Ernst von Glasersfeld
http://www.univie.ac.at/constructivism/EvG/

In: R. Duit, F. Goldberg & H. Niedderer (ed.) Research in physics learning: Theoretical issues and empirical studies. Proceedings of an international workshop. Kiel, Germany: IPN, 29–39, 1991.

A Constructivist's View of Learning and Teaching

In the course of the Bremen Symposium, Rosalind Driver made the distinction between the construction of knowledge in the scientist who creates physics and the construction of knowledge in those who have to learn physics. In my contribution I want to do two things that stem from an analogous distinction between the development of the constructivist orientation and the relevance it has, in my view, for science education. In the first part, I want to bring into focus my *radical* position and to differentiate it from the crowd that has in recent years adopted the label of "constructivism" without relinquishing the sacred cow of traditional "objectivist" epistemology. In the second, far more tentative part, I shall try to make a few didactic suggestions concerning teaching and especially the teaching of science.

Let me begin the clarification of radical constructivism with a brief semantic consideration: The English word "knowledge", central in all epistemological considerations, suffers from a more or less hidden ambiguity. To bring the ambiguity to the surface, it is helpful to go back to Greece, where the Western concern with knowledge seems to have begun. The Greeks had four words which – although I am certainly not a Greek scholar – I have come to define roughly as follows:

DOXA OPINION or EXPERIENTIAL KNOWLEDGE;
EPISTEME UNDERSTANDING of the RATIONAL kind;
GNOSIS *TRUE* KNOWLEDGE, as claimed by metaphysicians;
SOPHIA WISDOM.

The last of these, *Sophia*, is the least troublesome in our context. Although it is part of the word "philosophy", that discipline has come to focus more and more on technical problems and, consequently, rarely speaks of wisdom. And since scientists cut loose from alchemy they consider it outside their domain.

The meaning of the other three Greek words has become hopelessly confused in our ordinary language, because the word "knowledge**"**, is used indiscriminately for all of them. This is due to the conceptual muddle traditional epistemology has managed to generate. In English we speak of "Theory of Knowledge" and may have in mind cognitive areas as different as technical know-how and metaphysics. In German the word "*Erkenntnistheorie* " is usually intended indiscriminately to cover all kinds of "*Wissen* ". Consequently, semantic usage is such that conceptual discrimination and understanding are made all but impossible.

To some extent the confusion was part of a specific program. For more than two thousand years, Western philosophy has struggled to find a way to substantiate the claim that *experiential* knowledge (*doxa*) could be turned into *true* knowledge of the world (*gnosis*). Most of the great philosophers have pursued this quest in spite of the fact that there were already among the Pre-Socratics some who showed incontrovertibly that human knowledge can never be separated from the *human* ways of perceiving and conceiving. Xenophanes**,** in the 6th century BC, pointed this out as clearly as one might wish:

> Even if a man were to represent to himself the world exactly as it is, he could not discover that this is the case. (cf. Diels, 1957; Fragment 34)

The reason why this discovery is impossible was put it in the simplest form by George Berkeley: "We shall find it impossible for us to conceive a likeness except only between our ideas." (Berkeley, 1710; Part 1, §8 and §9.)

To me, this constitutes the most fundamental *logical* reason why we can never know whether the "representations" we construct are *objectively true* – there is no way to compare them to what they are supposed to represent.

Throughout the ages, the sceptics have reiterated this in many ways. But the one thing they did not do, was to unravel the confusion of *doxa* and *gnosis*, the confusion generated by the indiscriminate use of "knowledge" and "Erkenntnis" for both these very different concepts.

I am not an historian, but in my eclectic reading I have come to the conclusion that among the first who seriously attempted to clear up the confusion were some theologians in 3rd century Byzantium. Their approach has become known as "apophatic" or "negative" theology. In simple terms, what they said was this: If God is *all-powerful, ubiquitous,* and *omniscient,* he must be an entity that is altogether different from anything we meet in our experiential world. Therefore, we have no way of grasping Him in rational human concepts and the only approach is the mystic's contemplation (cf. Lossky, 1957; Meyendorff, 1974). The apophatic theologians were promptly branded as heretics, because the Church and the Pope had, of course, a considerable interest in claiming communicable knowledge about God.

Although radical constructivism has no theological ambitions, it accepts the principle of the apophatic argument and applies it to the epistemological problem in general. If our concepts are derived by abstraction from experience, there are no grounds for the belief that they could capture anything that lies *beyond* our experience. This is a second logical confirmation of the sceptics' position and it tends to show that the philosophers' goal to *know* an ontological reality is illusory.

At the moment in history when science for the first time directly threatened the teachings of the Church, the problem of knowledge, again came to the surface. Cardinal Bellarmino, in an attempt to resolve the conflict, advised Galileo to be prudent and to present his theory as an experiential one whose purpose was to compute relations between experiential events, and to make predictions about such events. This, he said, would not constitute heresy. But on no account must Galileo present his theory as a description of God's world. This was tantamount to telling Galileo to treat his theory as *doxa*, but not as *gnosis* – for gnosis was the domain of the Church and the Church alone.

There was a profound insight in Bellarmino's remarks. Galileo's greatest contribution – and the reason why he is rightly considered the pioneer of modern science – is the novel intellectual gambit he chose: he used ideal fictions in order to relate and systematize *phenomena* (i,e. experiential findings) that could never be observed to behave quite like the posited models. This gambit has proven wonderfully successful in our experiential world, but this success does not warrant the belief that we are unveiling an ontic reality, it merely shows that we can segment and handle our experiences in a relatively orderly way. As Piaget said: "*l'objet se laisse faire"* – the object is amenable to our actions[1] (Piaget, 1970; p.35; Inhelder et al., 1977; p.64).

The idea of separating rational or scientific knowledge from mystical gnosis, metaphysics, and the inspired intuitions of poets and artists, is a fundamental principle that radical constructivism has taken over from Vico, who produced the first constructivist manifesto (1710).

From my point of view, anyone who claims to have knowledge that represents the world *objectively*, that is, as it might be prior to our experiencing it, can justify this claim only on the basis of mystical revelation. Like Kant, (at least the Kant of the *Prolegomena* and the 1st Edition of the *Critique*), I believe that it is logically impossible to say anything that could be reasonably demonstrated about a world beyond our experiential interface. On the other hand, the knowledge we can justify rationally is knowledge of the world in which we are actually living, knowledge we gain from experience. And this knowledge, no matter what we do, can be formulated only in terms that we have derived from *our* human ways of perceiving and conceiving. In short, radical constructivism insists on the separation between experiential and metaphysical knowledge, and concerns itself exclusively with the experiential kind.

When I make this point it is often assumed that I *deny* reality. In fact, this is not so. I merely deny that we can *know* reality, if by "reality" we intend something that "exists" and has a structure independent of the human knower.

Constructivism is an unpopular view. The notion that, as far as knowing goes, we are unconditionally trapped in our own ways of seeing and conceptualizing, irks a lot of people. It is a notion which seems as heretical to many, and perhaps even more difficult to get used to, than did – three or four centuries ago – the idea that we are not in the center of the universe.

To end this very incomplete introduction to constructivism, let me say a word about the concept of knowledge as it appears from this point of view. Rather than a picture or representation of reality, it is *a map of what reality allows us to do.* It is the repertoire of concepts, conceptual relations, and actions or operations that have proven to be *viable* in the pursuit of our goals. Hence knowledge is considered *instrumental*, and the goals in regard to which it is instrumental lie on two levels, one biological, the other conceptual.

Viability on the biological level is analogous to "adapted-ness", i.e. the ability of an organism or a species to survive and maintain its equilibrium, given the conditions and constraints set by their present environment (cf. Glasersfeld, 1980a & 1980b).

---

1 In German I would translate this as: das Objekt lässt sich behandeln.

Viability on the conceptual level refers to the experiential *fit* and the mutual compatibility of the cognitive organism's conceptual structures and is closely linked to what philosophers call the "coherence theory of truth".

Hence, radical constructivism can be described as a theory of knowing that attempts to separate the concept of knowledge from its traditional iconic relation to ontology.[2]

Finally, I want to emphasize that constructivism, *because it denies the possibility of ontologically "true" knowledge,* must not itself be taken as the description of an ontological reality. In fact, it makes no claims of "truth" in the traditional sense and should be considered a working hypothesis that may or may not be found useful.

Constructivist Notes on Teaching

A constructivist theory of Knowing can suggest three basic points about the practice of teaching. From each of them tentative directives can be derived. None of them claims to be new, but the constructivist theory makes their relatedness explicit. Hence my points overlap to a certain extent, but in what follows I shall maintain the initial division.

1. With regard to instruction, the notion of *teaching* must be separated from the notion of *training*. – Training aims and focuses on the trainee's performance, i.e., observable actions. In contrast, teaching aims at and focuses on the student's understanding, i.e., conceptual operations.

2. With regard to language, it has to be kept in mind that knowledge is a network of conceptual structures and, as such, cannot simply be transferred by the use of words because it must be constructed by each individual knower.

3. Then there is the fact that teaching is a social activity, it involves *others* whom the teacher intends to influence. Learning, however, is a private activity, in the sense that it has to take place in the student's own mind. To guide learning, therefore, the teacher will have to have some notion of the concepts the students already have and how they relate them.

Concerning Instruction

Whereas a trainer can tell by observing the behavior of students whether or not they have learned to do what they were trained to do, a teacher can only *infer* (from what students do and say) whether they have understood what they were intended to understand. The teacher's inferences are not only uncertain in practice – they are uncertain in principle, because one person's thoughts and ideas can never be directly compared with another's.

From the constructivist point of view, understanding can only be a matter of compatibility, not a matter of identity of ideas or conceptual constructs. We can only speak of "fit", not of "match", and the meaning of "to fit" must be further reduced. An item *fits,* when it does not run into constraints. To use a spatial metaphor, it is irrelevant how much smaller the item is than the hole or crack into which it has to fit.

---

2 A fuller exposition of the radical constructivist orientation can be found in my *Wissen, Sprache und Wirklichkeit,* Vieweg, 1987.

A quantity of liquid fits into a wine bottle, and so does a grain of sand or a piece of string, but a hammer or a bicycle does not.

Hence, teachers may assume that their students have understood, when they act and respond in ways that seem compatible with the teachers' understanding. But if a student merely repeats what the teacher or the textbook have said, this is of course no indication of a conceptual fit.

Concerning Language

Since learning is not passive reception, it has to be built up by the students themselves. And the building up is much more complicated than is usually assumed. For every single individual it begins with the *meaning* of words and phrases. This may seem a strange statement, because in many ways the speakers of a given language "communicate" quite well and it is usually assumed that the words they use have the same meaning for all. An example may help to explain my position.

To learn, let us say, the meaning of the word "apple", a child must see, touch, and taste at least one apple and associate the sound of the word with some abstraction from these experiences. To know what others mean when they say "apple" in other situations, the child must have experienced several apples, and it must have abstracted a *general concept* that fits apples of different sizes, colors, and tastes. Such concepts, however, can be built up only from the subject's own experiences, not from anyone else's. They are and remain subjective, no matter how much each speaker of a language has accommodated his or her concept through interaction with other speakers.

Language, therefore, cannot transfer concepts or conceptual structures from one person to another, it can only call up, in the listener, the re-presentations of experiences that the listener has associated with the particular words and word combinations that are being said. Nevertheless language can serve teachers to *orient* the students' conceptual activity and thus suggest certain directions and help to preclude others.[3]

The insight that the interpretation of all elements of language, be they words, phrases, or texts, is necessarily a subjective undertaking, changes also the concept of *understanding*.

To have been understood no longer implies that what we said has called forth in the listener the identical conceptual structures we had in mind when we spoke. At best we may conclude that the listener's reactions in speech and behavior seem *compatible* with those we intended or expected. But, as we all have experienced only too often, this compatibility cannot be taken for granted in other situations, even when these new situations seem quite analogous to us. This, I believe, is the reason why it is often deemed desirable to teach an algorithm that can be checked step by step. But learning to repeat an algorithm, though it may indeed serve as a basis for reflection, is not the same as grasping the conceptual operations that it implies.

3 The notion of language functioning as orientation was first suggested by Humberto Maturana.

Concerning the Social Component

The conception of *others* plays a particular role in radical constructivism (cf. Glasersfeld, 1986). The constructivist approach to this question, again, is by no means new. It was outlined by Kant (1781) in the 1st edition of his Critique:

> It is clear that, if one wants to imagine another thinking being, one has to put oneself in its place and impute to it one's own subjectness ... (A 354)

If we ask how a child comes to have a notion of "others" and ultimately of "society", this statement from Kant seems to me the only viable working hypothesis. Hence I find myself in disagreement with those "Social Constructionists" who take society as an ontological given and credit the child with an innate awareness of others and the social context in which it has to grow up. In my view, this context and the elements that constitute it in the course of children's development are no less a subjective construction than the "physical" environment children construct as their experiential world. In both cases, the child proceeds on the basis of induction, that is, on the basis of failures and successes of its own actions.

If this view is accepted, it follows that if I want to "orient" the conceptual construction of others, I would do well to build up some idea as to what goes on in their heads. In other words, in order to teach, one must construct *models* of those "others" who happen to be the students.[4] Only by operating on the basis of a more or less adequate model of the students' conceptual structures can one present the required "knowledge" in ways that are accessible to the students. And students obviously do not come as blank slates. They have their own constructs, as well as theories of how and why their constructs work. Such constructs or theories may be considered "misconceptions" from the teacher's point of view, because they are incompatible with the concepts and theories sanctioned by the particular discipline at the moment. Nevertheless they make good sense to the students, precisely because they have worked quite well in the context of the students' interests and activities. And because these concepts and theories *make sense* to the students, they also determine to a large extent what the students *see*. Hence it is often necessary to do a certain amount of conceptual dismantling before the building up can begin.

For teachers, "misconceptions" should be of great interest. Like other "errors" students make, misconceptions are a good indication of how the students think at the moment – and the way they think at the moment is the only locus where the changes desired by the teacher may begin.

Perhaps the most important precept in building a model of the person whom one wants to teach, is this: what thinking human beings do or say can nearly always be assumed to make sense to them at the moment. It is therefore nothing less than an insult to tell them point blank that the answer they have worked out for a given question is "wrong". This goes for first-graders no less than for older students. If, as sometimes happens, they answer facetiously, it simply shows that they have lost interest in what school wants them to learn. And this brings me to the question of motivation.

---

4 See Glasersfeld & Steffe, 1991.

In the United States we still suffer from the aftermath of "Behaviorism". To survey the damage done by the shift of focus from the mind to performance lies beyond the present scope. Hence I confine myself here to the notion of motivation.

In the behaviorist approach, teachers were supposed to "reinforce" a subject's correct response by a meat pellet or a pat on the head – depending on whether they were dealing with a rat or a school child. This method may well increase the future probability of a particular response, but for understanding it does nothing. This did not worry behaviorists of the Skinnerian mold, because they banned the notions of meaning, concepts, and the mind and, consequently, understanding lay outside their view.[5]

Being rewarded for a way of responding does not enlighten the learner as to *why* that particular behavior should be carried out (or how it solves the problem at hand), and therefore it is not likely to generate a thirst for *understanding.* Yet it is this kind of motivation one would like to foster, the motivation that springs from the desire to tackle new problems, to increase the order in one's experiential world. This desire can be generated only by experiencing the pleasure of having found the solution to a problem one has chosen oneself and solved oneself through one's own thinking. Thus the behaviorist method, even when it succeeds in *conditioning* the student to do the "correct" thing, disregards the basic axiom of intellectual education, namely that reflected understanding of ways to solve problems is far more important than learning particular solutions.

The teacher's art – and I am using the word "art" quite deliberately – resides in getting students to generate problems of their own that are conducive to the ways of thinking that are to be taught. We have probably all had the good fortune to have had one or two inspired teachers. I vividly remember one in particular during my high school days, and when I asked myself what made him so memorable, three things came to my mind. The first was his uninhibited enthusiasm for the subject he was teaching. The second was his patience and, above all, his respect for our first fumbling attempts at understanding. The third was the simple fact that he never pretended to have all the answers and, instead, gave us the feeling that there were still mysteries to be unraveled.

In order convincingly to manifest these aspects, teachers need to have a view of the field that is a good deal wider than the specific area they are to teach. To this I would add, that they must remain aware of the inherent relativity of knowledge, and that to provide students with an adequate view of the way science builds up knowledge is in the long run worth more than the acquisition of facts.

As Rosalind Driver pointed out, for students this building up of knowledge is not the same as for the working scientist. This, however, does not mean that students should not be given an honest picture of how scientists operate. Hence, scientific knowledge must not be presented as *gnosis*, that is, as description of an observer-independent reality. Rather, it has to be made clear that the world of science is a world of idealized abstractions. Against this it is often said that only exceptional students have the ability to cope with abstract fictions. I believe this is a myth perpetuated by

5 See, for instance, Skinner, 1971; p.12-20.

those who are afraid that they would lose their authority if they relinquished the claim that the knowledge they profess is unquestionable.

I would like to close with another school memory which has acquired specific importance for me. It was during one of my first lessons in geometry. In those far distant days the teacher had a long wooden ruler and large wooden triangles with which to draw geometrical figures on the blackboard. On that occasion, the teacher wanted to introduce us to the notion of "equilateral triangle". He picked up the big wooden contraption that had one angle of 90 and two of 45 degrees, held it up for us to see, and said: "This is an equilateral triangle because two of its sides are the same length." As he was doing this, he became aware of the fact that one corner of the triangle was broken off. He corrected himself and said: "Well, it *would* be an equilateral triangle, if you imagine that missing corner." – In retrospect, since I have begun to think about education, I realized that this teacher lost a wonderful opportunity to start us off, as it were, on the right foot. He should have said: "In fact, you have to imagine not only the corner, but the whole of the equilateral triangle, because there is no truly *equilateral* triangle in this world. The equality of two sides you might find by measuring them, could always be shown to be unequal if you used more precise measuring instruments. But you can *think* of a triangle whose sides are absolutely equal – and geometry concerns the triangles you construct in your thinking, not those of wood or metal." But he did not say this, and so it took those among us who pursued the subject an inordinate number of years to discover the real beauty, not only of mathematics but of the fabulous constructions of science as well.

References

Berkeley, George (1710) A treatise concerning the principles of human knowledge. Dublin: Jeremy Pepyat.

Diels, H. (1957) Fragmente der Vorsokratiker. Hamburg: Rowohlt.

Glasersfeld, Ernst von (1980a). The concepts of adaptation and viability in a radical constructivist theory of knowledge (Annual Meeting of the Jean Piaget Society, Philadelphia, 1977). In I.Sigel, R.Golinkoff, & D.Brodzinski (eds.), New directions in Piagetian theory and their application to education, (87–95). Hillsdale, New Jersey: Erlbaum.

Glasersfeld, Ernst von (1980b). Adaptation and viability (APA Symposium, Toronto, 1978). In American Psychologist, 35(11), 970–974.

Glasersfeld, Ernst von (1986). Steps in the construction of "others" and "reality". In R.Trappl (ed.), Power, autonomy, utopias: New approaches toward complex systems (107–116). London: Plenum Press.

Glasersfeld, Ernst von, & Steffe, L.P. (1991) Conceptual models in educational research and practice, J. of Educational Thought, 25(2), 91–103.

Inhelder, B., Garcia, R., & Vonèche, J. (1977) Epistémologie génétique et équlibration. Neuchâtel: Delachaux et Niestlé.

Kant, Immanuel (1781). Kritik der reinen Vernunft (1. Auflage). Akademieausgabe, Bd.4.

Lossky, Vladimir (1957) The mystical theology of the Eastern Church. Greenwood, S.C.: The Attic Press.

Meyendorff, John (1974) Byzantine theology. New York: Fordham University Press.

Piaget, Jean (1970) Le structuralisme. Paris: Presses Universitaires de France (4th edition).
Skinner, B.F. (1971) Beyond freedom and dignity. New York: Bantam Books.
Vico, Giambattista (1710) De antiquissima Italorum sapientia. Naples: Stamperia de'Classici Latini, 1858.
