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In Defense of Realism: It Really *Is* Commonsense

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ABSTRACT: "What is truth?" Pilot asked Jesus of Nazareth. For many in academe today this question seems quaintly passé. Rejection of "truth" goes hand-in-hand with the rejection of epistemological realism. Educational thought over the last decade has instead been dominated by anti-realist, instrumentalist ideas of two types: first by psychological constructivism and later by social constructivism. Social constructivism subsequently has been pressed to its logical conclusion in the form of relativistic multiculturalism. Proponents of both psychological constructivism and social constructivism value knowledge for its utility and eschew as irrelevant speculation any notion that knowledge is actually about reality. The arguments are largely grounded in the discourse of science and science education where science is "western" science; neither universal nor about what is really real. The authors defended the notion of science as *universal* in a previous article. The present purpose is to offer a commonsense argument in defense of critical realism and the epistemically and ontologically distinguished position of science (rather than privileged) within a framework of epistemological pluralism. The paper begins with a brief cultural survey of events during the thirty-year period from 1960-1990 that brought many educators to break with realism and concludes with comments on the pedagogical importance of realism. Understanding the cultural milieu of the past forty years is critical to understanding why traditional philosophical attacks on social constructivist ideas have proved impotent defenders of scientific realism.

The good Dr. Johnson and James Boswell were walking down a London street one day discussing George Berkeley's philosophy of immaterialism. Dr. Johnson, unconvinced by Berkeley's logic, said to Boswell, "I refute it thus!" Upon which he turned and soundly kicked the street curb with his big toe – much to Boswell's amusement!

Along with Boswell, one is amused. Of course, Samuel Johnson's refutation of immaterialism was no philosophical threat to Berkeley. What Johnson did was to present dramatically the wisdom of common folk and everyday, ordinary life. For most people philosophy is an esoteric, arcane discipline with little apparent practical value. Unfortunately, that is not always a wise view. For example, Duschl (1985) argued that for 25 years science curriculum developers ignored concurrent development in the philosophy of science, resulting in impoverished curricula. In the years since Duschl's article there has been much more interest in both the history and philosophy of science as these fields pertain to education. Indeed, educational thought over the last decade has been dominated by instrumentalist philosophy of two types: first by psychological constructivism and later by social constructivism. Social constructivism has been pressed to its logical conclusion in the form of relativistic (i.e., philosophical) multiculturalism. Proponents of both psychological constructivism and social constructivism value knowledge for its utility and eschew any notion that knowledge is actually about reality as irrelevant speculation, thus the label instrumentalism. The arguments are largely grounded in the discourse of science and science education where science is "western" science; neither universal nor about what is really real. We have defended the notion of science as *universal* in a previous article (Cobern & Loving, 2001). In this paper, our purpose is to offer a commonsense argument in defense of critical realism. The paper begins with a brief cultural survey of events during the thirty-year period from 1960-1990 that brought many educators to break with realism and concludes with comments on the pedagogical

importance of realism. Understanding the cultural milieu of the past forty years is critical to understanding why traditional philosophical attacks (e.g., Slezak, 1994 a&b; Suchting, 1992 & 1995) and ideological attacks (e.g., Gross, Levitt, & Lewis, 1996) on social constructivist ideas have proved impotent defenders of scientific realism for most educators including science educators.

From Where We Have Come

The National Science Foundation (USA) funded major science education curriculum reforms from the late 1950s through the late 1960s. Garrison & Bentley (1990, p. 188) called this decade the "golden era" of North American and European science education curriculum development. Prather (1990, p. 12) called the events of the 1960s a "revolution in science education." A mere two decades after this "golden era" for science education, however, one finds that the USA and other nations were once again agonizing over the inadequacies of school science (Duschl, 1985). Mallinson (1984, p. 2) wrote of the ironic déjà vu – that criticisms of the 1980s were "little more than plagiarism of statements that appeared in the literature of the 1950s and 1960s." According to Duschl, "Mallinson's irony" could in part be attributed to the philosophical and historical datedness of the science curriculum reformers.

> The point being made is that during the same period of time (1956-1966) in which various science contents were being revised and rewritten by scientists to produce curricula which would instruct students on how to operate and think like a scientist; the prevailing ideas among historians and philosophers of science about the nature of scientific inquiry were being challenged and changed. (Duschl, 1985, p. 548)

Nadeau & Desautels (1984, p. 7-8) concur:

> Numerous studies in recent years have shown that science teaching has not achieved the objectives set for it some twenty years ago when, under American influence, the most extensive renewal ever undertaken in science education was begun. It is almost universally agreed that this endeavor was a failure.

They go on to argue that by "by giving insufficient thought and attention to the nature of scientific knowledge and the conditions under which it has been developed, science teaching reinforces beliefs and myths that are inherent in scientistic ideology (Nadeau & Désautels, 1984, p. 8). They argued that school science promoted the "myth of scientism." This myth includes:

- Scientism: scientific knowledge deserves unquestioned epistemic privilege.
- Naive realism: scientific knowledge is about the way things *really* are.
- Naive empiricism: "the human mind as a *tabula rosa* on which knowledge is recorded item by item" (p. 24).
- Naive verificationism: scientific knowledge is developed via inductive processes.
- Objectivism: the scientist is a completely disinterested, objective participant in scientific endeavors.
- Excessive rationalism: "The conquest of truth is viewed as a cumulative and consequently continuous process that has gone on, uninterrupted by precipitate change or sudden alteration, since the days of Babylon" (p. 48).

This Mallinson-Duschl-Nadeau/Désautels analysis was by most accounts correct. The early NSF curricular efforts leaned too uncritically on a colloquial version of positivism (Cobern, 1997) at a time that logical positivism had lost almost all its traction amongst philosophers and historians of science.

It would, however, be incorrect to assume that the 1960s NSF science education curriculum reforms lacked any innovation. Reminiscent of Duschl's 1985 title, DeBoer (1991, p. 164) claims that in the twenty years preceding the NSF reform efforts, "science teaching had not kept pace" with new conceptions of science as described by Jerome Bruner and Joseph Schwab. Theirs was not like the inductivist-realist philosophy of science. That *received* view was "characterized by an urgent desire for 'objectivity', empiricism and elimination of metaphysics" (Elkana, 2000, p. 463) and,

the tradition in science teaching was to feed the student with huge amounts of information about 'objective' facts, and 'proved' laws of nature, and after the law had been memorized, the teacher performed a demonstration in class… [that] served as an experimental confirmation… (Elkana, 2000, p. 465)

Bruner (1960), in contrast, saw science textbooks as little more than collections of facts and ideas. He was concerned about the structure of science textbooks and science curriculum. He observed that science textbooks and curricula did not reflect the structures of scientific disciplines at a time when increasing importance was being attributed to the structures of disciplines. Bruner argued that:

> Grasping the structure of the subject is understanding it in a way that permits many other things to be related to it meaningfully. To learn structure, in short, is to learn how things are related. (Bruner, 1960, p. 7)

Similarly, Schwab (1962, p. 24) complained that school science was taught "as a nearly unmitigated *rhetoric of conclusions* in which the current and temporary constructions of scientific knowledge are conveyed as empirical, literal, and irrevocable truths." He went on to argue that the methods and processes of doing science were missing in current science textbooks and curricula. Hence, the fluidity of science was missing. The 1960s science curricula funded by the National Science Foundation were innovative in that they were attempts to reflect the structure of various scientific disciplines and to present science as inquiry rather than as the rhetoric of conclusions, to use Schwab's phrase.

What we see from the Mallinson-Duschl-Nadeau/Désautels analyses of the mid 1980s is that the structure of disciplines and inquiry concepts promoted by Bruner and Schwab represented a positivist-instrumentalist view of scientific knowledge that emphasized method:

> the one and only true method of science is the method of empiricism, of mathematical positivism, and… the elimination of

metaphysics…. science develops by empirical refutation of old theories, by objective formulation of 'critical experiments' and by empirical decision, as to which of the alternative theories is the better predicting instrument. (Elkana, 2000, p. 470)

Despite contrary philosophical views raised by Hanson (1958), Kuhn (1962) and Toulmin (1960) the positivist-instrumentalist view of science was strongly supported in the science community. In education this view mainly served to support the interests *of* the science community[1] that there be an adequate educational pipeline delivering future scientists (Cobern, 1996 & 1997). This is of little surprise given that a major stimulus for 1960s science curriculum reform effort was the Sputnik scare and the challenge of keeping scientific and technological pace with the Soviet Union. Regarding the lay citizenry, however, the reformers of the period simply assumed that "science would be inherently interesting to all students if it were presented in the way it is known to scientists" (Hofstein & Yager, 1982, p. 542).

From the beginning, critics of the NSF sponsored curriculum reforms argued that "the need was for an enlightened citizenry, not an educational elite" (DeBoer, 1991, p. 173). Gradually, Paul DeHart Hurd's (1998) notion of public science literacy or public scientific literacy took root. From the 1970s on there was a new progressivism in science education that spawned a series of science curriculum efforts that were more student-, socially-, and culturally-oriented. This was a remarkable educational shift from science education serving the interests *of* science to serving the public interest *in* science. DeBoer (1991) reminds us that during the 1920s, 1930s and 1940s the control of science curricula was in the hands of professional educators rather than scientists, prompting Joseph Schwab to complain that professional educators paid more attention to social needs than to subject matter. But, under the guidance of Schwab and Bruner that situation was reversed during the NSF-curriculum dominated 1960s; only to have the curriculum focus reversed yet again during the 1980s. One must agree with the Preacher: "The thing that hath been, it is that

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[1] For an excellent discussion of the difference between the interests *of* science and interest *in* science, see Eger (1989).

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which shall be; and that which is done is that which shall be done: and there is no new thing under the sun" (Ecclesiastes 1:9).

The Challenges to Authority

In the 1980s, the pendulum of science curriculum reform swung away from the subject-centered, structure-of-disciplines approach to school science. The proposed solution for the most recent "crisis in science education" was "to offer science that could help people in their everyday lives, that would allow them to make a contribution to the well-being of society, and that was interesting to students" (DeBoer, 1991, p. 198). These efforts included Science-Technology-Society programs, humanistic approaches to science education, values education approaches to science education, environmental education, and programs that use social issues to structure science education. According to DeBoer, Hofstein and Yager (1982) championed the use of social issues to structure science education arguing that the goals for science education must change to meet the current needs of society. The need in the 1980s was not to produce more scientists but to provide for a scientifically literate citizenry. The public knew this even if the science and science education communities were not so sure; after all, argued Yager (1983, p. 652-3) "since the advent of the… 'new' courses as structured by the science community, enrollments have dropped by more than 50%." The science curriculum alternatives of the 1980s would be a significant step away from discipline-focused science education reforms of the 1960s. They were not however a step away from instrumentalism. Indeed, the very notion of science for public use – "what works" – reinforced an instrumentalist perspective of science.

The reaction to this "flight from science" (Kromhout & Good, 1983, p. 648) came quickly. Critics argued that "as motivation for a coherent study of fundamental science" (p. 647) social issues and the like were fine. Fundamental science education, however, could not be effectively *organized* by such issues and concerns. Moreover, the critics were suspicious that alternatively oriented science curricula could too easily be hijacked by "antiscientific factions and social activists" (p. 647). The critics aligned themselves with C. P. Snow (1964, p. 10), who was sure that it

is the scientists who have "the future in their bones" and to scientists we must look.[2]

By the end of the 1980s, however, it was unmistakable that a broader cultural paradigm shift begun in the 1960s had taken place – and there would be no going back to the discipline-oriented school science curricula, either in the inductivist-realist mode of the 1950s or the positivist-instrumentalist mode of the 1960s. In the 1960s, there were four watershed cultural events in the United States that had worldwide reverberations and set the context for our discussion about science and epistemology at the onset of the 21st century. Thomas Kuhn (1922-1996)[3], who in 1962 published, *The Structure of Scientific Revolutions*, precipitated the first[4] of these watershed cultural events. Kuhn advanced an historical approach to the philosophy of science and his book was an instant commercial success that achieved far-reaching influence (Loving & Cobern, 2000). It was a book born of its period and had the unintended effect of undermining scientific privilege by undermining scientific claims to realism and universal validity.

The second watershed cultural event was the American Civil Rights Movement. The 1960s found a nation increasingly concerned about social progress. The youth culture – or youth *counter*culture – of the 1960s was acutely troubled by oppressive social practices and the gap between American democratic ideals and actual practice. Nor was science deemed to have much value for the cause. A 1960s popular song referred to the decade as the "Eve of Destruction" (McGuire, 1969), a decade of racial and ethnic hatred. Science might take us to space but science can't help us at home: "you may leave here for four days in space/ but when you return it's the same old place" (McGuire, 1969). The answers were in legislative and judicial action, and in a rising acceptance of cultural pluralism. The Civil Rights movement, Black Power and Afrocentrism advocates raised American cultural awareness (later followed by advocates for Feminist,

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[2] One indication that the critics failed in their efforts is that the Kromhout & Good title reappears thirteen years later in Gross, Levitt, & Lewis (1996). Indeed, in the eyes of many in science, the situation had only worsened as indicated by the two-word addition in the Gross et al title, *The Flight From Science and Reason*.

[3] See <http://www.emory.edu/EDUCATION/mfp/Kuhnsnap.html> for a brief biographical sketch of Kuhn's life and work.

[4] We are not indicating a chronological order. For the most part, these were simultaneous events during the decade.

Hispanic, and American Indian awareness). Whereas American society was once thought of as a "melting pot" (Crouch, 1995; Glazer & Moynihan, 1979) needing to be more inclusive, the particularities of culture were becoming more valued; Americans were becoming more culturally aware and accepting of American cultural pluralism.

As with the first watershed cultural event, the third event was precipitated by a book. Rachel Carson (1907-1964)[5] was a science writer and ecologist. During the Depression she worked for the U.S. Bureau of Fisheries writing radio scripts, and for the Baltimore Sun writing articles on natural history. She eventually became Editor-in-Chief of all publications for the U. S. Fish and Wildlife Service. However, after the end of World War II, "disturbed by the profligate use of synthetic chemical pesticides… Carson reluctantly changed her focus in order to warn the public about the long term effects of misusing pesticides" (Lear, 1998). She challenged the agricultural practices advocated by both government officials and scientists. In 1962, her book, *Silent Spring*, was serialized in the *New Yorker* and criticism was not long in coming – and from all quarters.

> Carson was violently assailed by threats of lawsuits and derision, including suggestions that this meticulous scientist was a 'hysterical woman' unqualified to write such a book. A huge counterattack was organized and led by Monsanto, Velsicol, American Cyanamid – indeed, the whole chemical industry – duly supported by the Agriculture Department as well as the more cautious in the media. (Matthiessen, 2001)

The force of her arguments and the elegance of her prose, however, could not be resisted. The Audubon and National Parks Magazine published further excerpts from *Silent Spring*, which rapidly was becoming a runaway best seller. Rachel Carson opened eyes to a new revelation: products of scientific knowledge contribute to environmental degradation and pose hazards for public health. The net effect was a certain loss of scientific innocence. Science may have enabled us

to win World War II and greatly contributed to the economic expansion of the 1950s, but now science was discovered to have a darker side.

The fourth watershed cultural event was the Vietnam War. The decade of the 1960s was a time of breaking with established norms and questioning established verities. The Civil Rights Movement brought about a great moral correction in American society and politics. The Vietnam War not only amplified the cultural dissonance of the 1960s, it turned dissonance into tragedy. Television brought the war home and people saw for the first time the effects of Napalm, Agent Orange and other products of scientific knowledge in the service of political and military needs. Students in particular were prone to change their estimation of science because of what they perceived as an unholy alliance between the community of science and a military-industrial complex that developed and produced weapons. The rhetoric of values neutrality and objectivity was not tenable when the science community having taken credit for such things as the Green Revolution now denied any responsibility for Agent Orange and Napalm. Science not only lost its luster, it lost its innocence. Or, as in the words of Roger McGuinn of the Byrds (Byrds, 1965):

> and I opened my heart to the whole universe/
> and I found it was loving/
> and I saw the great blunder my teachers had made
> scientific delirium madness

These watershed events set the stage for a significant philosophical development within education during the 1990s; what was unthinkable amongst educators during the 1950s was quite logical by 1990: anti-realism was believable. The shift to anti-realism began with concepts of psychological anti-realism in the early 1990s that evolved into concepts of cultural anti-realism in the late 1990s. The early 1990s phase of anti-realism was dominated by *radical constructivism*; but a psyche-centered radical constructivism later gave way to social-centered forms of constructivism (*social constructivism*) and ultimately to *philosophical multiculturalism*.[6]

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[5] See RachelCarson.org ("a website devoted to the life and legacy of Rachel Carson") at: http://www.rachelcarson.org/.

[6] For a discussion on types of multiculturalism, see: Haack (1998, Ch. 8).

The Insignificance of Reality

Thomas Kuhn's magnum opus, *The Structure of Scientific Revolutions* (1962) belongs to a small but elite group of enduring handbooks of human culture that transcend categories of specified knowledge to challenge traditional ideas and heighten the quest for universal knowledge. Most of the work in philosophy of science after 1962, when *The Structure of Scientific Revolutions* was first published, was directly or indirectly in response to Kuhn. Imre Lakatos, Larry Laudan, Dudley Shapere, Stephen Toulmin, Paul Feyerabend, David Bloor, Barry Barnes, Bruno Latour and David Hull are some of the names associated with the last thirty-five years of discussion and debate with Kuhn on the nature of science.[7] What has been particularly intriguing is the use of Kuhn's work in other disciplines. There appears to be a wide-ranging appropriation of his ideas about science to fields ranging from law to linguistics. Those who appropriate Kuhn's work find in him an invitation to rebel from tradition – the thrill of revisionism. Although Kuhn did not set out to promote such rebellion – his influence on revisionists appears enormous; "sociologists, political scientists, economists, policy specialists, geographers, anthropologists and marketers have pounced with glee on the theories of the historical school, in part because they find non-positivist approaches to the structure of science appealing and refreshing" (Donovan, Laudan & Laudan 1988, p. 7; also see Loving & Cobern, 2000).

Kuhn's concepts of "paradigm" and "incommensurability" were (mis)taken as signaling the passing of science's privileged claims to epistemic realism and universal validity. By the 1980s, the unthinkable was now scholarly. Collins (1981, p. 3) could tell us that the "natural world has a small or non-existent role in the construction of scientific knowledge." According to Gergen (1988, p. 37), "the validity of theoretical propositions in the science is in no way affected by factual evidence..." Of course, scientific realism was still defended by some as the only credible way to account for the instrumental reliability and efficacy of science (Boyd, 1983); but Aronowitz (1988, p. 204) – amongst others – countered that, "science legitimates itself by linking its discoveries to

power... a connection which *determines* (not merely influences) what counts as reliable knowledge." In education, Ernst von Glasersfeld (1989) argued that faith in the objectivity of knowledge, particularly of scientific knowledge, was misplaced. The difficulties confronting the possibility of objective knowledge, he wrote, were "brought to the awareness of a wider public by the publication of Kuhn's *The Structure of Scientific Revolutions*. There, undisguised and for everyone to read, was the explicit statement that" (Glasersfeld, 1989, p. 121):

> …research in parts of philosophy, psychology, linguistics, and even art history, all converge to suggest that the traditional epistemological paradigm is somehow askew. That failure to fit is also made increasingly apparent by the historical study of science… None of these crisis-promoting subjects has yet produced a viable alternate to the traditional epistemological paradigm… (Kuhn 1970, p. 121)

Glasersfeld, however, was there to supply the "viable alternate": radical constructivism.

We noted earlier that for most people philosophy is an esoteric, arcane discipline with little apparent practical value. There are however, moments when philosophy captures widespread attention. Such an occasion was the opening night of the 1990 annual meeting of the National Association for Research in Science Teaching. Ernst von Glasersfeld gave a highly stimulating lecture on radical constructivism. The concept was so well received in the science education community that a year later, Good (1991) remarked that most science education researchers had boarded the "constructivist express;" he asked, "is constructivism the new religion in science education?"

Constructivism refers to a view of learning derived from Piaget's concepts of assimilation and adaptation, a view further developed in Ausubel and Novak's work on meaningful learning. As such, this view of constructivism can be appropriately termed, pedagogical constructivism, or as Glasersfeld (1988, p. 8) rather pejoratively prefers, "trivial constructivism." The heart of Glasersfeld's position, however, and what was new

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[7] For a discussion of Kuhn's impact, see Loving & Cobern (2000)

for many science educators in 1991, was the linkage of pedagogical constructivism with radical constructivism. The latter is an epistemological (nature of justification) and ontological (nature of truth worthiness) philosophy that divorces knowing from any notion that reality is the referent of knowledge or that knowledge exists beyond one's individual construction. According to Glasersfeld (1989a, p. 122) the philosophy of radical constructivism,

> discards the notion that knowledge could or should be a representation of an observer-independent world-in-itself and replaces it with the demand that the conceptual constructs we call knowledge be viable in the experiential world of the knowing subject.

Interpretations of experience are all that one can know (an old empiricist argument, Matthews (1994) reminds us. one accepts the validity of interpretations in so far as they are pragmatically viable. The appeal of this position is that it renders moot an historical paradox in Western philosophy.

> Radical Constructivism was conceived as an attempt to circumvent the paradox of traditional epistemology that springs from a perennial assumption that is inextricably knitted into Western philosophy: the assumption that knowledge may be called "true" only if it can be considered a more or less accurate representation of a world that exists 'in itself', prior to and independent of the knower's experience of it. The paradox arises, because the works of philosophers by and large imply, if not explicitly claim, that they embody a path towards Truth and True representations of the world, yet none of them has been able to provide a feasible test for the accuracy of such representations. (Glasersfeld, 1989b, p.2)

Glasersfeld argues that in fact the ideas of radical constructivism can be traced to Copernicus in the 16th century. Glasersfeld quotes Andreas Osiander's preface in the original publication of *De Revolutionibus*. Osiander wrote that the repercussions of Copernicus' work should not be

feared because the works of astronomers are not to be regarded as truth, but only efficient calculating devices (Glasersfeld, 1989b, p. 3). Glasersfeld summarizes the radical constructivist position by paraphrasing an early 18th century philosopher, Giambattista Vico:

> God alone can know the real world, because He knows how and of what He has created it. In contrast, the human knower can know only what the human knower has constructed. (1989a, p. 123)

To say the least, this is an ironic application of the "God of the gaps" argument; but that is acceptable in radical constructivism given its presupposition of instrumentalism: "Cognition's purpose is to serve the individual's organization of his or her experiential world; cognition's purpose is not the discovery of an objective ontological reality" (Staver, 1998, p. 504)

Both Glasersfeld's epistemology and his ontology were clearly relativistic, but he retained the traditional focus of philosophy on the individual. His was a psyche-centered view of constructivism. The publication of Thomas Kuhn's 1962 book, *The Structure of Scientific Revolutions*, however, which was so critical to the acceptance of radical constructivism, was only the first of four 1960s watershed events. Very quickly, Glasersfeld's radical constructivist ideas precipitated by Kuhn's book were themselves influenced by ideas spawned by the other three watershed events that continue to percolate through Western intellectual culture. By 1997, Geelan was able to identify six thoroughly established forms of constructivist theory, only one of which was Glasersfeld's original radical constructivism. Amongst education researchers, there was a clear shift to social variants of constructivism, that is, to *social constructivism*.

A World of Multiple Realities

The American Civil Rights movement of the 1960s brought about an increased awareness of culture and that indeed America was a culturally plural society. Moreover, increasing economic and cultural globalization brings about greater cultural awareness (Reiff, 1993).

Increasingly, the world's inhabitants are living in close proximity to and interspersed among people of different ethnic and national backgrounds, and frequently at some distance from the land of their birth. (Fox-Genevese, 1999, p. 531-539)

Instead of the "melting pot," people began to use different metaphors, the "tossed salad," or the "jar of jelly beans." Culturally isolated or insolated it is much easier to maintain that one's own ideas are the correct ideas; confronted with others – with cultural contamination by those who are alien – it becomes much more difficult to maintain that one's ideas are the *sole* correct ideas and that the ideas of others are incorrect. Hence, cultural awareness can introduce cultural doubt, which in Western societies quickly spread to doubts about science.

Prior to 1960, science had been firmly bolted to epistemological confidence. By 1990, those bolts had been weakened, if not sheared. In the past, science would have been resistant to the infection of cultural doubt. A building on a solid foundation can resist an earthquake. If that first quake, however, damages the foundation, the building may not emerge unscathed from a second quake. Science withstood the earthquakes brought about by Kuhn, Viet Nam, and *Silent Spring* but its foundation was badly damaged. We have already discussed the Kuhnian effect. *The Structure of Scientific Revolutions* damaged science's epistemological foundation. Vietnam and *Silent Spring* damaged science's moral foundation. It was bad enough to have the vivid TV images of Napalm right in one's own living room. It was worse to learn of the disastrous unintended consequences of putative humanitarian science, such as the development of pesticides.

> *Silent Spring* created a nervous awareness that science and technology, followed blindly, could destroy life even when intended for beneficial non-military applications. It showed that scientists, narrow-mindedly pursuing profits, often acted ignorantly and implied that the narrowly focused specializations of modern science could have dangerous consequences. (Friberg, 2000, p. 50)

Add in Bhopal, the Challenger, Chernobyl, and Three Mile Island and it is no wonder that the reputation of science has suffered in the public square – a situation only worsened by the fact that the public makes little distinction between the aims, methods and theories of good science and the use – or abuse – of scientific findings for profit or power motives.

The critical point is that the cultural foundation on which science rests was weakened at the very moment in time when a plethora of competitors and challengers appeared. With the rise of cultural pluralism, people are far more inclined to take alien ideas seriously – ideas that heretofore would have been called ethnoscience and folklore, pseudoscience, and even quackery. With regard to Eastern concepts from Buddhism and Hinduism, popular articles and books, such as Fritjof Capra's *The Tao of Physics*, "worked to confer the prestige of modern science on Asian mystical traditions, already highly regarded for their sophistication and beauty, directing open-minded intellectual attention their way" (Friberg, 2000, p. 50). This Eastern influence is particularly notable in health care where "alternative medicine" is very much in vogue (see for example: Lyons, 2001; Rosenblatt, 2001; TIME, 2001).

The response in education to these cultural developments has been "multiculturalism curriculum reform" (Sleeter & Grant, 1987). Borrowing Haack's (1998) analysis, educational reform began with pluralistic educational multiculturalism: "it is especially desirable in multicultural societies… for students to know something about the cultures of others with whom they live" (Haack, 1998, p 137). This curriculum perspective is clearly presented in the original edition of Gollnick & Chinn's, *Multicultural education in a pluralistic society*:

> Multicultural education is an educational concept that addresses cultural diversity and the provision of equal educational opportunity in schools. For it to become a reality in the formal school situation, the typical environment must reflect a commitment to multicultural education. The cultural backgrounds of students are as important in developing effective

instructional strategies as their physical and mental capabilities. Educators need to understand the cultural strengths brought to class by students from diverse cultural backgrounds and use those cultural advantages to develop effective instructional strategies. (Gollnick & Chinn, 1986, p. 29-30)

Moreover, the importance of understanding "the cultural strengths brought to class by students from diverse cultural backgrounds" is said to be particularly critical in science education given that not all students within this diversity have achieved equally well. According to Luft (1998, p. 103):

> As classrooms become increasingly diverse, several researchers report that science instruction does not provide students with opportunities to do science, science instruction is not relevant to students' lives, and science instruction does not result in equitable achievement for students on science assignments… Although the relationship between doing science, the relevancy of science, or science achievement and ethnicity is not clear, African-American, Hispanic, and Native American students score lower than their white and Asian counterparts on science literacy assessments.

To remedy the uneven science achievement across cultural groups, educators have embraced pluralistic educational multiculturalism approaches that bring cultural diversity to the curriculum itself. *The Portland African-American Baseline Essays* (Adams, 1986) are one high profile, and controversial (e.g., Shanker, 1992; Loving & Montellano, 2000; Ortiz de Montellano, 1996), example of curriculum innovation in this vein: "Students' and staffs' lack of knowledge about ethnic groups spurred Portland schools to begin compiling 'baseline essays' about the contributions of six major geocultural groups" (O'Neil, 1991/1992, p. 24). Atwater (1994 & 1995) offers a more temperate perspective on multicultural science education, and indeed the literature during the 1990s is replete with culture and gender-oriented science lessons and activities. See Luft (1998) for a more recent review.

For other educators and families, multiculturalism is taken even further and construed as *particularistic educational* multiculturalism: "that students… should be educated in their own culture" (Haack, 1998, p. 137). For example, a major publisher of Christian-oriented k-12 textbooks proclaims:

> At *A Beka Book*, we are unashamedly Christian and traditional in our approach to education. Because of this, we have often had to go against the tide of the academic establishment in order to meet the highest standards of Christian scholarship. (http://www.abeka.com/ABB/Catalogs/AboutABB/AboutFrames.html)

The explosive growth of the home schooling movement over the last 15 years provides dramatic evidence for the interest in culturally situated education (see, McDowell & Ray, 2000) that Haack (1998) would describe as particularistic educational multiculturalism

Science education of the 1990s, with its emphasis on personal, social, and cultural relevance, meshed very well with these rapidly developing multicultural ideas. At the end of the decade, the dean of American science education, Paul DeHart Hurd (2000) wrote:

> The current science education reform movement in the United States has been underway since 1970. From the beginning, there has been broad agreement that the traditional goals of science education are obsolete and that new curricula need to be "invented" (p 282)…. A central theme for reinventing science curricula is to put science into service for individuals and for society. (p. 285)

This instrumentalist, utilitarian attitude easily fused with the now pervasive cultural awareness of difference. Salted by tacitly felt, growing doubts over Western scientific practices, accomplishments and attitudes, the fusion has yielded *philosophical multiculturalism* (Haack, 1998): all knowledge is local and culturally situated. Thus, there are "multiple realities" (Denzin & Lincoln, 1994, p. 14) – the world is lots of ways because people have lots of ways of

constructing it. There is no "preexisting reality 'out there'" to be discovered (Strauss & Corbin, 1994, 279). Rather,

> Realities are apprehendable in the form of multiple, intangible mental constructions, socially and experientially based, local and specific in nature... and dependent for their form and content on the individual persons or groups holding the constructions. Constructions are not more or less "true," in any absolute sense, but simply more or less informed and/or sophisticated. Constructions are alterable, as are their associated "realities." (Guba & Lincoln, 1994, p. 110-111)

> Rather than viewing truth as the fit between sense impressions and the real world, for a constructivist it is the fit of our sense impressions with our conceptions: the authority for truth lies with each of us. (Driver & Bell, 1986, p. 452).

Furthermore, according to this relativist philosophy, if the "authority for truth lies with each of us" then it clearly makes sense that one would speak of *Western* science rather than simply, *science*. The name of a knowledge domain is properly preceded by a culturally identifying adjective as in Eastern religion, Turkish history, or African philosophy. One might speak of masculine knowledge or feminine knowledge, but not simply *knowledge* as if knowledge were somehow universal, being grounded in a physical reality common to all. Rather, being culturally situated, no particular knowledge domain can be privileged vis-à-vis other cultural situations. The logical next step from this elevation of culture to its place as artist and arbiter of knowledge is that all knowledge is local; "what is taken to be universal, value-free truths is actually situated knowledge" (Brickhouse, 2001, p. 282).

The first step toward culturally situated knowledge is the rejection of epistemological universalism. The rejection of epistemological universalism is grounded in an instrumentalist/utilitarian rejection of epistemological realism. Our view is that the rejection of scientific universalism and scientific realism by multiculturalists has been altogether

much too facile – marked by a lack of attention to the logical implications of their contentions – and altogether unnecessary for the purposes of achieving equitable science education for diverse learners. In a previous article we made the argument for scientific universalism (Cobern & Loving, 2001; see Cobern, 1991; Loving, 1997; Siegel, 2001, Southerland, 2000). We now turn our attention to a commonsense view of realism.

A Metaphysical Choice

Understanding how people come to the rejection of scientific realism, does not endorse such a decision. To the contrary, it is our position that most rejections of realism amongst educators and educational researchers are simply naive and ultimately will not serve the needs of students with regard to an education in the sciences. Philosophical defenses of realism abound (e.g., Khlentzos, 2000; Matthews, 1994; Phillips, 2000, Sankey, 2001) and it is not our intention to repeat those defenses here. It is important to note that the defenses argued in the science education literature (e.g., Slezak, 1994 a&b; Suchting, 1992 & 1995), we believe, are rather ineffective – not for lack of philosophical depth or rhetorical skill, but for a lack of cultural acumen – particularly with respect to teachers. Our approach is a commonsense approach that first acknowledges watershed cultural events and the impact they have had on the public understanding of epistemology. Second, we suggest an alternative: culturally informed, critical realism. We must begin however, by drawing attention to what it would mean if we did indeed believe that knowledge was socially constructed, substantially unrelated to the true nature of the world in which we live.

We begin by first noting that too often opponents of relativism over-philosophize; they drown their intended audience in what many readers consider irrelevant pedantry. Eflin, Glennan, and Reisch (1999, p. 114) are led to suggest that, "philosophical debates about realism should be avoided… These debates are often Byzantine and confusing even to those of us who work in them." On the other hand, supporters of relativistic ideas, tend either to adopt a "taken for granted that this is obviously true" attitude toward anti-realism; or, they obfuscate the critical issues by adopting a strained writing style littered with the unique use of otherwise ordinary words. In this

latter group fall the very postmodernists, poststructuralists, and postcolonialists who accepted for publication, *Transgressing The Boundaries: Towards A Transformative*

Hermeneutics Of Quantum Gravity, which is of course the gobbly-gook article by physicist Alan Sokal (1996) who later revealed it as a hoax. The problem is that technical language taken to an extreme becomes a convoluted, hyper-obscurantist

private text that is, as Shakespeare wrote, full of sound and fury signifying nothing. Our intention is to present the critical arguments in common sense terms. Our method, reminiscent of Laudan's four-way discussion in *Science and Relativism* (1990, is a fictitious interrogation of a Philosophical Multiculturalist by a Critical Realist. The interrogation begins with the Critical Realist asking, "What is knowledge?"

The Critical Realist	The Philosophical Multiculturalist
CR: What is knowledge?	
	PM: Knowledge is a coherent system of thought. Coherence involves conceptual coherence and instrumental accuracy. If our theories are conceptually coherent and instrumentally accurate, we may regard them as valid – some may take "valid" to mean "truthful."
CR: Does such coherence speak to the true nature of reality?	
	PM: No. Reality is impenetrably shrouded. We have only our perceptions and the concepts we build upon those perceptions.
CR: Then how can one intelligently choose between competing theories or ideas built upon our perceptions?	
	PM: The theories that show the greatest conceptual coherence and instrumental accuracy are the ones we choose as the most valid.
CR: Ok, but we know that theories are revised, changed and discarded from time to time. How do you account for theory change?	
	PM: A theory can change based on conceptual changes concerning the same data where new conceptualizations of existing data result in greater coherence – consider the example of Copernicus rethinking the data on which the Ptolemaic system was based. And, there can be perceptual changes (e.g., new data) that lead to theory change. Consider the example of Kepler working with the massive observational data collected by Tycho Brahe.
CR: Are we talking about perceptual and experiential changes with regard to a *real* world?	

PM: Yes, of course. I'm no Berkeleyan idealist!

CR: Well good. So, would you not agree that perception is the perception of *something*?

PM: Agreed, but as I said, what that something *really is*, is impenetrably shrouded. It is our thoughts – locally influenced – that we project as reality.

CR: Perhaps but would you not agree that although one's perceptions are strongly influenced by conceptual structure – locally influenced as you say – perception is not wholly *determined* by our conceptual structures? Otherwise there would be no difference between a perception and an hallucination.

PM: First, it is not my contention that conceptual structures are *completely* determined by local influences. Second, an hallucination has little chance of leading to instrumentally accurate theory; so whether one can distinguish between an hallucination and perception is irrelevant.

CR: Well then, it seems that instrumental accuracy is quite critical to your argument. And, if you are agreeing that that conceptual structures are *not* completely determined by local influences, then it seems to me that no matter how inaccurate a perception may be, it still must contain something of reality if there is any instrumental accuracy at all.

PM: Perhaps but we can't know that to be true simply because we have no direct access to reality – I repeat: reality is impenetrably shrouded.

CR: Let's try a thought experiment. Could a conceptually coherent system that is *totally imaginative* be instrumentally accurate?

PM: Of course. The history of science provides many examples of serendipitous insight that leads to scientific advancement. Consider the example of Friedrich August Kekulé who worked out the ring-structure of benzene based on a dream he had!

CR: Could a totally imaginative, but coherent system that predicts experiences that *never* occur, be of any value in science?

PM: No

CR: In fact, for a system to be considered coherent it is important for that system to be instrumentally accurate. Isn't that so?

PM: Agreed

CR: Would you also agree that theory *improvement* means that a theory is made instrumentally more accurate and conceptually more coherent?

PM: Agreed

CR: Well then, could a speculative, coherent conceptual system that is (of course unbeknownst to us) in total ontological error, be instrumentally accurate and reliable?

PM: Anything is possible but I suppose such an occurrence would not be likely. Any accurate predictions would be quite fortuitous.

CR: Would you then also agree that any changes to this speculative, coherent conceptual system that moved it even further into ontological error, would only decrease its instrumental power?

PM: Again anything is possible but I think your statement is likely to be correct.

CR: Then consider this question: could instrumental power ever be increased in a situation where conceptual changes to the system moved the system *further* from ontological reality?

PM: It is unlikely.

CR: And consider this question: could instrumental power be improved by increasing conceptual coherence that in fact moves the system *toward* ontological reality?

PM: Yes, but you can't know that in fact this is happening.

CR: But, you agreed that we are talking about perceptual and experiential changes with regard to a real world, and that perception is the perception of *something*. And, you agreed that one's perceptions though strongly influenced by conceptual structure, are not *completely* determined.

PM: Yes, I agreed.

CR: Surely, we must them be able to say that perceptual and experiential experience are significantly grounded in ontological reality even when perceptual and experiential experience is suffused with error.

PM: I see where you are headed and I am not sure that I am willing to say that perceptual and experiential experience are *significantly* grounded in ontological reality.

CR: Then we have arrived at a metaphysical choice! It is true that we cannot know with certainty that perceptual and experiential experiences are significantly grounded in ontological reality. It is equally true, however, that we cannot know for certain that perceptual and experiential experiences are not significantly grounded in ontological reality.

I submit that nothing in human experience nor common sense suggests that it is better to accept that latter over the former.

PM: Go on.

CR: Then we surely can also agree that theory change that more sharply and accurately focuses a system on ontological reality will improve instrumental power and will itself be more conceptually coherent.

PM: Agreed, but I still must insist that you can't know that in fact this is happening.

CR: You can, given the nature of perception and experience. In so far as we reject the claim that the efficacy of a coherent system is totally *independent* of any ontological reality, the efficacy of a coherent system is at least partially dependent on ontological reality. Therefore, knowledge that increases conceptual coherence and instrumental power *is* knowledge that more accurately corresponds with reality. There is simply no other rational way to account for human ability to increase instrumental power other than that our knowledge has the characteristics of verisimilitude vis-à-vis the real world.

PM: Sigh….

Realism Reconsidered: Dürer Vs Kandinsky

The Critical Realist drives home the point that there is simply no other rational way to account for human ability to increase instrumental power other than that knowledge has the characteristics of verisimilitude vis-à-vis the real world. This is realism, that:

the world is as it is independently of how humans take it to be. The objects the world contains, together with their properties and the relations they enter into, fix the world's nature and these objects exist independently of our ability to discover they do. Unless this is so, realists argue,

none of our beliefs about our world could be objectively true since true beliefs tell us how things are and beliefs are objective when true or false independently of what anyone might think…. Nonetheless, realism is controversial. (Khlentzos, 2000)

This controversy – the assertion, as made by the Philosophical Multiculturalist, that objective knowledge about a real world is unobtainable – is an old one. Mortimer Adler noted that the question of how ideas can actually represent knowledge of an objective reality underlines all the unresolved "riddles and perplexities of later empiricism" (1974, p. x). The 18th century Scottish philosopher Thomas Reid, however, resolved this controversy in a way that many teachers of science today will find quite compelling. Reid was one of the founders of the "common sense" school of philosophy, or what Haack (1998, p. 156) calls "critical common-sensism."

> What this means is that Reid is not concerned to answer certain questions of justification that can seem enormously pressing to us in certain philosophical moods. He is not, for instance, interested in providing a justification for our belief in the external world by appeal to first principles of some sort. For instance, Reid feels he can refute skeptical hypotheses – such as Descartes's hypothesis of an evil demon who makes us believe that the world is the way we take it to be when it is really vastly different – simply by showing that such a hypothesis is no more likely to be true than the common-sensical belief that the world is much the way we perceive it to be. Since the belief in the external world is a dictate of common sense, it is, Reid thinks, as justified as it needs to be when it is shown to be on the same footing as any alternative. Justification, therefore, does not necessarily require providing positive reasons in favor of common-sensical beliefs; common sense beliefs could be adequately justified simply by undermining the force of the reasons in favor of alternatives to common sense. (Yaffe, 2000).

We can apply this view of alternatives to the "metaphysical choice" in the dialogue between the Critical Realist and the Philosophical Multiculturalist. The Critical Realist asserts:

> Then we have arrived at a metaphysical choice! It is true that we cannot know with certainty that perceptual and experiential experiences are significantly grounded in ontological reality. However, it is equally true that we cannot know for certain that perceptual and experiential experiences are not significantly grounded in ontological reality.

Reid's response would be that without very strong reason indeed, one should not reject that which human experience and common sense suggests is true.

This is not to deny that this position has difficulties and certainly the proponents of realism do not hold the unreflective position opponents of realism in education seem to think that they do. The purported difficulties for realism such as changes in science over time and the differences amongst cultures have long been recognized. Realists have always recognized that knowledge changes and develops. The realist recognizes that knowledge at any given time only approximates reality and that the quest for accuracy is endless. The realist understands that an individual constructs knowledge of reality from sense perceptions and from conjectural theories, which are subject to many influences. Knowledge is fallible (Pierce, 1931). What is the cause of fallibility? In the past one would most likely cite the inherent limitations of experimental efforts and intellectual acumen; and of course the limited nature of the scientific knowledge base at any one time. In other words our best current efforts are limited by the lack of experimental and intellectual perfection. What has changed in light of cultural, historical and philosophical studies is that in addition to these internal limitations we now recognize a new range of external limitations: metaphysics, cultural factors, predispositions, prejudice, power relationships, politics, ideology and economics.

Hence, the realist is not naive, but critical (Polkinghorne 1991). Knowledge of reality is not

like a photograph, but more like representational art. In a Dürer painting, for example:

> there is little of sensuous beauty; but the rude, stark outlines of life itself, the literal-minded dwelling on the last detail of the imaginative vision, the intense seriousness of the preoccupation with the furniture of practical life, whether in the creased strength of those faces of his merchant friends – "I think the more exact and like a man a picture is the better the work," he said ... (Randall, 1940, p. 127)

Representational art and photographs, however, are not easily confused. The vicissitude of knowledge is widely recognized in representational art. The goal may be exactitude, but the goal is ever elusive. Too often opponents of realism take realism to be an "either/or" sort of thing; either we know the real world without error, or we cannot know the real world at all. But there is a more nuanced view of realism, a critical realism, that, "recognizes that there is always some element of construction in knowledge, but maintains the common sense view that the world external to or prior to our thought places limits on what can count as knowledge" (Lillegard, 2001).

It would seem that those who embrace non-realism have grown tired of the quest to know reality and thus declare reality unimportant. It is only the construction, in and of itself, that is important. To carry further the artistic metaphor, radically, culturally, or socially constructed knowledge is a form of aesthetic *modernism* as one finds in modern art:

> Modernism ... denies the primacy of an outside reality, as given. It seeks either to rearrange that reality, or to retreat to the self's interior, to private experience as the source of its concerns and aesthetic preoccupations ... There is an emphasis on the self as touchstone of understanding and on the activity of the knower rather than the character of the object as the source of knowledge ... Thus one discerns the intentions of modern painting ... to break up ordered space ... to bridge the distance between object and spectator, to "thrust" itself on the viewer and establish itself

immediately by impact. (Bell, 1976, p.110, 112)

As with a Wassily Kandinsky painting, there is no intention to represent the natural world. The value of the art is in its impact. The value of locally constructed knowledge is also in its impact, but in science that impact is instrumental accuracy. One does not worry that knowledge match reality; only that knowledge allows the useful prediction of experience, its impact. But what metaphysic does instrumental accuracy reinforce? The eminent physicist Cecil Frank Powell noted, "all our experience of the development of science suggests that there is indeed an order in nature which we can discover..." (1972, p. 5). We go even further and assert that instrumental accuracy – *whether* in the form of Traditional Ecological Knowledge[8] amongst First Nations people of Canada or quantum physics from the Fermi Lab – reinforces the estimation that knowledge is approaching reality, and in fact undermines the radical notion of philosophical multiculturalism.

The concepts of realism and universalism in science are often perceived as threatening to other ways of knowing, particularly indigenous and traditional ways of knowing. This perception is not without warrant (see Ladriere, 1977). As European contact with peoples from far away places increased, European "perceptions of the material superiority of their own cultures, particularly as manifested in scientific thought and technological innovation, shaped their attitudes toward and interaction with peoples they encountered overseas" (Adas, 1989, p. 4). Why? Adas goes on to explain.

> In the late eighteenth and nineteenth centuries, most European thinkers concluded that the unprecedented control over nature made possible by Western science and technology proved that European modes of thought and social organization corresponded much more closely to the underlying realities of the universe than did those of any other people or society, past or present. (Adas, 1989, p. 7)

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[8] For more on Traditional Ecological Knowledge, see Snively & Corsiglia (2001).

Western teachers carried this sense of superiority based on science and technology into the colonial education system. In a rare moment of honest reflection, one such teacher admitted: "In common with so many others, I used to think that we could get rid of Bantu 'stupidities' by suitable talks on natural science, hygiene, etc., as if the natural sciences could subvert their traditional lore or their philosophy" (Tempels, 1959, p. 30). Tempels recognized resistance to invading ideas and wondered if the invaders were doing the right thing. Development theorists through the 1960s had few such doubts. Economic development theory was based on displacing traditional beliefs by modern ones compatible with science and technology (Rostow, 1971). In 1962, the prestigious journal *Science* published an approving article about movement toward a single world culture dominated, of course, by science (Dedijer, 1962).

This type of scientistic idealism explicitly directed toward the non-western world now seems far removed, but other forms are alive and well. Bunge (1996), Dawkins (1986), Gross, Levitt and Lewis (1996), and Mahner and Bunge (1996) come readily to mind. Nevertheless, the high-octane rhetoric of an outspoken few should not be taken as proof that realism and universalism in science are inherently scientistic beliefs. Nor should one conclude that the best way to protect other ways of knowing from the imperialistic behavior of scientistic true believers is to adopt a relativistic, instrumental stance toward knowledge. One should consider, for example, that no First Nations person thinks of Traditional Ecological Knowledge (TEK) as instrumental or viable. TEK exists because it is thought to be true knowledge about the real world. The concepts of "instrumentalism" and "viability" are of Western origin; and to the extent that anti-realism is promoted based on these ideas, an imperialism is being practiced that is just as menacing as any of the 19th century forms. Indeed, realism is the philosophical domain that invites indigenous knowledge – actually any proposed knowledge about the physical world – to bid for respect. Regardless of its origins, regardless of local influences, any proposed knowledge that provides insight on our physical world can gain a hearing, because realism is literally the common ground we all share. What realists want are rational or cognitively constructed warrants for believing knowledge to be true or to represent reality – evidence.

Conclusion

It is past time to get over the false claim that science does *not* really provide an objective, universal but approximate description of the real world – without forgetting that science is imperfect, incomplete and fallible; and is not the only source of knowledge that we as humans find of value. Our contention is that professional educators have been all altogether too facile in their rejection of epistemological realism. If time is taken to carefully examine the logical consequences of anti-realism, we think that most would agree that what "works" is knowledge about a real world shared by all. Moreover, universal scientific realism is not the cause of the epistemological imperialism that is so offensive to professional educators and which drives them to philosophical multiculturalism. Epistemological imperialism is the direct consequence of scientism. Attacking realism is thus wrongheaded; but worse, it is self-defeating. Attacking realism undercuts the very ground on which *other* contributions to knowledge about Nature can gain a hearing and respect beyond local borders.

Following Haack (1998), we believe that science is well deserving of *distinction* because it has been such a powerful tool for the accurate description of Nature and illumination of natural processes. Privilege is another matter. Science cannot answer all the questions humans are wont to ask; thus science can only be privileged within the boundaries of its purpose. As one noted scientist remarked: "for all its explanatory powers, science is very limited in the kind of questions that it can address well: how things work, problems amenable to quantification, and deriving general laws about the properties of matter" (Alexander, 2001). Other fields of study are called upon to answer and illuminate other questions that humans have. Different people ask different questions calling upon various forms of knowledge. It is thus appropriate that educators promote a pluralistic view of knowledge: pluralism not relativism, distinction not privilege.

17

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