

From Misconceptions to Constructed Understanding
The Fourth International Seminar on Misconceptions Research
(1997)

Article Title: Science Education and HConstructivism

Author: Ellett, Frederick S. Jr.; Allison, Derek J. & Ericson, David P.

Abstract: In his recent article in *Educational Researcher*, "The Good, the Bad, and the Ugly: The Many Faces of Constructivism," D.C. Phillips sets out to provide a clear understanding of *the range of various positions* involving "constructivism." According to Phillips, there is a very broad and loose sense in which all of us these days are constructivists. In Part I, we present Phillips' "way of the viewing the various forms of constructivism"; we consider Phillips' framework for comparing the constructivisms. We will argue that it is important that Phillips finds *Karl Popper* to be situated at about the middle of the constructivists.

In Part II, we argue that Phillips *has not presented* a full array of the significant possibilities at all. In developing the argument, we develop a framework that primarily takes into account the *interrelations* among epistemology, ontology, and (theories of) truth. We defend a form of constructivism in which "realism and idealism come together". We also suggest that these matters are themselves related to theories of the person. To illustrate a broader framework, we present some of the features of a Hconstructivist view and then critically compare Hconstructivism with the Popperian viewpoint.

In Part III, we use the Hconstructivist view to consider some of the important educational issues for the specialist in science and for the general student.

Keywords: science, epistemology, constructivism (ontic), realism

General School Subject: science

Specific School Subject: physics

Students: primary, secondary, college

Macintosh File Name: Ellett-Hconstructivism

Release Date: 10-2-97 A, 12-3-97 C

Editor: Abrams, Robert

Publisher: The Meaningful Learning Research Group

Publisher Location: Santa Cruz, CA

Volume Name: The Proceedings of the Fourth International Misconceptions Seminar - From Misconceptions to Constructed Understanding

Publication Year: 1997

Conference Date: June 13-15, 1997

Contact Information (correct as of 12-23-2010):

Web: www.mlrg.org

Email: info@mlrg.org

Note Bene: This Proceedings represents the dedicated work of many authors. Please remember to use proper citation when referring to work in this collection. The electronic publication of this collection does not change the respect due the authors and their work. This collection is made possible by the efforts of the conference organizers at Cornell University, and the members of the Meaningful Learning Research Group. This publication is copyright Meaningful Learning Research Group 1997. The transformation of this collection into a modern format was supported by the Novak-Golton Fund, which is administered by the Department of Education at Cornell University. If you have found this collection to be of value in your work, consider supporting our ability to support you by purchasing a subscription to the collection or joining the Meaningful Learning Research Group.

“Science Education and HConstructivism”

Frederick S. Ellett, Jr.
Faculty of Education
University of Western Ontario
London, Ontario N6G 1G7
Canada
(519) 661-2087
Fax: 519 - 661 - 3833
e-mail: ellett@edu.uwo.ca

Derek J. Allison
Faculty of Education
University of Western Ontario
London, Ontario N6G 1G7
Canada

David P. Ericson
College of Education
University of Hawaii at Manoa
Honolulu, Hawaii, 96822
USA

Paper Presented at the Conference

From Misconceptions to Constructed Understanding

Cornell University
School of Education
Ithaca, New York
June 13-15, 1997

Descriptors: science: epistemology, constructivism (ontic), realism

“Science Education and Hconstructivism”

F. S. Ellett, Jr., D. J. Allison, University of Western Ontario, Canada
& D. P. Ericson, University of Hawaii at Manoa, USA

Completion date: July 23, 1997

Abstract

In his recent article in *Educational Researcher*, “The Good, the Bad, and the Ugly: The Many Faces of Constructivism,” D.C. Phillips sets out to provide a clear understanding of *the range of various positions* involving “constructivism.” According to Phillips, there is a very broad and loose sense in which all of us these days are constructivists. In Part I, we present Phillips’ “way of the viewing the various forms of constructivism”; we consider Phillips’ framework for comparing the constructivisms. We will argue that it is important that Phillips finds *Karl Popper* to be situated at about the middle of the constructivists.

In Part II, we argue that Phillips *has not presented* a full array of the significant possibilities at all. In developing the argument, we develop a framework that primarily takes into account the *interrelations* among epistemology, ontology, and (theories of) truth. We defend a form of constructivism in which “realism and idealism come together”. We also suggest that these matters are themselves related to theories of the person. To illustrate a broader framework, we present some of the features of a Hconstructivist view and then critically compare Hconstructivism with the Popperian viewpoint.

In Part III, we use the Hconstructivist view to consider some of the important educational issues for the specialist in science and for the general student.

Descriptors: science: epistemology, constructivism (ontic), realism

“Science Education and Hconstructivism”

F. S. Ellett, Jr., D. J. Allison, University of Western Ontario, Canada
& D. P. Ericson, University of Hawaii at Manoa, USA

Completion date: July 23, 1997

“What has to be accepted, the given, is -- so one could say -- forms of *life*”
-- Wittgenstein

Introduction: Are We All Now ‘Constructivists?’

Sometimes it seems to be a widely held belief that “now we are all constructivists.” We believe, however, that it is far from clear what this shared belief even *means*. One noted researcher, Nel Noddings, has written that

“Constructivism is, logically, a post-epistemological position. The standard questions of epistemology cannot be answered -- or even reasonably asked -- from this perspective. Its premises suggest, rather, abandonment of traditional epistemological language.”¹

But in response to Michael R. Matthews in 1992, D. C. Phillips had this to say:

“Nel Noddings is ... far too nice a person; her labelling of constructivism as a post-epistemological position implies that the constructivists have understood traditional epistemology so thoroughly that they are able to go beyond it! My own interpretation is less charitable, while not regarding them as complete chumps, I accuse them of being philosophical amateurs who have become excited by some psychological and pedagogical ideas that are worth getting excited about, but who have been dangerously cavalier and sophomoric with respect to what they infer from these ideas.”²

Although Phillips was harsh with Noddings, his response to M. Matthews³ was rather mild mannered. Phillips’s response failed to mention the following. First, Matthews’ critique of constructivisms did not mention either Kant or the post-Kantians.⁴ Second, Matthews inexplicably failed to consider the senses in which “most constructivists are realists;” he failed to elaborate and classify the possible forms. Matthews’ critique focused

totally on the ‘strong-idealist’ forms. Matthews did, however, *suggest* that many constructivists suffer because they continue to follow the “empirical-Aristotelean paradigm.” Here we think Matthews had (almost) achieved a deep and important insight.⁵ We will try to draw it out and explain its significance.

Again, there seems to be much confusion about the nature of ‘constructivism.’ In their widely cited book *Higher Superstition: The Academic Left and Its Quarrels With Science*, Gross and Levitt regard “cultural constructivism,” in the ‘strong form,’ as a kind of *skepticism* about science.⁶ And though they do a good job in rooting out the most extreme forms of ‘constructivism,’ they seem to be totally unaware of the basic issues and concerns which motivate the more ‘plausible’ forms of ‘constructivism.’ Their book just does not present the full range of important forms of ‘constructivism.’

Thus, one might have been pleased to find D. C. Phillips’s recent article, which appeared in the *Educational Researcher*, “The Good, the Bad, and the Ugly: The Many Faces of Constructivism.” In the article, Phillips⁷ claimed to have provided the reader with a *clear understanding of the range* of various positions involving constructivism.⁸ In Part I, we present Phillips’ *way* of viewing the various forms of constructivism;⁹ we present his framework for comparing the constructivisms.¹⁰ According to Phillips, there is a very broad and loose sense in which *all of us* these days are constructivists.¹¹ We will argue that it is *quite important* that Phillips finds that *Karl Popper* is situated at about *the middle* of the (second and major) continuum.¹² In Part II, we will argue that Phillips has not, after all, presented many of the prominent “constructivist” possibilities. In developing the argument, we develop a framework that primarily takes into account the *interrelations* among epistemology, ontology, and (theories of) truth. We defend a constructivism in which ‘realism and idealism come together’. We also argue that these matters are themselves related to theories of the person or epistemic agent. To illustrate a broader framework, we present some of the features of a Hconstructivist view and then critically compare Hconstructivism with the Popperian viewpoint.

In Part III, we will consider some of the educational issues arising from the *Hconstructivist* viewpoint for the specialist in science and for the general student.

I. Phillip's Way of Viewing the Various Forms of Constructivism

We believe it would be helpful to provide a rough but serviceable, global view of the field. Figure 1 shows the classical rationalists (to the far left), the enlightenment thinkers (to the top of the centre), and some the major contemporary thinkers (to the lower-right). Figure 2 enlarges the lower, right-hand section of figure; it shows that what are now called “naturalistic views” (sometimes called “pragmatic” views) divide into two major groups: those who hold that epistemology can be “naturalized” (ala Quine) and those who think that it cannot be so “naturalized.” (Perhaps in the discussion we can talk more about these general orientations). At any rate, Figures 1 and 2 suggest that epistemology is in some sense “naturalistic.” All forms of Transcendental and *apriori* approaches are now very much on the defensive.

We can now situate D. C. Phillips (and Popper) into these general orientations. Popper was, of course, one of the first critics of the central themes of logical empiricism. We have shown Popper's relative-position in Figure 1. We believe that it can be shown that Popper strongly opposed the type of Quinean approach to epistemology (which ‘reduces’ it to psychology). In general, Phillips adheres to Popper's central themes; so, he too should be opposed to “naturalized epistemology.”¹³ If these remarks are sound, then one might expect Popper and Phillips to fit into the lower right side of Figure 2. But as we will argue, Popper's “modified essentialism” does not fit into a strong “constructivistic” view.

Near the beginning of the *Educational Researcher* article, Phillips claims that “there is a very broad and loose sense in which all of us these days are constructivists.”¹⁴ As Phillips puts it, most people do not believe that individuals (and thereby groups) come into the world with their “cognitive data banks” already pre-stocked with empirical knowledge, or with pre-embedded epistemological criteria or methodological rules. We, too, think that most now agree that the basic concepts and criteria are not *apriori* and that in the scientific domain humans begin from a position of relative ignorance. Somehow or other, it appears that our knowledge is in

some sense evolving. Furthermore, we believe Phillips is correct when he says that most do not believe that “most of our knowledge is acquired, ready-formed, by some sort of direct perception or absorption.”¹⁵ We might call these claims the *negative* thesis of constructivism. It is, of course, helpful to know what a group of thinkers opposes. (Phillips does, of course, go on to develop a *positive* characterization). Here, at any rate, it can be seen that the following can be constructed: ‘knowledge,’ ‘concepts,’ ‘criteria,’ and ‘rules.’¹⁶

D. C. Phillips repeatedly warns his readers that the various forms of constructivism are complex views which are not “single issue” positions because they address a number of deep problems.¹⁷ Still, Phillips holds that it is possible that the various form of constructivism can be spread out along *three different dimensions* (or continua or axes). Each of these dimensions, it seems, represents one key issue. Phillips says that forms of constructivism that are close together on one issue (or dimension) may be quite far apart on another dimension.¹⁸

The *first* dimension can be given the label “individual psychology versus public discipline.”¹⁹ According to Phillips, some constructivists, for example, Piaget and Vygotsky, have been primarily concerned with how the *individual* learner (or inquirer) goes about the construction of knowledge in his or he own cognitive apparatus. On the other hand, other constructivists have been primarily concerned with how human *communities* (or groups) have constructed public bodies of knowledge known as the various disciplines.²⁰ In other words, this first dimension is concerned with the “*site* of the constructed.”²¹

The *second* dimension is the one Phillips’ thinks is really the “most crucial one”; it is the dimension “that, in essence, allows one to define a thinker as being a constructivist.” This dimension (or continuum) can be characterized crudely by the label “humans the creators versus nature the instructor.” (See Figure 3.) As Phillips puts it:

The issues is as follows: When knowledge [say] is constructed (whether in the mind or cognitive apparatus of the individual learner, or whether it is a public discipline), is the process one that is influenced chiefly by the minds or creative intelligence of the knower or knowers, together perhaps with the “sociopolitical” factors that are present when knowers interact in a community? Or, at the other

extreme, is the knowledge “imposed” from the outside; does nature serve as an “instructor” or as a sort of template that the knowing subjects or subjects (or community of knowledge builders) merely copy or absorb in a relatively passive fashion? In short, is new knowledge - whether it be individual knowledge, or public discipline - *made* or *discovered*?²²

The *third* dimension was, in a way, touched upon earlier: the construction of knowledge [say] is an *active* process, but the activity can be described in terms of individual cognition or else in terms of social and political process (activities) (or, of course, in terms of both).²³ For Phillips, the activity can either be physical or mental, or again, both. But if the “process” were “carried out automatically, by following some predetermined inflexible routine or some mechanical process,” then the process would *not* count as constructivist.²⁴ Thus, even though the early empiricist John Locke allows the *complex* ideas of the mind to be built up from the *simple* sensory impressions of ideas, this process of building up the complex is “too automatic” - it is not clear that it is a conscious or deliberate activity of the knower - for Locke to be regarded as being within the general constructivist camp. (See Phillips’s *Figure 3* for a representation of the second dimension. Notice that Phillips places John Locke close to the far left end of the second dimension (or axis)). It is important that Phillips claims that Popper is situated at about the middle of the “humans the creators versus nature the instructor” dimension.

It is, perhaps, surprising that Phillips did not give an example of a constructed “epistemological criteria or methodological rule.” We believe the following will do nicely. It should be well known that C. S. Peirce, J. Dewey, and I. Scheffler have argued that the concept of ‘probability’ has come to play an ever increasing role in scientific thinking (as well as in everyday activities). But this concept was *not innate*; it was largely *created* (in its present form) in the early 1600’s and developed more fully in this century by scientists and mathematicians.²⁵ It is, of course, not without its own problems. But it still seems to be playing an important role in inquiry. Now Popperians do not regard it as centrally related to theory “testing” in the widest sense, for they hold that the most probable theory is likely to be

the *simplest*. Popperians hold that good science should develop and test (by means of falsification) theories that are *rich in content* so that our understanding of the world is deepened. But the Popperian has no need to deny the other ways in which ‘probability’ is a useful term. At any rate, the concept of ‘probability’ is plausibly taken to be *constructed*.

Given this way of viewing the various constructivisms, one can see why Phillips might plausibly claim that Popper is a philosopher who is situated about in the middle of the dimension-two continuum. According to Phillips, Popper’s theory of the growth of public bodies of knowledge can be roughly summarized as “man proposes, nature disposes.” For Popperians, a tentative theory is a creation of human intellect. And here, Popperians claim there is no logic of discovery just to allow for pluralistic and wide ranging inventiveness. The logic of justification (i.e., testing by means of falsification) pertains to the error elimination done by nature.²⁶

Part II: A Broader Way of Organizing Constructivisms

In his section on “the range of constructivist authors,” Phillips presented I. Kant as the *second*, noteworthy constructivist author.²⁷ Indeed, one should agree that Kant is a *paradigm* case of a constructivist! Here is what Phillips said about Kant:

[For Kant] [t]he cognitive apparatus (in particular our “category-governed modes of synthesis” in the case of natural science, as one commentator put it) was responsible for *shaping our experience*, and giving *it* causal, temporal, and spatial features.²⁸

It is quite important to notice that the remark talks only about shaping *one’s experience*. This is the reading of Kant that G.E. Moore, in large part, foisted upon anglo-american philosophy. A Moorean interpretation of Kant does not mention that Kant’s major point was *ontological*: Kant held that the *objects* of our knowledge are (partly) constructed by the (universal, *a priori*) categories (concepts) of humans. As Aristotle and Locke believed, Kant, too, believed the world had a *law-like* structure. But contrary to Aristotle and Locke, Kant held that the only way we could account for knowing the (universal) *laws* involves humans having (*a priori*) universal concepts. (We shall return to the *post-Kantian* themes in a moment.)

And it is here that one should contrast this Kantian view with the Popperian view. (Here we intend to pick up on Michael Matthews claim that many remain committed to an empirico-Aristotelean approach). Popperians say quite easily that science is concerned with the growth of knowledge, that science is “progressive.” And it is true that Popper held, just as Aristotle, Locke, and Kant had held, that the (physical) world is governed by laws (or nomological structures). Indeed, the ultimate purpose of science is to “find” those laws. But Popper has always held that whatever “formulation” of the laws one has at any time, these are to be regarded as merely *conjectures*! These are never to be regarded as (simply) true. Popper meant to oppose both Aristotle’s essentialism (the world has definite, fixed structures and the human mind (*nous*) can discern them) and the empiricist’s Hempel’s inductivism (the world is governed by laws and the “inductive methods” can discern them). Popper has called his position “modified essentialism.” As Popper puts it:

I do not think that we ever describe, by our [conjectural] universal laws, an *ultimate* essence of the world. I do not doubt that we may seek to probe deeper and deeper into the structure of our world or, as we might say, into properties of the world that are more and more essential, of greater and greater depth.²⁹

So, for Popper the (ultimate) essences (or structures) of the world are *really unknowable*, but we can somehow come to *approximate* these ‘structures’ through the work of science, which for Popper involves falsification (and verisimilitude).

Now we come to our major point about Popper. For Popper has always held that in *no way whatsoever* do human concepts “colour or mould” the real laws (or structures) in the world. One might put it this way: in the very long run, science will converge onto the “ready-made,” real laws (or structures). As Popper has put it, “the rationality of science is essentially bound up with its *progress*, with the ever-renewed discussion of the relative merits of new theories; it is bound up with the *progressive* overthrow of theories.”^{30 31} Again, our point here is that Popper has regarded the (real) laws (or structures) of nature as totally fixed, ready-made, totally independent of any “input” from human inquiry.³² For Popperians, then, the (real) nomological structures of the physical world are *not constructed* by humans.

Let us return now to Kant and the Post-Kantians. For Kant, the *laws* of the world are the *joint product* of the (noumena) world and the *a priori* concepts humans (allegedly) have. Post-Kantians typically make two *major* adjustments in Kant's views. *First*, post-Kantians typically reject the claims that there is a transcendental self and that the real person has such *a priori* concepts. The concepts are largely the collective, social products of the specific, concrete preforming *forms of life* into which the person has been enculturated.³³ Each generation (of inquirers) "naturally," informally, and tacitly enculturates the next generation of individuals. The process of preformation (in which one group of persons *Hconstitutes the next set of individuals*) is by and large *tacit and unconscious*; it goes on behind the persons' backs. In anglo-american philosophy, this basic line of thought was first developed by Wittgenstein in critical response to G. E. Moore and Bertrand Russell.³⁴ *Second*, post-Kantians typically see *the forms of life* has having a history: the concepts, norms and values change over time. Thinking, itself, is regarded as being *historicized*. Persons are regarded as having, not natures, but *histories*; persons are (in a strong sense) constituted by the preformative traditions.³⁵ The post-Kantian holds that these adjustments are required to give any plausible account of *science* as an *realism and an objective mode of inquiry*.

Once these two major post-Kantian adjustments have been put in place, then it is plausible to argue that the (physical) world, the world discernable to humans, is in some strong sense constituted (Hconstructed) by the ongoing work of the historically and socially situated inquiry. For the Hconstructivist, the cultured-folk-creators versus the world-instructor (or universe-instructor) dimension is *mythic*. *There is no principled way* to sharply distinguish what the mind contributes from what the world contributes.³⁶ See Tables 1, 2, and 3. (We call it *Hconstructivism* to emphasize the *historical-cultural* dimension. One should not regard it as merely a kind of evolutionary view. Persons are incarnate in the biological *homo sapiens*, but they are *not identical* with the biological form. Persons *emerge* at a "level" above the biological.)

Again, once one makes the post-Kantian adjustments, then something "more" needs to be said about one's *theory of truth*. Now, of course, Popper has a theory of truth; he holds Tarski's theory of truth. Yet Tarski's conception requires that the language used be *extensional* and that

bivalence holds (for every “suitable” proposition P, P is either true or false). But it should be well known that the requirement that the language be extensional seems to rule out the mental (or intentional or cultural) terms. The best known “statement” of this conflict is Quine’s attack on “Brentano’s thesis.”³⁷ At any rate, whether an extensional logic will fit the human sciences (and natural languages) is not necessarily so. The question is still quite controversial.³⁸

It is also the case that whether one should use a bivalent (or a multi-valued) theory of truth depends in some way on the nature of the phenomena being studied. In other words, whether bivalence holds in a given domain of inquiry is a matter to be settled *relative* to the domain itself. Nonetheless, the view that whether a theory of truth holds in a given domain is, in some sense, an empirical matter to be partly determined by the nature of the objects in the domain of inquiry seems to be completely contrary to Popper’s view that method is not dependent upon the domain. We believe these differences between the Popperian views and Hconstructivist views are reflected in the *meta-philosophies* themselves. C. A. Hooker has plausibly argued that Popper’s *metaphilosophy* is almost the same as that of the logical positivist!³⁹

Tables 1, 2, and 3 summarize our discussion. Phillips really only attends to the first two rows in Table 1. It is most important to see that Phillips has not grasped the post-Kantian possibility presented in Table 3. (Again, Popper view’s can be used to illustrate the comparison between rather conventional views of science and the post-Kantian or Hconstructivist views.)

Part III: Educational Issues from the *Hconstructivist* Viewpoint

As we have noted above, there appears to be much confusion about the sense in which we are all ‘constructivists’ nowadays. Even those who are correct in rejecting the extremes of ‘constructivism’ seem to have a narrow view of the possible forms of ‘constructivism’ can take. We have tried to show that this is true of D. C. Phillips’ work on constructivism. One of the major purposes of our paper has been to expand Phillips’s category system to allow for more of the significant possibilities. We believe we have succeeded. (See, again, Tables 1, 2, and 3).

But what are the some of the educational implications for a Hconstructivist view? Of course, there are many views which can fit within the Hconstructivist camp. Here we shall just outline what we take to be a quite plausible Hconstructivistic view and then consider some of the important issues.

First, it is helpful to compare the Hconstructivist viewpoint with the well-known view of Paul Hirst, which he presented in his “Liberal Education and the Nature of Knowledge.”⁴⁰ A close reading of the essay will reveal that Hirst links rationality (and objectivity) to public standards and criteria. In particular, Hirst holds that a claim is objective (or rationally defensible) *only if* it can be shown to conform to the public standards and criteria. We believe that one might sensibly call this the stereo-typic *logical positivist’s* view of “objectivity.” Hirst nowhere shows that *the standards and criteria* (to which the appeals are to be made) are themselves *objective!* Furthermore, Hirst never slows down to sort out the *ontological* issues arising in the various domains of inquiry. In particular, Hirst never really shows that scientific inquiry (whether in the physical or the human realms) is, in any sense, a *realist* enterprise. A plausible interpretation of Hirst is that he denies that science is realist. At any rate, Hirst just does not show that scientific inquiry is *ontologically* objective. For the Hconstructivist, however, it can be plausibly shown that science is *objective epistemically* and *ontologically*. (Of course, it is well beyond the scope of this paper to provide the arguments here.)⁴¹

And though Hirst does say that the “rational self-conscious mind” is developed by inculcating the forms of knowledge, he never goes very far in developing a theory of the agent (or person). In contrast, the Hconstructionist holds that persons are *Hconstituted* by their preformative cultural traditions (practices).

Given all of Hirst’s shortcomings, we believe one can plausibly say that Paul Hirst was a *postmodernist* before his time! The postmodern, as typified by R. Rorty⁴² and Lyotard,⁴³ denies that there is any kind of epistemic or ontic *objectivity* to scientific inquiry. They do, however, offer an argument which has two parts. *First*, they argue that all attempts at providing *foundations or universal* standards are doomed to fail. *Second*, they argue that the only account of objectivity that will do is one that uses foundations, universal rules, or some other form of illicit privilege. The

Hconstructionist agrees with the first point, but rejects the second point. For the Hconstructivist, the postmodernist shows he has a latent hangover from modernity by invoking the (outdated) modernist criteria!⁴⁴

Suppose, then, that the Hconstructivist has made a plausible case that certain forms of inquiry are doubly objective-- both epistemically and ontically objective. We believe there are good reasons for educators to try to get *all* students, both the generalist and the specialist, to come to understand the nature of science from the Hconstructivist's point of view. Such course work would emphasize that science itself is a kind of practice-driven, tradition-driven mode of being which plausibly results in both epistemic and ontological *objectivity*. In so far as the students are to come to understand science (or social science), they will be enculturated both explicitly and tacitly into what are the *collective* norms, paradigms, and conceptual frameworks of the domain of inquiry. In other words, a good deal of the education will be a form of socialization and training of attitudes, expectations, and conceptual facility.

Course work for the specialist in science should also (eventually) take into account the deeper philosophical issues. A good deal of the science education will be a form of socialization and training of attitudes, expectations, and conceptual facility. Here our view can be expressed in this way: science as merely first order inquiry without second order (philosophical, legitimative) inquiry is blind; second order (philosophical, legitimative) inquiry without the content of first order inquiry is blind. Reflecting upon the 'best achievements' of science, upon how these were achieved, and upon how scientific inquiry might be enhanced in the future are *legitimative* activities that are quite important to the ongoing *vitality of science*. It is here that philosophy and science are seamlessly one. For the Hconstructivist, the *objectivity* of science and the *realism* of science can be plausibly defended only by addressing the basic philosophical problems and issues which arise from within scientific activity itself.

TABLES

Table 1: A Comparison of Popper’s Views and an Hconstructionist View

	Popper’s view	Hconstructionist view
concepts, theories, conjectures	the important ones are created	agrees
epistemic criteria (i.e., probability)	socially constructed	social-historical constructions
science	science is “progressive” and objective	science is not “progressive,” but it has both epistemic and ontic objectivity
real entities and (nomological) structures (in the physical realm)	<i>real</i> entities and structures have ready-made essences (natures) (which are totally independent of human inquiry)	<i>real</i> entities and structures -- at best posits always at risk -- are Hconstructed (See table 3)
rationality	limited to deductive logic	the styles and norms are Hconstructed (e.g., probability) (Here is the theme of <i>praxis</i>)
theory of truth	accepts the <i>extensionality</i> and <i>bivalence</i> of Tarski’s conception as required for inquiry	extensional logic and bivalence are not <i>apriori</i> required for the human sciences. It is relatively implausible that they <i>fit</i> the domain
persons (agents)	Popper’s “methodological individualism” is good step, but Popper never developed a theory of institutions	Persons are <i>Hconstituted</i> by the preformative cultural traditions (practices). (Here is the theme of <i>social constructivism</i>)

Table 2: Phillips’s Three Dimensions of the Forms of Constructivism

The Dimensions of Forms of Constructivisms	The Popperian View (According to Phillips, 1995)	The Hconstructivist View
individual psychology vs. public discipline	[Popper’s view of world three?]	Only persons are the agents of inquiry. But such a competency is enabled (and limited) by the preformative enculturation into the (collective) socio-historical traditions
humans the creators vs. nature the instructor (nature as template)	“Popper is situated at about the middle of this dimension: man proposes; nature disposes”	Man proposes; physical nature disposes. But what the world is like is a question that only arises within a conceptual- theoretical framework. (See table 3)
an <i>active</i> ‘process’ vs. a <i>passive</i> ‘process’ (in the construction of knowledge)	[Popper’s view of world three?]	Persons are the agents of inquiry; but such a competency is enabled (and limited) by the preformative and largely tacit enculturation into the (collective) socio-historical traditions

Table 3: Popper’s Modified Essentialism vs. Hconstructivism

	The Popperian View: ‘modified essentialism’ “The Aim of Science”- 1972	The Hconstructivist View: Putnam (1990); Margolis (1995)
feature 1	There is a physical realm of the universe that exists independently of and predates human inquiry.	It is a posit of human inquiry that there is a physical realm of the universe that exists independently of and predates human inquiry
feature 2	<p>The physical realm consists of a fixed, invariant (basic) set of real objects, real properties, and real (nomic) relations.</p> <p>Popper holds that we can never “describe, by our universal laws, the ultimate essence of the world... .”</p> <p>Nonetheless, he is a “metaphysical realist” and an “epistemological optimist,” for the “verisimilitude” of our theories can [be discernibly known to] increase. (Popper 1972, 1968)</p>	<p>What the world is like is a question that only arises within a (manmade) conceptual-theoretical framework. There is no <i>apriori</i> reason for thinking there is a unique conceptual framework; it is <i>likely</i> that there is more than one ‘adequate’ conceptual framework.</p> <p><i>It is here that ‘realism’ and ‘idealism’ come together.</i></p> <p>It is not required that there be nomic invariances for physical science to be sensible. There are no nomic invariances in the social sciences; human inquiry is a paradigm of free action.</p>

FIGURES START ON NEXT PAGE

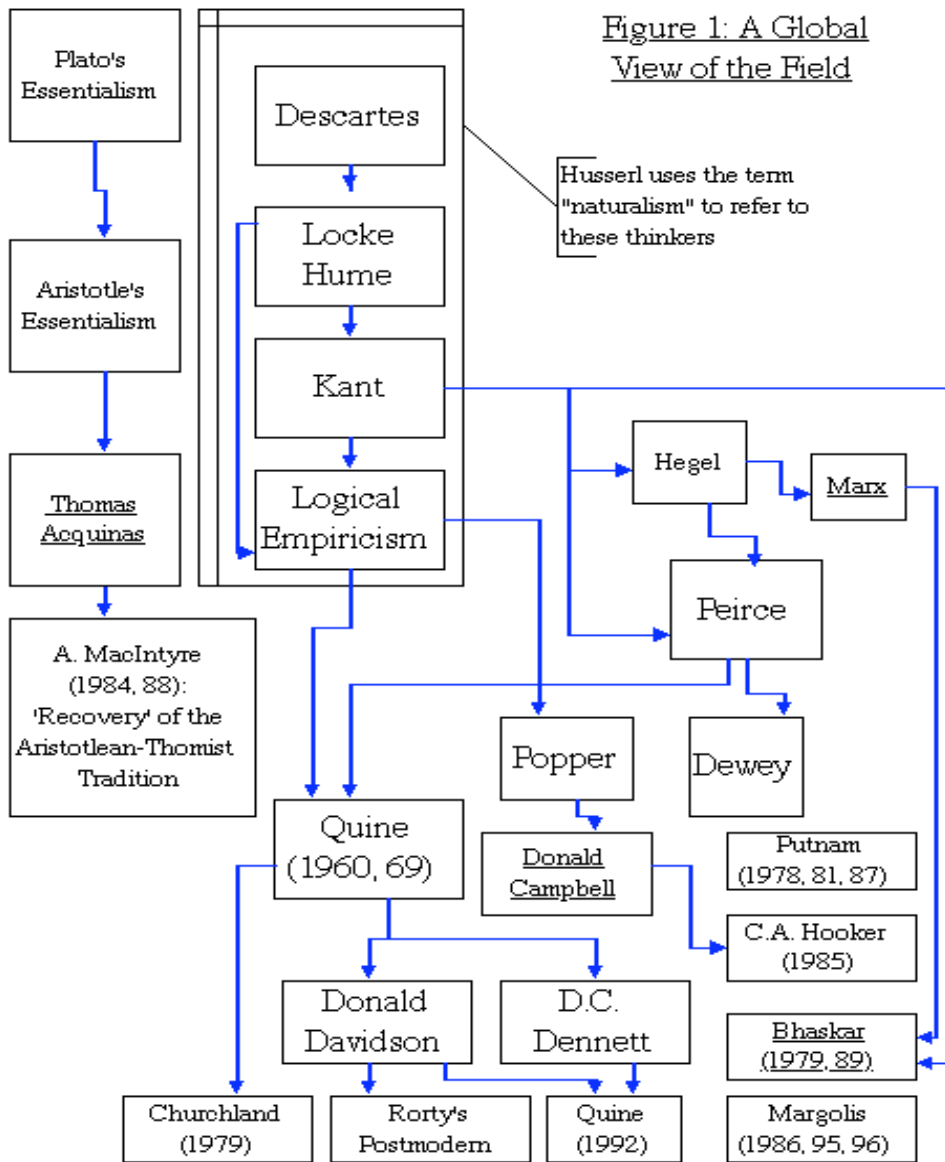


Figure 1: A global view of the field.

Figure 2: Naturalisms

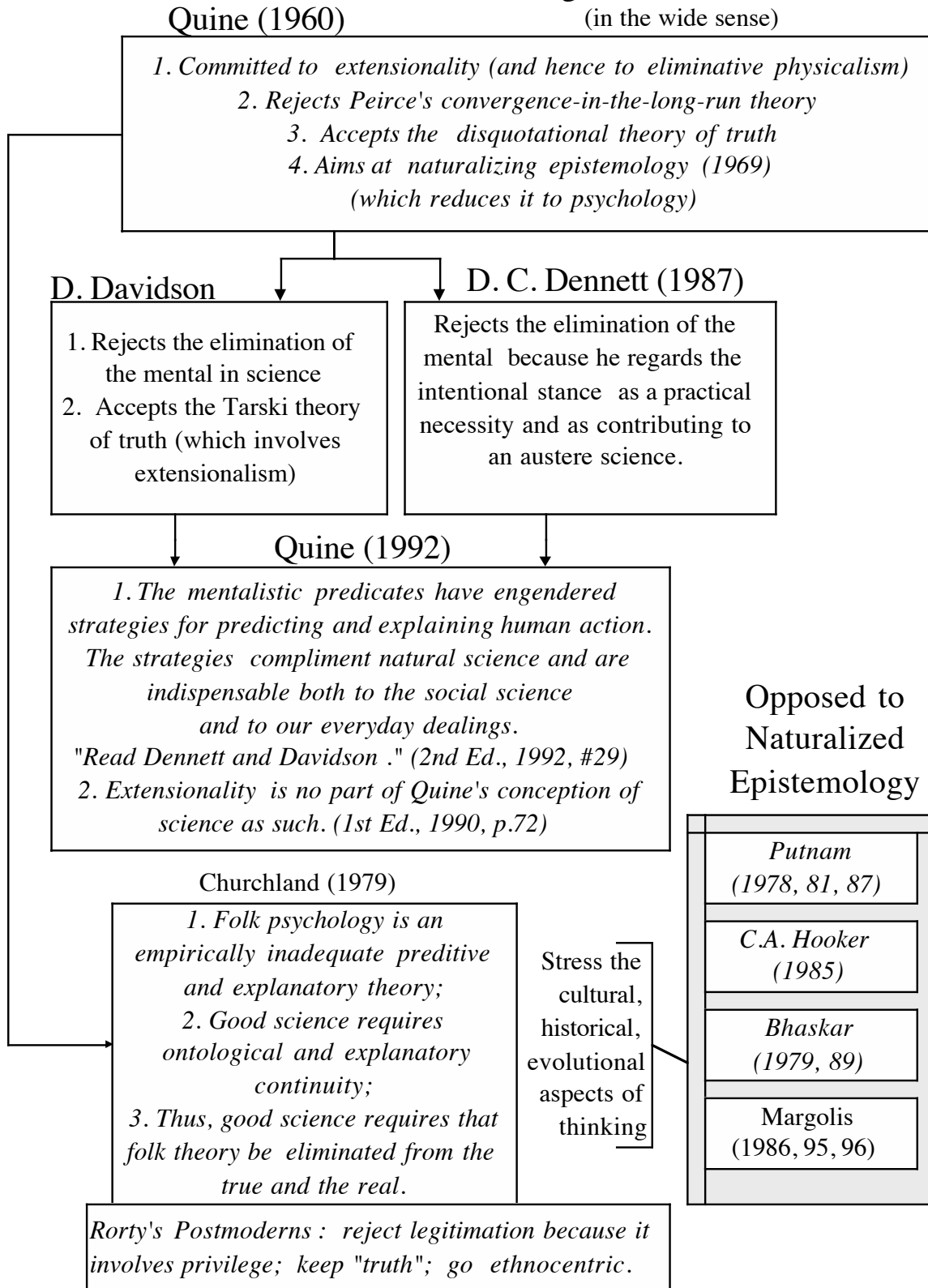


Figure 2: Naturalisms in the wide sense

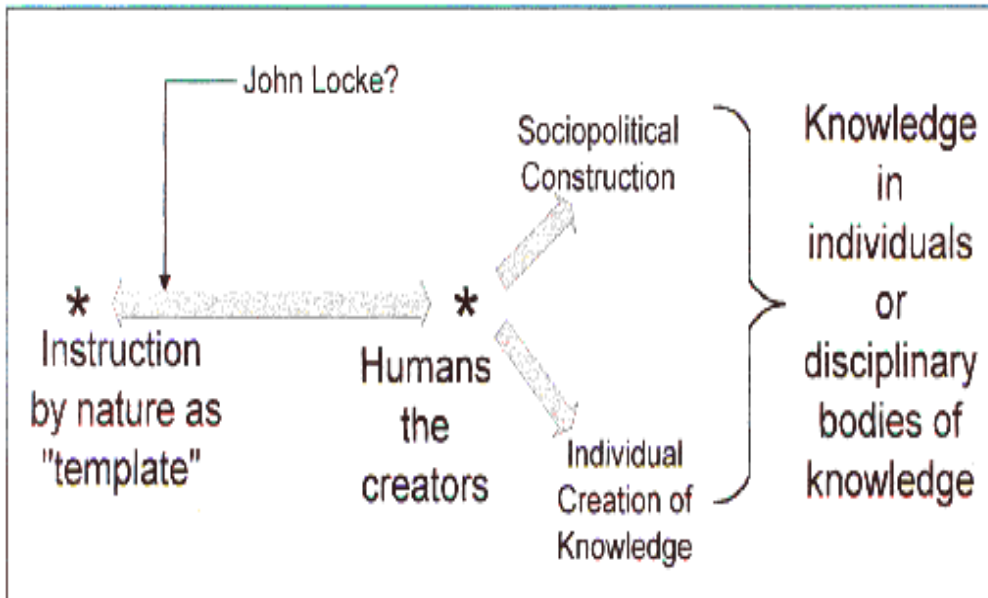


Figure 3: Complexities of the second constructivist dimension

Figure 3

F. S. Ellett, Jr. is Associate Professor on the J.G. Althouse Faculty of Education, University of Western Ontario, London, ONT N6G 1G7. His primary areas of scholarship are theories of rationality and morality and theories of social science research. D. J. Allison is Associate Professor on the J.G. Althouse Faculty of Education University of Western Ontario, London, ONT N6G 1G7. His primary areas of scholarship are theories of educational administration and organization and theories of social science research. D. P. Ericson is Professor and Chair in the Department of Educational Foundations, College of Education, University of Hawaii at Manoa, Wist Hall, 1776 University Avenue, Honolulu, HA 96822. His primary area of scholarship is the philosophy of education.

ENDNOTES

¹ Nel Noddings, "Constructivism in Mathematics Education," in *Constructivist Views on the Teaching and Learning of Mathematics*, eds. R. B. Davis, C. A. Maher, and N. Noddings (Reston, Virginia: National Council of Teachers of Mathematics, 1990), p. 18.

² D. C. Phillips, "On Castigating Constructivists," *Philosophy of Education, 1992*, H. A. Alexander (ed.) (Urbana, Ill.; Philosophy of Education Society, University of Illinois, 1993), p.314.

³ Michael R. Matthews, "Old Wine in New Bottles: A Problem With Constructivist Epistemology," *Philosophy of Education, 1992*, H. A. Alexander (ed.) (Urbana, Ill.; Philosophy of Education Society, University of Illinois, 1993), 303-311. Our view would serve as a useful corrective to the work of Matthews, for Matthews, too, seems unable to grasp the full set of constructivist possibilities.

⁴ Kant was the first western thinker to introduce (two kinds of) *constructivism*: one for ethics and one for the physical sciences. Here we will focus on the second kind: the Kantian (and post-Kantian) constructivism in the physical sciences which deals directly with the *objects* of our knowledge of the *world*. It was a key part of Kant's argument that the mind had *apriori* concepts to structure the 'objects.'

⁵ Matthews (1992) did try to cover, at the same time, both the physical sciences and mathematics. This suggests that the kinds of objectivity pertinent to mathematics are quite similar to kinds of objectivity pertinent to the physical sciences. Karl Popper has repeatedly rejected this suggestion; we reject it too. In the rest of this paper, we will consider the physical sciences.

⁶ Paul R. Gross and Norman Levitt, *Higher Superstition: The Academic Left and Its Quarrels with Science* (Baltimore, Md: The John Hopkins University Press, 1994), p.45. Gross is a professor of life sciences, and Levitt is a mathematician.

⁷ D.C. Phillips, “The Good, the Bad, and the Ugly: The Many Faces of Constructivism.” *Educational Researcher*, 1995 Vol. 24, No.7, 5-12.

⁸ *Ibid.*, pp.5-6.

⁹ *Ibid.*, p.5.

¹⁰ *Ibid.*, p.7.

¹¹ *Ibid.*, p.5.

¹² *Ibid.*, p.7.

¹³ Thus, we interpret Phillips remarks (1995, p. 12, fn. 3) that “Alvin Goldman has a promising research program” not to be in any way an endorsement of Goldman’s “naturalized” approach. See A. I. Goldman, *Liaisons* (Cambridge, Ma.: M.I.T. Press, 1992).

¹⁴ *Ibid.*, p.5.

¹⁵ *Ibid.* One might think that this last claim really says that most people now regard all forms of foundationalism, apriorism, and other forms of privileged access to be implausible (or undefensible). Thus, Chomsky, who attributes a *universal* formal structure of language to humans, J.A. Fodor, who attributes a *universal* set of “basic” concepts to persons, and Piaget, who attributes some kind of *universal* sequence of stages to humans, can be read as thinkers who oppose all forms of illicit privilege yet who nonetheless think that the resources that remain can support *universal truths*. Richard Rorty, for one, is opposed to all three. See J.A. Fodor, *Representations* (Cambridge: Ma.: MIT Press, 1981).

¹⁶ It will help to remember that, roughly speaking, “S knows P” means that 1) S believes P, 2) S has adequate evidence for P, and 3) P is true. Each of these features could be said to offer a constructivist move. We shall return to develop the point.

¹⁷ *Ibid.*, p.7.

¹⁸ *Ibid.*, p.7.

¹⁹ *Ibid.*

²⁰ *Ibid.*

²¹ This is not Phillip's terminology; it is ours.

²² Ibid., p. 7. We shall, for simplicity, focus on science. How this dimension will work for mathematics is a question for another day. But the reader should be concerned about a possible Platonism here.

²³ Ibid., p.9.

²⁴ Ibid.

²⁵ See Ian Hacking's "Language, Truth and Reason," in *Rationality and Relativism*, Eds. M. Hollis and S. Lukes (Cambridge: MIT Press, 1982), pp. 48-66; and Hacking's *The Emergence of Probability* (Cambridge: Cambridge University Press, 1975).

²⁶ Ibid., p.9.

²⁷ The first mentioned is John Locke! No mention is ever made of Hegel, Marx, Heidegger, Wittgenstein, Goodman, Quine, Putnam, or Gadamer.

²⁸ Ibid., p.6 (our emphasis).

²⁹ Karl Popper, "The Aims of Science" in Popper's *Objective Knowledge: An Evolutionary Approach*. (Oxford: Clarendon Press, 1972), 191-205, p. 196.

³⁰ Karl Popper, *Realism and the Aims of Science (from The Postscript to the Logic of Scientific Discovery)*, ed. W.W. Bartley, III (Totowa: Rowman and Littlefield, 1983), p. 58 (our emphasis).

³¹ Here one might sense that Popper has developed a kind of Peircean limit view of the real. If so, it too would be subject to Quine's devastating refutation of Peirce's view. Popper and Peirce have garnered illicit privilege! See W. V. O. Quine, *Word and Object* (Cambridge: MIT Press, 1960), p.23.

³² Popper might have believed that the postulation of real structures is *required* in order to make science sensible. Recent work shows such a claim is indefensible. See N. Cartwright, *How the Laws of Nature Lie* (Oxford: Clarendon Press, 1983) and B.C. Van Fraassen, *Laws and Symmetry* (Oxford: Clarendon Press, 1989).

³³ This is the shared theme of such apparently diverse thinkers as M. Heidegger, M. Foucault, H.G. Gadamer, and the later L. Wittgenstein.

³⁴ Here the key term is "*lebensformen*" -- *forms of life*. See L. Wittgenstein, *On Certainty*. Ed. G.E. M. Anscombe and G. H. von Wright (Oxford: Basil Blackwell, 1969). Wittgenstein had, of course, no interest in history. (See also footnote 26).

³⁵ Note that this is an ontological claim. The best development and defence of these ideas is given, we believe, by J. Margolis. See Margolis, *The Flux of History and the Flux of Science* (Berkeley: University of California Press, 1993). Margolis builds upon M. Foucault, *The Order of Things: An Archaeology of the Human Sciences* (New York: Vintage, 1973) and H.-G. Gadamer, *Truth and Method*, trans. (from the 2nd Ed.) G. Barden and J. Cumming (New York: Seabury Press, 1975). The closest feminist is C. MacKinnon, *Toward a Feminist Theory of the State* (Cambridge, Ma.: Harvard University Press, 1989).

³⁶ For early version of this argument, see H. Putnam, *The Many Faces of Realism* LaSalle, Ill.: Open Court, 1987), pp.26-7.

³⁷ Quine (1960), pp.221-2. Donald Davidson, in a series of essays, has tried to argue that an *extensional* logic will *actually fit* natural languages. See D. Davidson, *Inquiries into Truth and Interpretation* (Oxford: Clarendon Press, 1984). We are among the many who regard Davidson's claim as quite implausible.

³⁸ Popper's "methodological individualism" is a good step, but more is needed. Popper holds that "rational human behaviour ... is something *intermediate* in character between perfect chance and perfect determinism- something intermediate between perfect clouds and perfect clocks.." Karl Popper, "Of Clouds and Clocks," in *Objective Knowledge* (1972), p.228. See also his "On the Theory of the Objective Mind," 191-205, same volume.

³⁹ C. A. Hooker, "Philosophy and Meta-Philosophy: Empiricism, Popperianism, and Realism," in *A Realistic Theory of Science* (Albany: SUNY Press, 1985), 61-107. Hooker's own "evolutionary, naturalist, realist meta-philosophy" is a meta-philosophy a Hconstructivist would find to be basically acceptable. Popper asserts that his "theory was not intended to be a historical theory, or a theory to be supported by historical or other facts." K. Popper, *Realism and the Aim of Science, Vol. 1 of Postscript to the Logic of Scientific Discovery* (Totowa, N.J.: Rowman and Littlefield, 1983), p. xxxi; see also p. xxv.

⁴⁰ Paul Hirst, "Liberal Education and the Nature of Knowledge," in R. F. Dearden, P. H. Hirst, R. S. Peters (Eds.), *Education and the Development of Reason* (London: Routledge and Kegan Paul: 1972). It appears that Hirst has been more influenced by the 'logical behaviourism' of Gilbert Ryle, *The Concept of Mind* (New York: Barnes and Noble, 1949), than by the major themes of the later Wittgenstein. (The Hconstructivist provides a much *deeper* sense of "initiation" than the one found in such writers as R. S. Peters, *Education as Initiation* (London: Evans, 1964; an inaugural lecture delivered at the University of London Institute of Education, 9 December 1963.)

⁴¹ See Frederick S. Ellett, Jr., and David P. Ericson, "In Defence of Public Reason: On the Nature of Historical Rationality," forthcoming in *Educational Theory*, 1997.

⁴² Richard Rorty, “Habermas and Lyotard on Postmodernity,” in *Essays on Heidegger and Others* (Cambridge: Cambridge University Press, 1991), 164-176.

⁴³ Jean-Francois Lyotard, *The Postmodernist Condition: A Report on Knowledge*, trans. G. Bennington and B. Massumi (Minneapolis: University of Minnesota Press, 1984).

⁴⁴ Another major reason for being careful in dealing with Popper’s views comes from a critique by Max Black (1983, p. 27):

In an essay titled “Utopia and Violence,” Karl Popper partly identifies his own version of “critical rationalism” in the following terms: “A rationalist, as I use the term, is a man who attempts to reach decisions by argument, and perhaps, in certain cases, by compromise, rather than by violence.” Popper then makes the following remarks about the basis of his own “rationalism” as thus understood: “[M]y rationalism is not self-contained, but rests on an irrational faith in the attitude of reasonableness. I do not see that we can go beyond this...”. Here Popper uses the word “irrational” not in its usual sense of “contrary to reason” but rather as meaning “non-rational,” that is, unable to be supported by argument. That this is his intention is made explicit by the following passage: “My rationalism is not dogmatic. I fully admit that I cannot rationally prove it. I frankly confess that I choose rationalism because I hate violence, and I do not deceive myself into believing this hatred has any rational grounds.” (Popper, 1963, pp. 356-357).

As Black (1983, p. 27) concluded, “It is worth noting that this position implies that there are also no [objective] reasons for or against violence.” Given that one is trying to defend some kind of view about *objective* (moral) value judgements, we conclude that Popper has little to offer. See Max black, “Why Should I be Rational?” in Black’s *The Prevalence of Humbug* (Cornell University Press, Ithaca: 1983). Popper’s “Utopia and Violence” is Chapter 18 in his *Conjectures and Refutations* (Harper Torchbook, New York: 1963, 1965).