification is the result of a personal experience. This experience is only a temporary existential state, due to which the subject acquires some private non-propositional dispositions. However, these dispositions cannot be regarded as knowledge[34] because the subject, in the course of this unificatory experience, cannot, by definition, be aware of himself/herself, his/her status, and also his/her experience. Such an awareness can only be achieved through reconstructing the experience in question by means of language and concepts and through the use of memory. Such a reconstruction is not identical with the original experience, which is a pure existential state and not a representation of that state.[35] In other words, *knowledge by presence* is not knowledge at all. Removing the epistemic boundary between subject and object results not in a more accelerated growth of knowledge, but rather makes acquiring knowledge impos-

sible by reducing objective knowledge to the processes of personal, subjective experience.

Of course such subjective experiences, as the critical rationalists argue, are vital for enriching the subject's World 2 (i.e., his/her subjective world of cognition, emotion, and volition).[36] A rich World 2 can prepare the ground for producing fruitful conjectures as solutions to the problems/challenges that reality (i.e., World 1) introduces to the subject.[37]

Knowledge, as explained earlier, ought to be publicly accessible since it belongs to the objective (in the above sense) World 3.[38] World 3 is the abode of the thoughts that human beings have produced in response to their cognitive and non-cognitive needs and that have remained publicly accessible: scientific theories and knowledge claims, blueprints of technological machines and systems, stories, novels, music, melodies, movies, rules, conventions, and similar things.[39] Of course, an individual can have personal, subjective knowledge. But such knowledge should not be conflated with the processes of personal experience in which the subject is unified with the object. An individual's subjective knowledge can be presented to the public arena, since it is formulated in terms of concepts and language. Personal experience should also not be conflated with objective knowledge about reality, whose abode is not the subjective World 2 but the objective World 3.[40]

Nicolescu's suggestion concerning removing the boundary between object and subject, contrary to his intention, neither helps to introduce new spirituality into our knowledge-garnering pursuits nor to make progress with respect to acquiring knowledge about an objective reality. Instead, it leads to a debilitating idealism of the sort that had bedevilled Hegel's and the philosophies of other German idealist system-builders.[41]

In line with the main tenet of idealism, Nicloescu maintains that "physical objects cannot be thought of as existing apart from a thinking mind."[42] The above statement, of course, as Rasmussen[43] has argued, can mean two things. The first, which is endorsed by idealists, is that physical objects, or reality, somehow depend, for their very existence, upon a thinking mind. Nicloescu asserts that quantum mechanics has provided evidence that supports this position.[44] The other sense, which is endorsed by realist philosophers, is the commonsensical view that in order to think of physical objects or reality, a thinking mind is needed. In other words, realist philosophers make a distinction between the act of thinking and the object of thinking, whereas idealists believe that a thinking mind (whether of individuals or a supreme being) is causally (whether partially or wholly) responsible for bringing the physical reality into being.[45]

Niclosecu's second axiom needs particular attention. The way he has formulated it implies that he, like the early Wittgenstein and the logical positivist members of the Vienna Circle, views that reality itself as having a "logical structure." This logical structure apparently conforms to the axiom of the included middle, as defined by Niclosecu.

At least three important objections can be raised against Nicolescu's second axiom. First, the demise of logicism and the abortion of the logical positivists' program for logical reconstruction of reality, as well as Wittgenstein's repudiation of his assumption concerning the logical structure of reality in his later works, provide powerful counterexamples with regard to a conjecture or axiom that suggests a logical structure for reality.[46]

Second, it ought to be noted that logic is a tool devised to deal with the validity (or otherwise) of our arguments. Logic does not tell us anything about reality in a direct way. In this respect, it is even more general and abstract than mathematics. This was the main reason behind the (doomed) project of logicism, which had sought to reduce mathematics to logic.[47] While mathematical axioms (at least according to realist philosophers of mathematics) refer to some possible worlds and not all (e.g., the axioms of Euclidian geometry are not valid in a non-Euclidian world), logic is applicable to all possible worlds. In fact, as a formal tool it has got nothing to do with the contents of our arguments.

Third, the axiom of the included middle, which seems to be a restatement of Hegel's triad of "thesis, anti-thesis, and synthesis,"[48] suffers from a number of shortcomings. In the first place, the import of this axiom conflates logic (a pure formalistic tool) with metaphysics (which makes substantive claims about reality and beings). Moreover, in a strict logical sense, the acceptance of just one contradiction opens the floodgates for the acceptance of the most ludicrous claims.[49] Furthermore, it seems this principle, as far as garnering knowledge about reality is concerned, violates Ockham's advice: If we find inconsistencies in our thinking, we need not to ascribe it to reality. In the words of a philosopher of science and a philosopher of logic, "[m]ost thinking is through inconsistencies (problem solving); successful thinking eventually straightens the inconsistencies out."[50] Nicolescu's appeal to quantum mechanics as a way of "justifying" his introduction of the principle of the included middle does not seem to be of much help. As a philosopher of science who prefers to remain anonymous has observed,

> [the] idea that quantum mechanics shows that there are different contradictory levels of reality seems to me to be lazy thinking. Even on the most charitable interpretation, waves are not the contradictories of particles; waves and par-

> ticles are different aspects of reality that (perhaps) cannot be fully displayed at once. But this is an old story: the table that is made of wood and the table that is made of atoms also reveal different aspects of reality, but (except for those who want to be scandalous) they do not show that reality is contradictory. Plato identified the four elements with four of the five regular convex polyhedrals, and sought to explain the observable world in geometric terms. None of this licenses the introduction of the law of [the] included middle.[51]

Other aspects of his model also deserve close scrutiny. Like many contemporary philosophers of science, Nicolescu is against scientism.[52] However, while he is right to be concerned about the negative effects of the ideology of scientism on the growth of knowledge, he seems to be completely oblivious to the fact that his own faulty philosophical model is not only incapable of countering the danger of scientism, but also poses a threat to the growth of knowledge.

One of scientism's most influential forms was advocated by the members of the Vienna Circle. Nicolescu, as was argued above, shares some of the main tenets of a positivist philosophy of science, albeit unwittingly. Moreover, in his bid to break away from the shackles of scientism he makes a fatal move towards idealism by taking two mistaken steps: insisting upon removing the theoretical boundary between subject object, and unknowingly accepting the positivists' misguided conception of objectivity.[53] In passing, it must be noted that positivists, notwithstanding their emphasis on objectivity, were forced to embrace idealism or, even worse, solipsism.[54]

In criticising the views of those who regard the transdisciplinary approach as a method and not a methodology, Nicloescu asserts:

> This version of transdisciplinarity does not exclude the meaning "beyond disciplines" but reduces it to the interaction of disciplines with social constraints. The social field necessarily introduces a dimension "beyond disciplines," but the individual human being is conceived of as part of a social system only. *The spiritual dimension is therefore absent in this approach.* It is difficult for us to understand why "joint problem solving" must be the unique aim of transdisciplinarity. It is certainly one of the important aims but not the only aim. The use of such a narrow characterization seems to us dangerous, as in religion, allowing unnecessary wars and unproductive dogmatism.[55]

He does not explain how the spiritual dimension could be included in this approach. Critical rationalists argue that while the inquirers' spirituality must not interfere with the objectivity of their research, intellectual honesty and adherence to ethical norms are indispensable if the pursuit for knowledge is to be successful.[56] Moreover, they endorse Immanuel Kant's view that while

ethics does not need the support of religion or the sacred, it would, inevitably, lead to an appreciation of the sacred and a spiritual/religious (though not in the sense of established religions) aspects of reality.[57] Furthermore, they argue (as we have already seen) that while scientific findings ought to be as devoid as possible of the inquirers' values, technology is informed by its inventors'/users' values. A spiritually enlightened user of the transdisciplinary approach could use it in ways that are commensurate with his/her values.

It is not clear why Nicolescu thinks that "joint problem solving" would lead to dogmatism, as dogmatism stems from absolutist, utopic, exclusivist worldviews that leave scant room for pluralism and critical assessment. However, for a critical rationalist who maintains, on the one hand, that "all life is problem solving,"[58] and, on the other, emphasizes that our ignorance is boundless and yet it is not impossible for us to collectively move closer, by means of a critical assessment of our ideas, to a more truthful understanding of reality, a method (or a meta-method) that could improve our joint problem solving ability need not be regarded as a means for producing dogmatism.

Nicolescu seems to want to argue against relativists and post-modern philosophers.[59] But once again his own faulty philosophical approach betrays him and leads him to embrace theses that are relativist in tone and/or very similar to the way post-modern philosophers develop their own arguments. A case in point is how he makes use of Gödel's incompleteness theorem.

> This open structure of the unity of levels of Reality is in accord with one of the most important scientific results of the twentieth century concerning arithmetic, the theorem of Kurt Gödel, which states that a sufficiently rich system of axioms inevitably leads to results that are either undecidable or contradictory. … The Gödelian structure of levels of Reality implies the impossibility of a self-enclosed, complete theory. Knowledge is forever open.[60]

Gödel's theorem is a meta-logical theorem about formal axiomatic systems. Given that it does not say anything directly about physical reality, deducing any direct conclusion from it concerning the nature of reality amounts to a category mistake and the abuse of knowledge. The above quotation reminds one of the postmodern writers' inappropriate use of such scientific theories like morphogenetic or homology and differential topology in the social sciences and humanities. The American physicist Alan Sokal, in his *Intellectual Impostures*,[61] exposed and parodied the above approach. Ironically, Nicloescu is not unaware of Sokal's book and arguments.[62]

Due to space constraints, I must end my critical assessment of Nicolescu's philosophical views here. But before ending this section I would like to high-

light another serious weaknesses of his "philosophical system": his fondness of using "definitions" in lieu of arguments. He writes:

> Based upon our definition of levels of Reality, we can identify other levels than the ones in natural systems. For example, in social systems, we can speak about the individual level, the geographical and historical community level (family, nation), the cyber-space-time community level, and the planetary level.[63]

Alas this "system" of categorisation, far from serving as a guide to understanding reality, only reminds one of Jorge Luis Borges' famous "system of classification for animals," which a character in of one of his essays attributes to a certain Chinese encyclopaedia entitled the *Celestial Emporium of Benevolent Knowledge*.[64]

The Transdiciplinary Approach as a Meta-method

The confusion between methodology and method seems to be common in most of the methodology and research methods textbooks, many of which contain very little or no mention of the term and concept of *methodology* or use it interchangeably with *method*. Similarly, in many research proposals, PhD theses, and MA/MSc dissertations, authors discuss the methods they intend to use in the "Methodology" section. The following examples are self-explanatory. In his book *Research Methodology: A Step-by-Step Guide for Beginners*,[65] the author only mentions *methodology* five times (including on three title pages and one section heading). In fact, there is no discussion whatsoever of this concept except for the following paragraph in the preface:

> Research methodology is taught as a supporting subject in several ways in many academic disciplines such as health, education, psychology, … The core philosophical base for this work comes from my conviction that, although these disciplines vary in content, their broad approach to a research inquiry is similar. … It is true that some disciplines place greater emphasis on quantitative research, and some on qualitative research. My own approach to research is a combination of both. …[66]

The following quotation from another work is equally revealing:

> The proposal should also be very specific about methodology: the research participants you will study, what instruments or techniques you will use to study them, and how you will analyze the data collected. Finally, the proposal should answer the "so what" question: Assuming the study goes forward, how will the findings from this study make a difference to other researchers (basic research study) or practitioners in the field (applied re-

search study)? By the end of the proposal, the reader should have a clear idea of how the study will be conducted and why it is important.[67]

Such examples, unfortunately, can be multiplied many times. Few books on research methods make it clear that methods are mere tools or techniques for collecting data and information are, in and of themselves, blind and therefore need to be guided with regard to the data and information they collect. Methodologies, which are part of epistemologies, deal with issues such as the criteria for assessing the merit of competing theories and conjectures (including interpretations used to evaluate the data collected), evaluating the effectiveness of models of explanation, and guidelines concerning the choice of suitable methods for the type of research under consideration.[68]

As a technology, the transdisciplinary approach is a meta-method. The idea of meta-methods is familiar to all students of methodology. Meta-methods are used in cases where large amounts of various types of data from different fields are required. A case in point is research conducted in the field of Futures Studies. In the course of developing scenarios for various trends concerning specific phenomena, these researchers make use of two major meta-methods, namely, foresight and forecast, in order to collect the required data from a large number of experts who work in fields related to the phenomena in question. Under the general umbrella of these meta-methods, many more specific methods could be used.[69]

It seems that transdiciplinarity, in a similar way, could also be regarded as an all-covering umbrella under which various disciplines' methods could be used in the service of collective problem-solving in cases where "the problem" under consideration needs to be tackled from numerous angles and with the assistance of all types of experts working in different disciplines. Researchers in the subfields of a major transdiciplinary approach could use various methods and meta-methods, including interdisciplinary and multidisciplinary approaches. At the level of transdisciplinary research, all such approaches and data collected by methods/meta-methods are combined to produce a unified view of the problem at hand. The problem under consideration, of course, is a multi-faceted one and hence requires the concerted and coordinated efforts of practitioners from diverse fields.

As suggested earlier, there are many cases of actual real scientific research in which researchers have claimed that they have been able to apply the meta-method of transdiciplinarity to the problems being analyzed. In their review of transdisciplinary research in sustainability science (a survey of 236 transdisciplinary papers), Patric Brandt and his colleagues correctly concluded that:

> Transdisciplinary sustainability research utilizes a broad range of different methods for knowledge integration and production, and there is no clear set of tools required for different process phases or integration of different types of knowledge. Nevertheless, it may be helpful to develop a broad suite of accepted and (to some extent) standardized methodological tools. This may increase the efficiency, effectiveness and repeatability of transdisciplinary research in sustainability science and help to communicate its findings to both other scientists and the wider public.[70]

In view of what I have discussed so far, I suggest critical rationalism as an "all-encompassing methodological/philosophical" framework for the meta-method of transdisciplinarity. As a methodological framework and philosophical perspective, critical rationalism subscribes to and upholds the following theses, among others[71]: (1) All knowledge is conjectural, and yet it is not impossible to get closer to a true understanding of reality, whether natural or socially constructed; (2) We learn though our own mistakes and by reflecting upon the mistakes of others; (3) Confirmation and confirming evidence do not add one iota to our knowledge; it is through the process of refuting knowledge claims that we learn about reality; and (4) Knowledge advances in two complementary ways: *via negativa* and *via positiva*. The former pertains to what we learn from refutations of the conjectures made about reality: we learn that reality is not as these conjectures explain. The latter pertains to conjectures that, so far and despite our best and sincerest efforts to refute them, have proved resilient and remained corroborated. Such claims are regarded as our best provisional candidates for knowledge about reality. But such positive knowledge is and always remains provisional, since sooner or later even our best corroborated conjectures will be replaced by better ones that lack the defects found in the existing corroborated ones. No matter how accurate our conjectures are, they always fall short of fully capturing reality simply because reality is, as the critical rationalists explain, infinite and we are finite creatures with limited cognitive abilities.[72]

Critical rationalism also subscribes to the theses summarized in the following list: realism; the comprehensibility of reality; correspondence truth; epistemic pluralism; dialogue as a tool for assisting knowledge pursuits; rejection of all sorts of relativism, dogmatism, inductivism, justificationism, foundationalism, radical scepticism, and scientism; and intellectual honesty. For a comprehensive introduction to critical rationalism, one should consult the works of Karl Popper.[73]

The Transdiciplinary Approach: Some Lessons from the Muslim Experience

If the reader does not accuse me of anachronism, I would like to suggest the following conjecture: It seems that the spirit, although certainly not the term and strict structure, of the transdisciplinary approach, in the sense explained in the previous section, was to some extent not alien to Muslim scholars during Islamic civilization's "golden age" (eighth to thirteenth centuries).[74] In the modern era, as I shall explain, some modern Muslim scholars have apparently tried to apply this meta-method to a rather misguided project known as "The Islamization of Knowledge."

As far as the Muslim scholars of the golden age are concerned, I must emphasize, as suggested above, that they were not consciously aware of the status and significance given to this approach in our own time. They had a vague idea of the fact that systematic and organized intellectual collaboration among disciplines could facilitate and accelerate the growth of knowledge. Accordingly, some of them actually engaged in research that required them to move beyond the boundaries of specific disciplines. The result was the creation of a wealth of new and useful knowledge as well as the production of many new machines and incredible innovations that paved the way for the Renaissance.[75]

The first group to successfully apply "the transdisciplinary approach"[76] was the Ikhwan al-Safa (The Brethren of Purity), who are hailed as the initiators of "Humanism in the Renaissance of Islam."[77] They were also responsible for the first scholarly encyclopaedia in the intellectual history of Islam,[78] a collection of texts that appeared in the form of a series of epistles (*rasā'il*). They explained the work's structure in the first epistle:

> We have produced an epistle for each branch of … sciences and mentioned in them some of those meanings, and we have completed them with a general epistle to awaken the negligent and guide the beginners.
>
> Know, my brother, that there are three kinds of sciences with which people busy themselves, namely: the propaedeutic [that is, introductory] sciences, the sciences pertaining to revealed law and the sciences of true philosophy.
>
> The propaedeutic (sciences) are … of nine kinds: (1) writing and reading; (2) language and grammar; (3) calculation and operations; (4) poetry and prosody; (5) auguries and auspices, and the like; (6) magic, talismans, alchemy, mechanical devices and the like; (7) professions and crafts; (8) sale and purchase, trades, cultivation and breeding; (9) the study of campaigns and history.

> [R]eligious sciences … are of six kinds: (1) the science of revelation; (2) the science of interpretation (*ta'wīl*); (3) the science to do with transmissions and reports (from past religious authorities); (4) the science of jurisprudence, norms and laws; (5) the science relating to remembrance, exhortations, asceticism and mysticism; (6) the science of the interpretation of dreams.
>
> The philosophical sciences are of four kinds: (1) mathematical; (2) logical; (3) physical; (4) divine.[79]

In their fourth epistle, the Ikhwan clearly show that they favor an approach that is not far from the spirit of the transdisciplinary approach:

> Know this, my Brother: we are not opposed to any science, we do not to cling fanatically to any doctrine, and we do not keep ourselves away from any of the books that the sages and the philosophers have written or composed on the various sciences and the subtle meanings which they have extracted by their intellects and observations.[80]

Their openness to scientific and philosophical ideas, which was greatly encouraged by the Buyid (Buwayhid) dynasty, not only led them to introduce fascinating new visions, but also encouraged fellow-travellers to take bold and innovative steps toward developing new ideas and technologies.[81] An interesting case in point is the Persian astronomer Abu Said Sijzi (945-1020), "who spent some time at the Buwayhid court in Shiraz and assisted in 969/970 at the observations of the solstices … ."[82] One of his great achievements was the invention of a heliocentric astrolabe, a great conceptual leap for the time.[83] Abu Rayhan Biruini, another great Muslim scientist (of whom we talk more below), writes the following about this invention:

> I have seen a simple astrolabe – it did not contain a northern or southern section – made by Abu Sa'id al-Sijzi and called *al-zawraqi*. I liked it very much, for he had invented it by employing an independent theory, held by some people, stating that the apparent universal motion is due to the earth and not to the heavens. I earnestly believe that [such motion] is difficult to ascertain and analyse, and it should not concern those who depend on geometric lines, i.e. the engineers and the astronomers, for it does not invalidate their craft in any way. The natural philosophers, however, are the ones charged with the analysis of such problems and doctrines.[84]

The Samanid dynasty (819-999), another enlightened Persian dynasty that preceded the Buyid dynasty, tried to provide an environment for collaboration among scholars from different fields. This environment paved the way for a "transdisciplinary" collaboration. An interesting example that highlights these scholars' attitude is the critical exchanges that took place between Abu Rayhan

Biruni (Alberonius, 937-1048) and Ibn Sina (Avicenna, 980-1037) with regard to some of the intricacies of the accepted cosmology of the day.

Ibn Sina was, like his fellow Persian-learned colleague, was a polymath well-versed in many branches of sciences who sought to defend the received scientific paradigm in the face of Biruni's detailed challenges. These two predominant figures of the eleventh century discussed, at length, a number of important issues covering a wide range of cosmological and physical topics.[85] The technique of "Questions and Answers," as some scholars have argued, was used extensively in the Islamic intellectual tradition[86] and played an important role in promoting the spirit of the transdisciplinary approach. Their correspondence served as a model of scientific and scholarly exchanges among Muslim scholars during this period and further facilitated the trend toward lateral thinking and "transdisciplinary" interaction. The following excerpts from one of their exchanges vividly demonstrates the point made above about the presence of the transdisciplinary approach's spirit among Muslim scholars. Here, the narrator is Ibn Sina, who also formulates Biruni's question. The letter may have been written by one of Ibn Sina's close disciples, most probably Ma'sumi, who later on answered some of Biruni's other questions on behalf of his master.[87]

> *In the name of Allah the Most Merciful the Most Compassionate.* This letter is in response to the questions sent to him [i.e. Ibn Sina] by Abu Rayhan al-Biruni from Khawarazm. May Allah surround you with all you wish for, and may He grant you all you hope for and bestow on you the happiness in this life, and hereafter, and save you from all you dislike in both lives. You requested—may Allah prolong your safety—a clarification about matters some of which you consider worthy to be traced back to Aristotle, of which he spoke in his book, *al-Sama' wal-'alam*, and some of which you have found to be problematic. I began to explain and clarify these briefly and concisely, but some pressing matters inhibited me from elaborating on each topic as it deserves. Further, the sending of the response to you was delayed, awaiting al-Masumi's dispatch of letter to you. Now, I would restate your questions in your own words, and then follow each question with a brief answer.
>
> **The first question:** You asked—may Allah keep you happy—why Aristotle asserted that the heavenly bodies have neither levity nor gravity and why did he deny absence of motion from and to the center.[88]

Ibn Sina's response, as indicated above, is within that period's dominant peripatetic paradigm, to which Biruni also subscribed. But being more involved with astronomy and empirical sciences than Ibn Sina, he had his doubts about its complete validity.

> We can assume that since the heaven is among the heaviest bodies—and that is an assumption, not a certainty—it does not require a movement to the center because of a universal law that applies to all its parts judged as similar. If every part had a natural movement toward the center, and the parts were all connected, then it would result in a cessation (*wuqūf*) [of all motion] at the center. Likewise, we can assume that the heaven is among the lightest of all bodies, this would not necessitate (i) a movement from the center until its parts have separated and (ii) the existence of vacuum outside the heaven. And if the nonexistence of vacuum outside the heaven is an established fact, then the heaven will be a composite body like fire. [And you also say] that the circular movement of the heaven, though possible, might not be natural like the natural movement of the planets to the east [which] is countered by a necessary and forceful movement to the west. If it is said that this movement is not encountered because there is no contradiction between the circular movements and there is no dispute about their directions, then it is just deception and argument for the sake of argument, because it cannot be imagined that one thing has two natural movements, one to the east and one to the west. And this is nothing but a semantic dispute with agreement on the meaning, because you cannot name the movement toward the west as opposite of the movement to the east. And this is a given; even if we do not agree on the semantics, let us deal with the meaning.[89]

While the above examples were positive instances of Muslim scholars moving beyond the boundaries of known disciplines, my last example touches upon a negative case: the project of Islamization of Knowledge, which has been pursued by some Muslim scholars in Islamic and western countries since the late 1960s and early 1970s. Its promoters, who are critical of modern sciences and somewhat like Nicolescu, maintain that modern science has lost its link with spirituality, the sacred, and the divine. They claim that by using the resources found in Islamic culture and civilization, as well other spiritual cultures and devising new methods and methodologies that would overcome the present rigid boundaries between sciences, it would be possible to develop a new science that would greatly improve our ability to understand reality.

This project of Islamizing knowledge or producing sacred science has many representatives, the best known of whom are Ismail Faruqi (d. 1986), Seyyed Hossein Nasr, Seyyed Naqib Al-Attas, and Ziauddin Sardar.[90] But the snag with this particular project, whose advocates actually promote a transdiciplinary approach not dissimilar to what Nicolescu suggests, is that their research project is misguided.[91] For example, Sardar has produced a lengthy table (partially reproduced below), in which he contrasts the differences between his own model of "Islamic science" and what he maintains to be "modern science."[92]

Table 2. Western Science vs. Islamic Science

Western Science	Islamic Science
Puts its faith in rationality	Places its faith in revelation
Values science for the sake of science	Sees science as a form of worship that has a spiritual and a moral function
Posits one all-powerful method as the only way of knowing reality	Uses many methods based on reason as well as revelation
Claims impartiality – to be value free; a scientist is not responsible for the use to which his/her work is put	Claims partiality – towards the truth; consequences must be morally good
Claims the absence of bias	Admits the presence of subjectivity
Reduces the world to what can be empirically verified	Admits the reality of the spiritual dimension
Is fragmented into disciplines	Values synthesis, is multidisciplinary but holistic in its approach

The above table, as I have argued elsewhere,[93] suffices to show the fallacy of category mistake committed by this project's advocates.

> For example the claim that the so-called Islamic science "places its faith in revelation" tells nothing substantive or worthwhile. On one reading, i.e., if it is taken to mean that Islamic science accepts apparent meaning of revelation in a blind manner, it can promote a dangerous epistemic attitude. On another reading, i.e., if it is taken to mean that it accepts revelation, as a potential source of knowledge, then it says nothing special. The reason is that when a researcher uses revelation or any other potential source of knowledge, for that matter, he/she must interpret it. Interpretations are, inevitably, conjectures made by fallible human beings. As such they cannot be perfect representations of reality. Their shortcomings must be disclosed in the public arena and through critical assessments. But this is exactly what modern science does with all potential sources of knowledge, including revelation.[94]
>
> The claim that Islamic science "sees science as a form of worship which has a spiritual and a moral function" betrays other types of confusions. Worship, as explained above, is a form of technology. It assists the believer in his/her pursuit of knowing the Master of the realm of being. But worship, like all other technologies, does not provide us with knowledge. Moreover, as crit-

> ical rationalists argue, science/knowledge and morality go hand in hand. In the absence of a moral attitude the chances of improving our knowledge about reality are drastically reduced.[95]

Conclusion

In his recent *An Inquiry into Modes of Existence*, French anthropologist Bruno Latour narrates the story of a French anthropologist who has become frustrated with the way modern anthropologists put others into neat boxes and subject them to research according to the canons of modern sciences. She decides to apply her knowledge to an analysis of western society itself. In the course of her research, when she asks her subjects about their view of modern society,

> [t]hey explain that with the end of the age of theocracy, collective life has become rationalized, professionalized and secularized, resolving itself into a set of separate "domains" such as law, economics, politics, and of course science, which trumps all the others.[96]

Latour, through the champion of his book, argues that the doctrine of separate "domains" is nothing but a self-serving delusion.[97] The snag with Latour's diagnosis is that in his bid to uphold his social-constructivist approach, he forgets the fact that socially constructed realities, notwithstanding their dependence on our collective intentionalities, have power and to a large extent are independent of us, whether individually or collectively.[98]

Boundaries of knowledge, like all other boundaries, are imposed by us upon reality. But such boundaries, despite being man-made, are our best conjectures to help us, as it were, "carve reality at its joints." These conjectures, like all our other conjectures, will be replaced as soon as new refuting evidence is found. But until such evidence appears, we are rationally entitled to regard our existing best corroborated conjectures as our best guides to reality.

Latour and other like-minded researchers who are dissatisfied with the present boundaries should take a leaf from the work of another French scholar who also happened to be dissatisfied with the knowledge-claims of modern science and wanted to make room for religious beliefs: Pierre Duhem (d. 1916). This scholar did his best to develop an instrumentalistic interpretation of modern science. However, interestingly enough, in his endeavor to reject the veracity of scientific claims he came to the conclusion that while a physical theory should be regarded as an instrument, nevertheless it "is not merely an artificial system, suitable today and useless tomorrow, but … an increasingly more natural classification and an increasingly clearer reflection of realities which experimental method cannot contemplate directly."[99]

Present-day scientific disciplines are our best classifications, to date, for moving closer to reality. Although they are not written in stone, they cannot be changed according to the whims of this or that group. The transdisciplinary approach can serve scholars in various fields to better appreciate the limitations of their disciplines and encourage them to dialogue with fellow researchers working in other fields. This would increase the degree of epistemic pluralism in our own cultural/knowledge environment. The combination of this pluralism plus a critical rational attitude toward knowledge claims would, it is hoped, provide us with our best chance of improving our knowledge.

Endnotes

1. Basarab Nicolescu, "Transdisciplinarity as a Methodological Framework for Going beyond the Science-Religion Debate," *Transdisciplinarity in Science and Religion* 2 (2007): 35-60, 1.
2. David Cassinari, et. al. "Transdisciplinary Research in Social Polis," 2008, available at http://public.citymined.org/Transdisciplinarity_print.pdf; B. A. Pescosolido, et al., "Under the Influence of Genetics: How Transdisciplinarity Leads Us to Rethink Social Pathways to Illness," *American Journal of Sociology* 114, no. S1 (2008): S171-S201; Andrea Aeberhard and Stephan Rist, "Transdisciplinary Co-production of Knowledge in the Development of Organic Agriculture in Switzerland," *Ecological Economics* 68 (2009): 1171-81.
3. I briefly discuss some of critical rationalism main tenets' in section 3. For further information on critical rationalism, see Karl Popper, *Objective Knowledge* (Oxford: Oxford University Press, 1979); Karl Popper, *The Myth of the Framework* (London: Routledge, 1994); David Miller, *Critical Rationalism: A Restatement and a Defence* (Chicago and La Salle: Open Court, 1994); David Miller, *Out of Error* (Aldershot: Ashgate, 2006).
4. This section partially draws on two of my papers: "How Indigenous are 'Indigenous Sciences'? The Case of 'Islamic Sciences,'" in *Asia-Europe Dialogue and the Making of Modern Science: Implications for History, Philosophy, and Sociology of Knowledge*, ed. Arun Bala, (147-66) (New York: Palgrave, 2011) and "Faqih as an Engineer: A Critical Assessment of the Epistemological Status of Fiqh," *Journal of Law and Religion* (2015) (forthcoming).
5. Ali Paya, "The Misguided Conception of Objectivity in Humanities and Social Sciences," in *The Crisis of the Human Sciences: False Objectivity and the Decline of Creativity*, ed. Thorsten Botz-Bornstein (151-84) (Kuwait: Gulf University for Science & Technology Publications, 2011).
6. Popper, *Objective Knowledge*; Karl Popper, *The Open Society and Its Enemies* (London: Routledge, 1945/1962); Karl Popper, *The Logic of Scientific Discovery* (London: Routledge, 1959/2002); Karl Popper, *Conjectures and Refutations* (London: Routledge, 1963/2002); Miller, *Critical Rationalism*; Miller, *Out of Error*.

7. Popper, *Conjectures and Refutations*; Ali Paya, *Analytic Philosophy: Problems and Prospects*, rev. ed. (Tehran: Tarh-e Nou, 2015).
8. Paya, "Misguided Conception."
9. Joseph Agassi, *Technology: Philosophical and Social Aspects* (Dordrecht: Reidel, 1985).
10. Martin Heidegger, "The Question Concerning Technology," *Basic Writings* (London: Harper Collins Publishers, 1993).
11. Ludwig Wittgenstein, *Philosophical Investigations*, II. xi (Oxford: Wiley-Blackwell, 2009), 193-229, especially p. 204e.
12. Miller, David, "Putting Science to Work," lecture presented at a number of academic centres in 2006 and 2013. One version of the paper (December 2009) was kindly provided by the author; Karl Popper, *The Poverty of Historicism* (London: Routledge Paul, 1957/2002).
13. Miller, *Out of Error*; Paya, *Analytic Philosophy*; Paya, "How Indigenous Are 'Indigenous Sciences'?"
14. Paya, "How Indigenous Are 'Indigenous Sciences'?"; Nicholas Maxwell, "The Need for a Revolution in the Philosophy of Science," *Journal for General Philosophy of Science* 33 (2002): 381-408.
15. Michael Gibbons, et. al., eds., *The New Production of Knowledge* (London: Sage Publications, 1994).
16. Nicolescu, "Transdisciplinarity as a Methodological Framework," 39; Basarab Nicolescu, "Methodology of Transdisciplinarity: Levels of Reality, Logic of the Included Middle and Complexity," *Transdisciplinary Journal of Engineering & Science* 1, no. 1 (2010): 19-38, 26.
17. Nicolescu, "Transdisciplinarity as a Methodological Framework," 40; Nicolescu, "Methodology of Transdisciplinarity," 23.
18. Nicolescu, "Transdisciplinarity as a Methodological Framework," 40.
19. Ibid.
20. Nicolescu, "Transdisciplinarity as a Methodological Framework"; Basarsab Nicolescu, "Methodology of Transdisciplinarity"; "The Latest on the Sokal Affair: Beyond Three Extremisms." Comments on Alan Sokal, Pseudosciences et postmodernisme: Adversaires ou compagnons de route?" *Transdisciplinarity in Science and Religion* 1 (2007): 228-32.
21. Nicolescu, "Transdisciplinarity as a Methodological Framework," 41-42.
22. Popper, *Conjectures*, chap. 1.
23. In compliance with a set of constructive advice suggested by an anonymous referee of this journal, I provide a brief explanation of terms that may not be familiar to some readers. *Induction* is used both a method of inference: it comes to generalization (a general statement) from a limited number of facts, data, and observations about particular things, events, and processes. It is also used a method for generating hypotheses based on examining limited samples. *Abduction* is another method of inference used to generate hypothesis. Upon the examination of a particular event, it (allegedly) helps investigators discover its cause. See Popper, *The Logic of Scientific Discovery: Miller, Critical Rationalism*; Miller,

Out of Error; Norwood Hanson, *Patterns of Discovery* (Cambridge: Cambridge University Press: 1958).

24. Karl Popper, *Unended Quest* (London: Routledge, 1974/2002).
25. Nicolescu, "Transdisciplinarity as a Methodological Framework," 42.
26. Nicolescu, "Methodology of Transdisciplinarity," 29, emphasis added.
27. Isaac Ben-Israel, "Philosophy and Methodology of Intelligence: The Logic of Estimate Process," *Intelligence & National Security* 4, no. 4 (1989): 660-718, 684-86.
28. Nicolescu, "Transdisciplinarity as a Methodological Framework," 43.
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30. Reza Shah Kazemi, *Path to Transcendence: According to Shankara, Ibn Arabi, and Meister Eckhart* (Bloomington: World Wisdom, 2006).
31. Jonael Schickler, *Metaphysics as Christology: An Odyssey of the Self from Kant and Hegel to Steiner* (Aldershot: Ashgate, 2005).
32. Seyyed Hossein Nasr, "Sadruddin Shirazi (Mulla Sadra)," in *A History of Muslim Philosophy*, ed. M. M. Sharif (Weisbaden: Otto Harrassowitz, 1963): 932-61.
33. Haeri Yazdi, *The Principles of Epistemology in Islamic Philosophy: Knowledge by Presence* (Tehran: Academy of Philosophy, 1992).
34. Karl Popper, *The Open Society*; Paya, *Analytic Philosophy*; Paya, "How Indigenous are 'Indigenous Sciences'?"; Paya, "Faqih as an Engineer."
35. Paya, *Analytic Philosophy*.
36. Popper, *Objective Knowledge*.
37. Ibid.
38. Ibid.
39. Ibid.
40. Ibid.
41. Popper, *The Open Society*; Roger Trigg, *Reality at Risk* (Brighton: Harvester Press, 1980); Douglas Rassmusen, "Review of The Reality at Risk," *Reason Papers* 9 (1983): 85-90.
42. Rassmusen, "Review of *The Reality at Risk*," 85.
43. Ibid.
44. Nicolescu, "Transdisciplinarity as a Methodological Framework"; Nicolescu, "Methodology of Transdisciplinarity."
45. Rassmusen, "Review of *The Reality at Risk*."
46. Ludwig Wittgenstein, *Tractatus Logico-Philosophicus* (London: Routledge, 1922/1981); Rudolf Carnap, *The Logical Structure of the World* (California: University of California Press, 1928/1967); Paul Benacerraf, "Frege: The Last Logicist," *Midwest Studies in Philosophy* 6, no. 1 (1981): 17-35.
47. Hans Sluga, *Gottlob Frege* (London and Boston: Routledge and Kegan Paul, 1980).
48. Nicolescu define his axiom of "included middle" in the following way: "To obtain a clear image of the meaning of the included middle, let us represent the three terms of the new logic — A, non-A, and T — and the dynamics associated with them by a triangle in which one of the vertices is situated at one level of

Reality and the two other vertices at another level of Reality … . The included middle is in fact an included third. If one remains at a single level of Reality, all manifestation appears as a struggle between two contradictory elements. The third dynamic, that of the T-state, is exercised at another level of Reality, where that which appears to be disunited is in fact united, and that which appears contradictory is perceived as non-contradictory." Nicolescu, "Transdisciplinarity as a Methodological Framework," 50.

49. Popper, *Conjectures and Refutations*, ch. 15.
50. Miller, *Out of Error*, 236.
51. Private correspondence with the author.
52. Scientism is a "pejorative term for the belief that the methods of natural science, or the categories and things recognized in natural science, form the only proper elements in any philosophical or other enquiry." Simon Blackburn, *The Oxford Dictionary of Philosophy* (Oxford: Oxford University Press, 344). Nicolescu, "Transdisciplinarity as a Methodological Framework," 37; Nicolescu, "Methodology of Transdisciplinarity," 21.
53. Paya, "Misguided Conception."
54. "Solipsism: The belief that only oneself and one,s experience exists." Blackburn, *The Oxford Dictionary of Philosophy*, 430; Friedrich Stadler (ed.), *The Vienna Circle and Logical Empiricism: Re-evaluation and Future Perspectives* (Alphen aan den Rijn: Kluwer 2003).
55. Nicolescu, "Methodology of Transdisciplinarity," 23.
56. Mariano Artigas, *The Ethical Nature of Karl Popper's Theory of Knowledge* (Berne: Peter Lang Publishing, 1999); Zuzana Parusniková and Robert Sonné Cohen, *Rethinking Popper* (Berlin: Springer, 2009).
57. Immanuel Kant, *Religion within the Boundaries of Mere Reason*, ed. Allen Wood et al. (Cambridge: Cambridge University Press, 1998).
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60. Nicolescu, "Transdisciplinarity as a Methodological Framework," 31.
61. Alan Sokal and Jean Bricmont, *Intellectual Impostures* (Hatton Gardens: Profile Books Ltd., 1998).
62. Basarab Nicolescu, "The Latest on the Sokal Affair," 228-32.
63. Nicolescu, "Methodology of Transdisciplinarity," 27.
64. Jorje Luis Borges, "The Analytical Language of John Wilkins," *Other Inquisitions* 1937-1952 (New York: Washington Square Press, 1964).
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66. Ibid., xvii.
67. Scott VanderStoep and Deirdre Johnston, *Research Methods for Everyday Life: Blending Qualitative and Quantitative Approaches* (San Francisco: Jossey-Bass, 2009): 10.
68. Carlos Verdugo, "Popper's Thesis of the Unity of Scientific Method: Method Versus Techniques," in Zuzana and Cohen, *Rethinking Popper*, 155-60; Robert

Nola and Howard Sankey, *Theories of Scientific Method* (Stocksfield Hall: Acumen, 2007).

69. P. Assakul "Futures Studies Methods," (2003), available at: www.cgee.org.br/atividades/redirKori/565; Theodor Gordon and Jerome C. Glenn, Futures Research Methodology – V2.0 (Washington: AC/UNU Millennium Project, 2003).
70. Brandt Patric, et al., "A Review of Transdisciplinary Research in Sustainability Science," *Ecological Economics* 92 (2013): 1-15.
71. This is based on my "How to Promote 'Modern Critical Thinking' in the Context of Islamic Studies in the Virtual Environment?" in *The Proceedings of the E-Learning and Islamic Studies: An International Conference*, London, 24 May 2014. The proceedings of the conference will be published by the ICAS Press, 2015.
72. Ben-Israel, "Philosophy and Methodology"; Sokal and Bricmont, *Intellectual Impostures*.
73. Popper, *Objective Knowledge*; Popper, *The Myth of the Framework*; Popper, *Conjectures and Refutations*; Miller, *Critical Rationalism*; Miller, *Out of Error*.
74. Seyyed Hossein Nasr, *Science and Civilization in Islam* (Chicago: ABC International Group, 2007).
75. Seyyed Hossein Nasr, *An Introduction to Islamic Cosmological Doctrines* (New York: State University of New York Press, 1993); Nasr, *Science and Civilization*; George Saliba, *Islamic Science and the Making of the European Renaissance* (Cambridge, MA: Massachusetts Institute of Technology Press, 2011); Ahmad Hassan and Donald Hill, *Islamic Technology: An Illustrated History* (Cambridge: Cambridge University Press, 1992).
76. In view of the above qualification, whenever I refer to the use of Muslim scholars of the classic period of the transdisciplinary approach I place this phrase in inverted commas.
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78. Richard Netton, *Muslim Neoplatonists: An Introduction to the Thought of the Brethren of Purity* (London: Routledge, 2002).
79. *Rasa'il Ikhwan al-Safa'*, I:274, 266-67, quoted in Godefroid de Callataÿ, *Ikhwan al-Safa* (Oxford: Oneworld Publications, 2005): 59-61.
80. *Rasa'il Ikhwan al-Safa'*, IV:167, quoted in de Callataÿ, *Ikhwan al-Safa*, 73.
81. Netton, *Muslim Neoplatonists*.
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83. Nasr, *An Introduction to Islamic Cosmological Doctrines*.
84. Quoted in M. J. I. Young, et al. (eds.), *Religion, Learning, and Science in the 'Abbasid Period* (Cambridge: Cambridge University Press), 1990.
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88. Ibid.
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92. Paya, "Muslims and Modernity," 557.
93. Ibid.
94. Ibid.
95. Ibid., 557-58.
96. Jonathan Ree, "From Straight Talk to Speaking Well," *TLS*, January 10 (2014): 7-8, 7.
97. Ibid.; Bruno Latour, *An Inquiry into Modes of Existence* (Cambridge, MA: Harvard University Press, 2013).
98. John Searle, *The Construction of Social Reality* (London: Penguin, 1996).
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