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# Constructivism: Defense or a Continual Critical Appraisal – A Response to Gil-Pérez et al.

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**Abstract**
This commentary is a critical appraisal of Gil-Pérez et al.'s (2002) conceptualization of constructivism. It is argued that the following aspects of their presentation are problematic: (a) Although the role of controversy is recognized, the authors implicitly subscribe to a Kuhnian perspective of 'normal' science; (b) Authors fail to recognize the importance of von Glasersfeld's contribution to the understanding of constructivism in science education; (c) The fact that it is not possible to implement

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a constructivist pedagogy without a constructivist epistemology has been ignored; and (d) Failure to recognize that the metaphor of the 'student as a developing scientist' facilitates teaching strategies as students are confronted with alternative/ rival/conflicting ideas. Finally, we have shown that constructivism in science education is going through a process of continual critical appraisals.

## 1. Introduction

This commentary is primarily a response to Gil-Pérez et al.'s (2002) presentation of constructivism, which in our opinion has various questionable aspects. In this section we briefly summarize the development and evolution of constructivism in science education in the last three decades, and then in subsequent sections we present a critique of Gil-Pérez et al.'s conceptualization of constructivism.

Most science educators would perhaps agree that during the seventies and the eighties among other forms of constructivism, Ausubelian and Piagetian constructivism played a dominant role. The research literature maintained an intense debate between these constructivist positions (cf. Novak 1977). Ausubelian constructivism promoted meaningful receptive learning and 'concept maps' (Novak 1979), whereas Piagetian constructivism promoted the 'learning cycle' generally associated with discovery learning [*Science Curriculum Improvement Study*, SCIS (Karplus et al. 1977)]. Both parties were aware that constructivism was a controversial topic and only debate could elucidate its different aspects. Interestingly, the *1980 AETS Yearbook: The Psychology of Teaching for Thinking and Creativity* (Edited by Anton E. Lawson) bears witness to the willingness of the protagonists to engage in critical appraisals (The Yearbook has chapters among others by Ausubel, Case, Karplus, Lawson, and Novak). The Foreword to the Yearbook was written by Piaget, who after recognizing that "This *Yearbook* provides a rich diversity of opinion regarding the development of intelligence and creativity", concluded: "It simply is not enough for the student to listen to lessons in the same manner as an adult listens to a lecture for reasoning to be created in the child and adolescent" (Piaget 1979, p. i). Given our present understanding of constructivism, many science educators may consider this statement to be rather 'trivial' (cf. Tsaparlis 2001), and even common ground between those who support constructivism and those who oppose it for other reasons.

Detailed and perceptive critiques were soon to follow and the one by Hodson (1985), although primarily a critique of the Nuffield curriculum, is quite representative: “To a large extent it is teachers’ inadequate understanding in philosophy of science, particularly the continued advocacy of inductivism (long since abandoned by philosophers of science), that leads them to project an unfavourable image of science and the activities of scientists through the hidden science curriculum. Such a view of scientific method undervalues creativity and treats discovery as testing and proof” (pp. 27–28). Similarly, Millar and Driver (1987) critiqued Piagetian constructivism by suggesting that science teachers need to go beyond processes by emphasizing content.

Looking ahead, 1990 was perhaps a landmark year for the science education community. Ernst von Glasersfeld, was the invited plenary speaker at the 63 Annual Conference of the National Association for Research in Science Teaching (NARST), Atlanta, GA. The session was presided by Ken Tobin and among others Anton Lawson was on the panel. Interestingly, however, at the same Conference there was a Symposium entitled: “Role of the Epistemic Subject in Piaget’s Genetic Epistemology and its Importance for Science Education”, with the following participants: Richard Kitchener, Anton Lawson, Joseph Novak and Mansoor Niaz. The presence of Ernst von Glasersfeld could be interpreted by some as the dawn of a new ‘paradigm’ (preferably research program) while yet the old paradigm (Piagetian constructivism) continued to debate important issues. It is interesting to note that Kitchener (1987), an important scholar in Piagetian genetic epistemology, was also making his debut at NARST. During the Symposium, von Glasersfeld was in the audience and interpreted the importance of Piaget’s epistemic subject within his constructivist framework: “. . . there is also the subject that does the actual constructing of an epistemic subject *qua* abstraction, and this is always a psychological subject with all its ties to the social and historical context in which it operates” (von Glasersfeld 1990). Details of the presentation of other participants in the Symposium are available in the literature (Kitchener 1993; Lawson 1991; Niaz 1991). Von Glasersfeld’s plenary lecture aroused considerable interest, to the extent that he was invited as a plenary speaker again at the 66th Annual Conference of NARST, Atlanta, GA, 1993. To our knowledge, in the last twenty years only one other plenary speaker (John Bransford) has been invited twice by NARST.

Ernst von Glasersfeld's radical constructivism has been the subject of intense critical scrutiny in the science education community. Ken Tobin, a major proponent of his ideas, now seems to be skeptical of constructivism in general (including radical) and wants to 'move on' towards other alternatives (Tobin, 2000). Osborne (1996) is particularly critical of radical constructivism's conflation of validity and viability. In other words, for radical and some social constructivists, experience is the ultimate arbiter for deciding between scientific theories and how students acquire knowledge. Kelly (1997) and Niaz (2001a) have asked: Should we teach both creationism and evolutionary theory, given that many students and teachers find creationism viable with their experience? This inevitably leads to the following dilemma: "The radical constructivists seem to have smuggled in positivistic theory choice criteria under the rubric of viability" (Kelly 1997, p. 366). Nola (1997) has emphasized that von Glasersfeld and other constructivists ignore the fact that their conceptualization of the growth of knowledge has to compete, and often unfavorably, with rival views. Hardy and Taylor (1997), on the other hand, want to blend radical constructivism with Habermas' theory of communicative action.

In the case of Jenkins (2000), who asked: 'Constructivism in school science education: Powerful model or the most dangerous intellectual tendency?', Gil- Pérez et al. (2002) almost foresee conspiratorial overtones. Our reading, however, shows that this was not the intention. Jenkins (2000) has argued that early research on 'misconceptions' dealt with concepts such as force, energy, gravity and mass (all related to everyday experiences of the students) and hence the popularity of constructivism in teaching such concepts. On the other hand, it is extremely difficult to elicit students' ideas about concepts such as an ion, electromagnetic radiation, oxidation, free energy, chemical equilibrium, and a host of other concepts. Finally, Jenkins has cautioned with respect to the limitations of constructivism (i.e., it is not a powerful model) and nor does it constitute the 'most dangerous intellectual tendency' (p. 607).

An important aspect of most constructivist notions is 'participant observation', viz., in order to understand students' construction of scientific concepts, the researcher must observe them as closely as possible and preferably without prior theoretical frameworks (cf. Erickson 1986, Guba & Lincoln 1989). Philosophers of science have drawn attention to the problematic nature of observations and that most observations are theory laden (Kuhn 1962, Lakatos 1970). This leads us to a paradox. Early critiques of Piagetian constructivism (cf. Hodson 1985) were based precisely on its underlying empiricist philosophy (discovery learning). Matthews (1993) was perhaps the first critic to have argued that even radical and social constructivism are basically empiricist in orientation: "Any epistemology that formulates the problem of knowledge in terms of a subject looking at an object and asking how well what is seen reflects the nature or essence of the object [participant observation] is quintessentially Aristotelian or, more generally, empiricist" (p. 364). For a recent appraisal of the empiricist stance of constructivism and its relation to Berkeley's idealism, see Nola (in press).

In these brief introductory remarks, we have tried to show the controversial nature of the growth of knowledge and the various forms of constructivism. In the last three decades we have seen how Ausubelian/Piagetian constructivisms had to compete not only among themselves but also with radical, social and other forms of constructivism (Geelan 1997, Marín & Benarroch 1994, Phillips 1995). Some scholars would even argue that Piagetian constructivism has still a lot to offer (cf. Smith 1999, Marín et al. 2000). This leads to the issue as to what is important is not consensus but rather a continual critical appraisal of our theoretical formulations, which precisely shows the tentative nature of science and hence science education (Abd-El-Khalick & Lederman 2000, McComas et al. 1998, Smith & Scharmann 1999; Niaz 2001b).

## 2. Development of Science Education as Kuhnian Paradigms

Although the role of controversy is recognized, Gil-Pérez et al. (2002) implicitly subscribe to a Kuhnian perspective of 'normal' science and hence the emphasis on 'emergent consensus' (p. 557, 558), 'preparadigmatic' (p. 557), 'paradigm change' (p. 558). According to the authors, in the early 1980s science education was still a 'preparadigmatic' discipline. However, ". . . an impressive development throughout the last two decades, . . ." (p. 557) has facilitated an 'emergent consensus', leading to a 'paradigm change' (it cannot be paradigm change, unless there is a prior paradigm). As we have shown in the 'Introduction', this conceptualization lacks the understanding that a 'consensus' is at most a transitory feature of scientific progress both in science and education. Given the popularity in education of the Kuhnian thesis of paradigms being replaced (Lincoln 1989), it is not surprising that science educators also follow the same philosophical thesis. Interestingly, however, the Kuhnian thesis has also been questioned by a leading educational theorist: "Where Kuhn erred, I believe, is in diagnosing this characteristic [controversies/conflicts] of the social sciences as a developmental disability . . . it is far more likely that for the social sciences and education, the coexistence of competing schools of thought is a natural and quite mature state" (Shulman 1986, p. 5). In our opinion, research in science education in the last three decades has been a process of competing research programs (Ausubelian, Piagetian, Radical, Social and other constructivisms) based on critical appraisals of the controversial nature of constructivism, that has facilitated 'progressive transitions' (Lakatos, 1970).

Finally, in a strict Kuhnian sense (incommensurability thesis), science education currently is not paradigmatic at all, because if it were, the underlying premises of the field would be impervious to the very debate we are all engaged in. Philosopher Gerald Holton (a close friend of the science education community) has provided insight as to how we may conceptualize continual critical appraisals: ". . . the scientists chief duty . . . [is] . . . not the production of a flawlessly carved block, one more in the construction of the final Temple of science. Rather, it is more like participating in a building project that has no central planning authority, where no proposal is guaranteed to last very long before being modified or overtaken, and where one's best contribution may be one that furnishes a plausible base and useful material for the next stage of development" (Holton, 1986, p. 173).

## 3. Influence of von Glasersfeld in Science Education

Failure to recognize the importance of critical appraisals lead Gil-Pérez et al. to state: "We must insist on the negligible influence of von Glasersfeld in the development of the 'constructivist consensus' in science education" (p. 559). Furthermore, according to the authors, first references to von Glasersfeld in the science education literature started to appear in 1988 and in the next decade (1988–1998) the following journals had a total of only seven citations to his work (*Journal* *of Research in Science Teaching*, *JRST* = 3, *Science Education, SE* = 2, *International Journal of Science of Education, IJSE* = 2, *Studies in Science Education, SSE* = 0; 5 of these 7 citations were made by the same author, Ken Tobin). In order to pursue this aspect further we surveyed the above mentioned journals for the three year period (1999– 2001) and found the following citations to the work of von Glasersfeld: *JRST* = 18, *SE* = 6, *IJSE* = 14, and *SSE* = 4. This gives a total of 42 citations in three years – a six-fold increase with respect to the previous ten years, and of these only one citation was due to Ken Tobin. Interestingly, von Glasersfeld (1989) received the most (9 out of 42) citations.

We present these figures in order to follow the line of argument suggested by Gil-Pérez et al. On the contrary, in our opinion citation data alone do not tell the whole story and must be accompanied by qualitative indicators (Garfield & Welljams-Dorof 1992), such as von Glasersfeld's participation in NARST conferences (see 'Introduction' section). We have shown that von Glasersfeld (without necessarily agreeing with him) wields considerable influence in science education and was in part responsible for some of the 'transitions' (or transitory consensus, if you prefer).

Once again, the Kuhnian perspective of the authors manifests itself in the following line of argument: As science education has attained the status of 'a new field of research and knowledge' (p. 557), acceptance of new ideas 'reduces its theoretical bases to the [mere] *application* of external knowledge' (p. 560) and hence the 'contributions made by Kelly and . . . von Glasersfeld' (p. 560) are questionable, as 'none of them work in science education' (p. 560).We have shown that this perspective is not conducive towards a critical dialogue between the different competing research programs and especially in the case of von Glasersfeld the science education community does seem to accept it as useful to a certain degree. In conclusion, although von Glasersfeld was not 'the originator' with respect to constructivism, he could perhaps be considered as 'the synthesizer'.

## 4. Constructivism in Science Education and Philosophical Constructivism

Gil-Pérez et al. (2002) fail to recognize the importance of history and philosophy of science (HPS) for science education by asserting: "So, we must stress that what we call constructivism in science education has little to do with philosophical constructivism" (p. 559) and furthermore that, ". the debate put forward by Suchting and others (Nola 1997, Hardy & Taylor 1997) *is not our debate*" (p. 559, original italics). Nola (1997) has argued how philosophical constructivism and constructivism in education are intertwined and the failure to recognize this precisely leads to, ". . . throwing out the dirty bath water of didacticism . . . [along with] . . . the baby of objective knowledge" (p. 80). Nola goes on to show how Plato and Socrates as early constructivists, differentiated between beliefs and knowledge (a distinction generally ignored by constructivists), and that teachers transmit beliefs and not knowledge. No wonder, if this is 'not our debate', Nola (1997) was right in having foreseen: "It seems with respect to epistemology that many of the recent moves in constructivist science education have been steps backwards, not forwards, from Socrates and Plato" (p. 81).

There has been a plethora of arguments by science educators for including history, philosophy of science and epistemology in the classroom, primarily because recent developments in these fields merit their discussion and furthermore the responsibility for this task (discussion of HPS related issues, perhaps through some form of constructivism) lies primarily with us (cf. Abd-El-Khalick et al. 1998, Burbules & Linn 1991, Duschl 1990, Gilbert & Swift 1985, Hodson 1988, Kelly 1997, Koulaidis & Ogborn 1995, Marín et al. 1999, Matthews 1994, Millar & Driver 1987, Monk & Osborne 1997, Niaz 1993, Smith & Scharmann 1999, Tsai 2002, Tsaparlis 2001).

Gil-Pérez et al. (2002) not only consider that this is 'not our debate' but also cite the following from Matthews (1997) to support their position: "It is clear that the best of constructivist pedagogy can be had without constructivist epistemology" (p. 561). In our opinion, these authors have misread Matthews' position as after the cited part, Matthews goes on to add: ". . . Socrates, Montaigne, Locke, Mill, and Russell are just some who have conjoined engaging, constructivist-like pedagogy with non-constructivist epistemology" (Matthews, 1997, p. 11). It is quite clear that Matthews is not endorsing 'constructivist pedagogy without constructivist epistemology', but rather alluding to the fact that much of constructivist pedagogy today amounts to 'pedagogical commonplaces' recommended by philosophers in the past. If there were any doubt with respect to what Matthews is trying to do here and for the last many years, consider the following written in the previous paragraph: “It is now basically accepted that when science educators speak of epistemological matters they need to be, to some extent, familiar with the tradition of epistemological debate in philosophy” (Matthews, 1997, p. 11). Similarly, Orlik (2002) has drawn attention to the fact that some of the positive aspects of constructivist pedagogy have been practiced in the ex-Soviet Union for more than 30 years (cf. Mahmutov, 1975).

It is important to note that although Gil-Pérez et al., implicitly do subscribe to a Kuhnian perspective, there is no explicit elaboration of a philosophical framework. On the contrary, the authors’ advice to science teachers and science education researchers is not to engage “. . . in the nuances and subtleties of the epistemology of different authors . . . [having] a common base. . . , such as Popper, Kuhn, Toulmin, Lakatos, Feyerabend, Laudan, Giere . . . ” (pp. 562–563). Indeed, even a professional philosopher may find it difficult to elaborate a common base for such a wide range of authors. Ironically, the journal *Science and Education* (now running in its 12th year) was founded on the premise: “The communities of philosophers, historians, sociologists, scientists, cognitive psychologists, and science educators are notoriously insular and seldom pay attention to issues outside their field. The educational loss is that all of the fields have contributions to make to the theoretical and practical problems facing science and mathematics teachers’ (Matthews, 1992, p. 2).

## 5. Student as a Novice Researcher or a Developing Scientist

Gil-Pérez et. al.’s presentation of the ‘*student as a scientis*t’ metaphor (p. 560) leads to a ‘straw man’ as hardly any science educator would perhaps accept the thesis that students work/learn as scientists (ontogenesis recapitulates phylogenesis). Science educators, psychologists and philosophers would perhaps agree that there is a limited relationship between the process of theory development by scientists and a students’ acquisition of knowledge, i.e., a ‘*developing scientist*’ (Chinn & Brewer 1993, Duschl 1990, Kitchener 1987, Piaget & Garcia 1989, Niaz 1995, von Glasersfeld 1989). Although the authors endorse the role of students as *novice researchers*, it appears that under certain situations they do visualize the *student as a scientist*, an aspect that has been critiqued previously (Marín et al. 1999, Pozo & Gómez Crespo 1998) and the following corroborates our claim: “The proposal to organize pupils’ learning as a knowledge construction corresponds to the first situation [solving routine problems], that is to say, to an *oriented research*, in fields very well known by the ‘research director’ (the teacher) . . . ” (Gil-Pérez et al. 2002, p. 560).

At this stage, it is interesting to note that the authors question the teaching strategy: “What is the sense of making pupils conscious of their ideas to immediately put them into conflict? In our opinion, the systematic confrontation of pupils’ ideas with scientific ones, can produce logical inhibitions [whatever that means]” (p. 565). Interestingly, a knowledge of HPS would recommend such a strategy, accompanied by cognitive and other variables appropriate to students’ learning (cf. Laburú & Arruda 2002, Marín & Benarroch 1994, Marín et al. 1999, Pozo & Gómez Crespo 1998, Tsaparlis, 1997) as scientists often have to work with alternative/rival/conflicting ideas. Furthermore, consideration of alternative ideas does not automatically lead to changes in the conceptions of neither scientists nor students. Both scientists and students resist changes and more so if the ideas form part of their ‘hard core’ of thinking (Lakatos, 1970).

## 6. Conclusion

It is concluded that insistence on the lack of a relationship between constructivism in science education and philosophical constructivism is futile and may even lead us to ‘atheoretical’ forms of constructivism – a possibility that most science educators, including Gil-Pérez et al. 2002, definitely do not entertain.

Finally, in our opinion continual critical appraisals of constructivism in science education can be compared to what the philosopher Hilary Putnam has referred to as the ‘boat metaphor’: ‘My image is not of a single boat but of a *fleet* of boats. The people in each boat are trying to reconstruct their own boat without modifying it so much at any one time that the boat sinks. . . . In addition, people are passing supplies and tools from one boat to another and shouting advice and encouragement (or discouragement) to each other. Finally, people sometimes decide they do not like the boat they are in and move to a different boat altogether. And sometimes a boat sinks or is abandoned. It is all a bit chaotic; but since it is a fleet, no one is ever totally out of signaling distance from all the other boats" (Putnam, 1981, p. 118).

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