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Constructivism and scientific realism? Which is the better framework for educational research

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ABSTRACT

The doctrines of constructivism and scientific realism have had a profound impact on recent progress in educational research. These doctrines are often depicted as conflicting doctrines in theoretical papers and methodology texts dealing with educational research issues. This paper explores the differences between the major tenets of constructivism and scientific reason. Different values ascribed to the scientific method in the context of these two doctrines are also examined. The paper focuses on three problems that have dogged the education research agenda: the conflict between the constructivist and scientific realistic viewpoints on science, the validity of observation statements and the role of relativism in science. An argument is made that discovery science is typically dependent on scientific realism, but that constructivism offers a counterpoint to the excessive scientism inherent in some kinds of empirical research. The most important differences, however, are probably found in their respective orientations to ~arch activity and problem-solving. The constructivist favours idiographic research and contextual analysis and the scientific realist is committed to nomothetic methods and empirical generalisation.

The doctrines of constructivism and scientific realism have had a profound impact on the progress of educational research. The influence of these two doctrines has been demonstrated frequently in theoretical papers and methodology texts that deal with educational research. Recent issues of the *Educational Researcher* abound with references to the conflict between constructivism and scientific realism and the implications for qualitative and quantitative research methods (Eisner, 1992; Erickson, 1992; Gage, 109; Rizo, 1991; Schrag, 1992). This paper contains an outline of the major tenets of constructivism and scientific realism. In particular, the paper focuses on three problems that are central to the conflict between the constructivist and scientific realistic agendas: the conflict between the constructivist and scientific realist viewpoints on scientific activity, the validity of observation statements and the degree of relativistic thought in these doctrines.

Despite their more obvious differences, most constructivists and scientific realists agree on two major issues. First, they both accept the view that the tenets of primitive empiricism, especially those associated with the version of the theory known as logical positivism, are essentially untenable (Boyd, 1983). Exponents of both doctrines hold to the position that crude empirical approaches are a poor basis for any substantive scientific theory, mainly because collections of brute facts invariably lead to superficial phenomenalism (Scruton, 1994). Realists and constructivists contend that undisciplined observations are not productive of scientific interpretation (Boyd, 1983). Proponents of both doctrines doubt that the cumulative accretion of data from particular categories of events will result in the acquisition of valuable theoretical knowledge.

Second, realists and constructivists agree that their fundamental differences are concerned with the nature of scientific theories and their relationship with the substance and brute facts of phenomena (Hacking, 1982). They concur in the view that science is concerned with the development of theoretical constructs and generalisations about the world. Both agree that valid theories are based on coherent and well articulated abstractions, though the status of the logical structure of such propositions is often disputed by the respective parties. The main dimensions of difference between the constructivists and scientific realists are outlined in Table 1. The major propositions contained in their different doctrines are explicated in the sections that follow.

THE CONSTRUCTIVIST'S VIEW ON THEORY AND THE NATURE OF SCIENCE

Constructivists are committed to the view that the on-going search for theoretical knowledge in a scientific domain is governed by rivalry between competing scientific theories or paradigms. They claim that historical and contemporary research reveals the social and competitive nature of scientific endeavour. They assert that elaborate conceptual schemes derived from particular constructions of knowledge largely determine the nature of the scientific agenda at any one period of time (Kuhn, 1970). Constructivists assert that absolute theoretical truths are elusive. According to the constructivists true science is not monumental theory, rather a set of tentative theoretical abstractions and analytical constructions.

Proponents of the constructivist doctrine contend that the typical scientist's views cannot be described in terms that are independent of the methodologies used to test their hypotheses. They maintain that scientists employ methods, analytical techniques and procedures that are biased toward particular conceptual categories (Feyerabend, 1975). Kuhn (1970) contends that those who have authored a particular scientific theory also show preference for particular scientific methods that are said to offer the best tests of the theory. Constructivists claim that scientific theory is so dependent on particular methods that the processes of theory building should be viewed as construction devices, not as discovery procedures (Boyd, 1983).

Constructivists assert that the paradigms and methodologies adopted by traditional scientists predispose them to particular views of reality. They maintain that theoretical views on the nature of reality are linked with major paradigms that depend on circumscribed types of knowledge. Facts are selected in such a way as to fit with such preordained views of the world. This is a radical view of knowledge acquisition, the assertion being made is that theoretical science is not objective. However, the view is not new in philosophical discourse. It has a long history in epistemology, derived mainly from the scepticism inherent in much of British empiricism. Constructivists claim that much of what scientific realists call theoretical frameworks are abstract contrivances, and that these have validity only within the knowledge framework favoured by elite groups. They assert that theory in science is intimately linked with particular conceptual frameworks, and that many of these are as contentious today as they were one hundred years ago. Further, scientific theory cannot be unalterably true, since it is constantly changing and adapting to current scientific discoveries. Constructivists deny the possibility of immutable reality in the theoretical entities of modern science. They use historical analysis to justify their conclusions about the weak relationships between empirical discoveries, conceptual frameworks and theory in traditional science (Kuhn, 1970).

Those who support the constructivist agenda in education typically eschew the traditional scientific methods of quantitative science. Instead they advocate qualitative research and case study methods and stress the importance of analysis rather than discovery. They maintain that there is an essential

arbitrariness in much of scientific and educational research and theory. They emphasise context in the interpretation of social phenomena and personal experience is given a great deal of prominence. Constructivists are particularly critical of scientism: the view that only in traditional science and its applications can one obtain the answers to many of the problems that pervade our everyday affairs.

THE SCIENTIFIC REALISTS VIEW ON THEORY AND THE NATURE OF SCIENCE

Scientific realists maintain that science is a body of knowledge that reflects real world phenomena and that valid theory is independent of the phenomena it describes. The generalisations of scientific theory are said to explain the brute facts of the world. They maintain that traditional science supports the scientific method as the basic mechanism for. the development of reliable knowledge. Searle (1995) has recently made a strong plea in defence the realist's position that the propositions used to describe the world are different from the substance and features of the world. He adopts the view that questions about the nature of reality should be distinguished from questions about how one acquires knowledge of that reality. The first is an ontological question; the second an epistemological question.

From the scientific realist's perspective, historical analysis reveals clear progress in the demonstration of improved theoretical representations of physical and social phenomena (Boyd, 1983). Consistent with this view, each scientific discovery is said to lead to a closer approximation of reality. Hypotheses derived from theory are used to direct the scientific agenda, but such constructs do not determine the outcome of scientific endeavour. Scientific theories are interpretations of phenomena that predict and explain phenomena.

The justification for the scientific method rests on the processes of abduction. By this it is meant that the key statements of science offer the best possible explanation of observed relationships. There is no obvious discontinuity in the different kinds of scientific explanation that emerge with each stage of scientific discovery. Progress in science is largely incremental, with more substantive representations of reality being revealed with each set of significant discoveries. Those who support scientific realism contend that the scientific method is the best logically defensible procedure with which to examine the world and the complex relationships that emerge among phenomena. The scientific method is also the basis for resolving questions about the value of competing theoretical structures. Contentious issues involving different paradigms or theories are decided by objective analysis of evidence. The purpose of the scientific method is to free the investigator from the biases that may abound because of prejudice, false doctrine or incorrect theory. The discipline of the scientific method allows the research worker to differentiate those questions or problems that are of a purely empirical kind from those that are value-laden or those requiring further conceptual clarification. Most realists maintain there is an essential dichotomy between statements of interpretation and statements that purport to inform us about the nature of the world.

Educators who support the scientific realist position adopt experimental and empirical viewpoints. They are typically strongly quantitative in orientation. Paradoxically, they are often sceptical of the results of a typical scientific investigation and constantly test the outcomes of such investigations and the accompanying theories and the predictions made in the name of science. They maintain that constructivism is essentially a sceptical philosophy that fails to recognise the high levels of prediction that follow the discovery of important scientific relationships. We now turn to the two issues that most divide the scientific realists and the constructivists. 1 refer to the matter of observation statements and relativism.

OBSERVATION STATEMENTS

Beliefs about the nature of reality can be derived from direct contact with relevant objects, reports of observations, or representations of reality in the form of social facts. The first of these are called primary observations (Fodor, 1984). The reports of such observation statements are claimed to be the basis of much reputable science. Observation statements are said to be the foundation of knowledge and the scientific method allows summary statements of these observations. These, in turn, are used as the basis of theories and interpretations of phenomena. Searle's (1995) notion of brute facts can be included under this heading. The second kind of belief is based on knowledge that can be derived from sources other than direct observation. For example, scientists typically use the reports of other scientists to bolster their claims about certain phenomena and relationships among extant data. They argue that their judgements depend on the validity of observation statements made by others. Such secondary sources are typically perceived to be less reliable than direct observations (Fodor, 1984).

The third category includes social facts or institutional facts and these are dependent on a different level of representation of reality. Searle (1995) has suggested that such social facts are very different from the brute facts and secondary observations described above. For example, the proposition that Mt Kosciusko is the highest peak in the country is a social fact dependent on the government instrumentality that gave the peak its particular name. The brute fact is that the mountain exists; the secondary observations are included in maps or descriptions drawn by cartographers. Scientists usually stress that they claim knowledge of the brute facts of the world, but use others' reports and conventional social and scientific categories to classify and describe relationships among features of objects and events.

The constructivist is usually sceptical of most of the claims made by realists about the objectivity of methods used to secure primary and secondary observations. They claim that much data gathering of the kind described above is dependent on preconceived views of the world. They claim that a typical scientist's theory determines the type of phenomena to be observed and that nearly all science is dependent on social facts, not brute facts. In particular, there is criticism of the extension or generalisation of particular scientific findings to other contexts or dimensions of experience (Fodor, 1984). The constructivist is critical of the realist's claim that the events observed by scientists are invariably reliable in different contexts. They also question whether there can be any extension of knowledge beyond the narrow confines of the particular instances of observation.

The constructivist denies that the scientist can offer a guarantee that direct observations will lead to reliable theories about the nature of phenomena. The possibility of other theories leading to similar predictions must always be considered (Feyerabend, 1975). They also maintain that the conceptual frameworks used in scientific observation invariably change with each new investigation. The training of the scientist is also seen to be crucial in determining choices about methodology, research hypotheses and analysis of data (Kuhn, 1981). It is posited that the scientific community dictates standards in all fields of investigative endeavour and determines how data are observed and how problems are solved in these fields.

Not surprisingly, the scientific realist challenges these claims. The realist replies that scientists are. constantly on guard against biased observations and inadequate theories. All observations are subject to checks done by others using alternate equipment, in other settings, and with other experimental subjects. Likewise, theory is subject to constant challenge and double-blind experimental procedures are

commonplace. Any observations that contain experimenter biases are rejected. If any of these observations lead to a conflict in the interpretation, then the conclusions drawn from those observations are rejected. Scientific realists recognise the tenuous links between observation and theory, but claim that the scientific method ensures that observations and their conceptual underpinnings are rigorously tested against valid criteria. They also claim that the theories they support must always have better predictive or explanatory power than any alternatives.

Many realists have made their reputations by disputing facts and challenging the methods and techniques used to support established theories. This is Popper's (1975) agenda for the reputable scientist. Popper advocates a version of realism and asserts that all theoretical structures should be tested against alternative interpretations. He has proclaimed the tentative and hypothetical nature of all scientific theories. Scientific realists reject the view that they have secure purchase over theoretical constructs, even those with supposed impeccable credentials.

Proponents of the opposed doctrines of realism and constructivism continue to debate these key issues. There is no resolution because each denies the premises of the other. Constructivists and realists are capable of pointing to the influence of external factors on the evolution of scientific thought. Both use historical analysis to confirm the prejudicial influence of elite scientific communities on scientific thought.

RELATIVISM

Advocates of constructivism deny that theoretical statements can be defined in terms of universally agreed criteria. According to their view, the validity of any set of statements can only be determined by reference to a particular context or observation. In a typical case, a context is defined in terms of relevance to a particular set of problems in a unique environment. Further, the measure of validity of any set of theoretical statements derived from such experience is determined by those confined to the same environment.

Constructivists often question the logical status of the propositions in the realist's agenda. They challenge both the inductive and hypotheticodeductive arguments of modern science. The logical problems of induction were identified by Hume (1739) and his insights are as valid today as they were several centuries ago. Hume argued that it is futile to trust the proposition that the future will be like the past, the essential basis of inductive argument. In essence, the argument is that it is logically false to base any theory about future events on the supposed validity of past events. The hypothetico-deductive argument is placed in the same category. In such cases the propositions of science demand a conceptual framework determined before data are gathered and analysed. Either way, according to the constructivists, the scientific bases of the scientific realist lack a logical basis.

The constructivist agenda is based on key tenets of relativism. Kuhn (1970) has said that "there is no standard higher than the assent of the relevant community" (p. 94). The relativist in this context argues that validity of any scientific proposition is determined by the judgements of colleagues in the same field. Kuhn's analysis of historical evidence has led him to support the view that there is constant adjustment of scientific viewpoints depending upon the cogency of prevailing views in established social and intellectual elites. Established paradigms in such circles determine the search for reality and these are also used to judge the validity of any conclusions drawn from research.

The realists are opposed to the relativist agenda. Realists assert the status of reality is in ontological truth (Searle, 1995). They claim that the world is independent of particular theoretical claims or philosophical interpretations. The principle of meaningful assertion is important in this regard. This holds that there is a class of

statements made about the world that can be confirmed or denied by empirical research. This is coupled with the principle of objective evidence. It asserts that any proposition should be capable of an independent validity check performed by other reputable scientists. It asserts that the ultimate truth of most theoretical propositions can never be completely verified, but that it is possible to falsify such claims by means of observation. Such fundamental tenets are claimed to counter to the themes of relativism espoused by the constructivists (Boyd, 1983).

Realists dispute the essential tenets of relativism. Well known philosophical arguments are used to attempt to defeat its logic. Plato in the Theaetetus, was one of the first to denounce the relativist argument. Plato claimed that, using the competence of an individual as an example, that expertise depends upon knowledge and that to have competence is to have demonstrated knowledge. Plato then asked: can we agree that the competent individual differs from the incompetent? In responding to this question, the relativists are often confounded. If they argue that the competent individual exists then they must define the characteristics that differentiate the competent individual from others. If they argue that such characteristics do not exist, they are obliged to support the view that the incompetent individual has the same status as the competent. Likewise, the question can be asked whether a theory in science can be defined in terms of its characteristics of worth and good science differentiated from poor science. According to the realist, the constructivist invariably asserts a sceptical position, which is essentially unacceptable in the context of modern scientific opinion.

The realist argues that science demands a measure of correspondence between the status of scientific propositions and phenomena in the real world. The realist need not support a correspondence theory of truth, rather a belief in the concordance of science and reality (Searle, 1995). If the facts correspond to the scientific hypotheses, or if the facts support or confirm the hypotheses then the conclusions are said to be valid. Independent observations are said to confirm or deny the truth of propositions of a scientific kind. Disagreements regarding particular beliefs are settled by reference to observational statements. If the observational statements do not support one kind of belief then that particular proposition is rejected. If not, then the proposition is tentatively accepted as a best possible explanation.

THE IMPLICATIONS FOR EDUCATION

Theory construction is the critical issue in the debate between the supporters of constructivism and scientific realism in education. Traditional science has favoured the views of scientific realism. This doctrine was backed by educators in the past because of its links with traditional empirical science. Education was categorised as a social science and included in the disciplines that utilised the scientific method. Science was respected because of its apparent rigour, its seeming validity, and its capacity to inform educators about the effectiveness of particular methods in the classroom. However, in recent decades the status of traditional science in education has been questioned, in large part because research on schooling has been said to offer few findings of great utility and generalisability. The present opposition to scientific realism reflects a disenchantment with the links between the methods recommended by empirical science and the teaching procedures used in schools.

More recently, theory building in education has drawn the attention of researchers from outside the traditional scientific mould. No longer is it the sole province of the scientific realist. This is partly because the central problems of education have shifted from generalised empirical findings to concerns about the individual teacher's experience of students in classrooms. Examination of the

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Table 1. A summary of the rival claims of constructivists and scientific realists

CONSTRUCTIVIST VIEWPOINT	SCIENTIFIC REALIST VIEWPOINT
(1) Theories and theoretical constructions define *reality*. It is foolhardy to attempt to separate the concepts used to define events and the 'facts' supposedly contained in the world. The constructivist accepts the scepticism inherent in much traditional epistemology.	(1) *Reality* is distinct from the propositions used to describe the world (Searle, 1995). Reality can be known (albeit often imperfectly) in the theories, hypotheses, propositions that are used to describe events in the real world.
(2) *Historical research* reveals the pervasive influence of social, political and cultural factors on the conceptual bases of scientific thought.	(2) *Historical research* reveals that scientific analysis is uniquely suited to solve particular types of empirical problems. Science has made great advances because it has freed itself from analytical methods applied in other domains of inquiry.
(3) *Scientific laws* are never confirmed or rejected. They may be shown to be commensurate or incommensurate with established paradigms (Kuhn, 1970). Favoured paradigms are typically overturned in revolutions; this happens because one paradigm is shown to be inadequate and another replaces it, the latter becoming the doctrine favoured by the weight of scientific opinion.	(3) We can never conclusively confirm *a scientific law*, but we can devalue it. The method of science is a process of error correction (Popper, 1975) or better approximation (Boyd, 1983). Some realists maintain that there can be confirmation or disconfirmation of scientific theories (Putnam, 1974).
(4) The advantages of the *scientific method* are a myth (Feyerabend, 1975). There is no one method that leads to objective and valid knowledge.	(4) The *scientific method* denotes a core of procedures that allow the testing of scientific assertions. The scientific method depends upon (a) reliable observations (b) independent verification of these observations. Theory-free observations settle scientific arguments (Fodor, 1984).
(5) The scientific method is so theory dependent that it is at best a construction procedure, not a *discovery* procedure (Kuhn, 1970,).	(5) The scientific method allows the scientist to make *discoveries*. These discoveries define progress in a scientific field (Boyd, 1983).
(6) The *validity* of theoretical propositions is defined in terms of coherence within established paradigms. The scientific community gives credence to some paradigms over others.	(6) *Validity* is determined by reference to observation and experimentation. Propositions are true if they are consistent with statements confirmed independently by other scientists. Some theorists maintain the value of a pragmatic theory of truth (operationalism) and some still retain hope for a correspondence theory of truth (Searle, 1995).
(7) Constructivist paradigms would be *logically commensurable* or of a qualitatively similar form if they embodied theories about a paradigm independent world (Kuhn, 1970).	(7) It is possible to give an account of the continuity of reference of theoretical terms which allows for demonstration of the logical *commensurability* of paradigms (Boyd, 1983).

viewpoint of the individual teacher has become paramount in examination of teaching practice. Idiographic research has come to dominate much of the research agenda in education. Educators are encouraged to explore their own experiences and those of their colleagues and students when offering explanations of classroom activity. Experience with the particular problems of the classroom is claimed as instructive to other teachers in similar contexts. The case study is viewed as the major vehicle of research methodology. Theory building is integral to an individual teacher's actions and not a task requiring knowledge of experimental methodology.

Relativism is inherent to all theory building according to those in the constructivist camp in education. Particular contexts are said to determine all spheres of action in teaching and learning. Wholesale generalisations of such experience are inappropriate because of the differences in each individual teacher's experience. Constructivists value qualitative and descriptive methods. The perceptions of the teacher dominate theoretical investigations and the individual's interpretations determine the study of educational experience. The personal perspectives that each individual brings to the classroom is seen to be critical to the analysis of the meaning of classroom events.

Realists in the research field of education teaching object to many of the constructivist's views (Schrag, 1992). They continue to espouse the value of the scientific model for the analysis of key research questions. The realists in education remain committed to scientific research of the traditional kind. They claim that there are empirical questions that require value-free analysis and that the methods of science allow the best form of investigation at this level. The importance of the nomothetic methods that focus on general laws and proven principles remains dominant in universities and schools that favour the realist agenda.

Many realists claim that an individual's experience of the world is not science and that excessive emphasis on case study methods leads only to an expansion of knowledge of individual activity. They claim that science does not promote analysis of individual values but should encourage the growth of knowledge general utility that can be useful to teachers. They are critical of the subjectivity and relativism of the constructivist agenda. They eschew the individualistic findings of the constructivists and press for greater objectivity in theory building and research endeavour.

One doctrine is committed to idiographic research; the other has an obligation to a nomothetic agenda. The constructivist is persuaded of the value of individual experience and the implications of this kind of research to individual problem solving. The realist perceives more objectivity in the scientific method and the links with traditional science. The debate continues to engender strong responses from both sides of the divide.

Academics in the field of teacher education have long been concerned with this problem. How do we justify our recommendations about how to teach and what strategies and methods should be employed in classrooms? Do we base our decisions on the case study methodologies and stress individual experience? Or do we adopt a different stance and look to the general principles derived from experimental methodologies? Most of us adopt the compromise position and use arguments from both sources to justify our advice to novice teachers. This is probably a good approach. Even so, we need to remind ourselves that there are different kinds of arguments needed to support these two categories of recommendation.

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