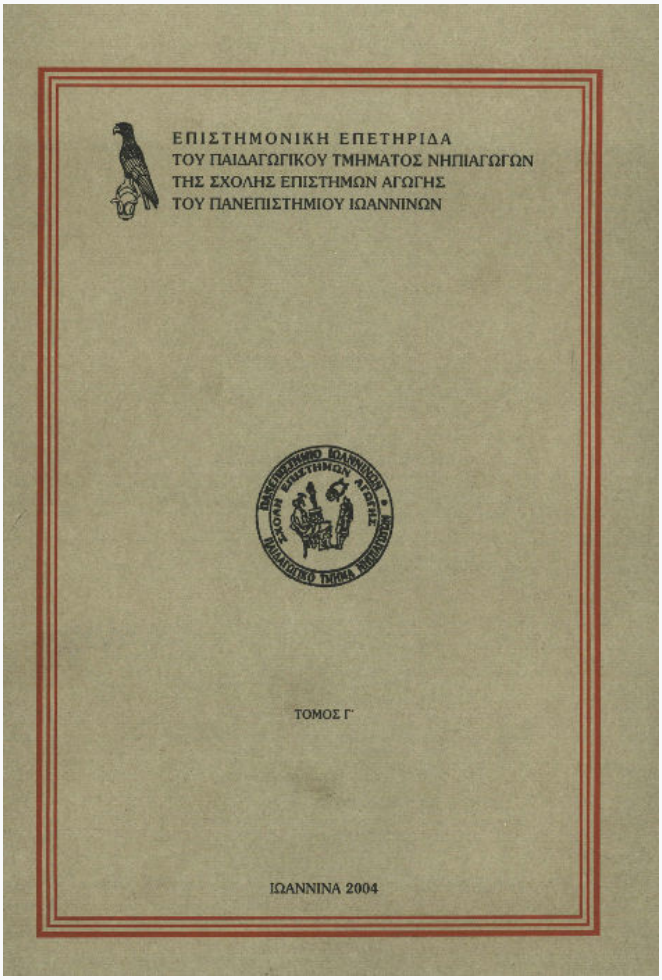
Επιστημονική Επετηρίδα Παιδαγωγικού Τμήματος Νηπιαγωγών Πανεπιστημίου Ιωαννίνων

Τόμ. 3 (2004)



Time for education: Ontology, epistemology and discursiveness in teaching fundamental scientific topics

Βασίλης Κόκοτας, Κατερίνα Πλακιτσή

doi: 10.12681/jret.964

Βιβλιογραφική αναφορά:

Κόκοτας Β., & Πλακιτσή Κ. (2015). Time for education: Ontology, epistemology and discursiveness in teaching fundamental scientific topics. *Επιστημονική Επετηρίδα Παιδαγωγικού Τμήματος Νηπιαγωγών Πανεπιστημίου Ιωαννίνων*, *3*, 49–62. https://doi.org/10.12681/jret.964

VASILIS KOKKOTAS - KATERINA PLAKITSI

TIME FOR EDUCATION: ONTOLOGY, EPISTEMOLOGY AND DISCURSIVENESS IN TEACHING FUNDAMENTAL SCIENTIFIC TOPICS

SUMMARY

Science has the character of construction of explicative normative models, whose semantic value is assessed instrumentally, though the quantified corroboration of predictions, or their compliance with the facts, constituting a separate world. But we oppose to its approach as a "logistic" activity, depraved of any ontological substantiation, since, this would ignore the meditative or interpretive features salient in it. The ontological appropriation of the world is a multidisciplinary task, which cannot be integrated without a form that combines argumentation with a meaningful discourse, open to culture.

The view of learning science as culture acquisition affords an intuitive, holistic, and rich appreciation of students' experiences in a science classroom. Common cultural mediators in science education are narratives. McClosky and Bruner have been long-time advocates of the use of narrative in education. As a case study, we applied a both cultural and ontological approach to the teaching of time in primary education.

Key words: ontology, epistemology, discursiveness, and science education.

Introduction.

We formulate, as an outline, our position, by stating that education cannot approach science and culture as "accomplished", "finished" products of the past, but must view them as processes in continuous evolution. This process as we know since Piaget, cannot ignore

the condition and the preconceptions of the learning subject, which have not a continuous smooth character, but involve in a conflictive form aesthetic, social and cultural elements, which cannot be excluded from the paedeutic practice. According to our opinion, education is interpretive both from the aspect of science but also from the point of view of the learning subject. We agree with J. Piaget's position that "the child must be considered, not as a purely imitative being, but as an organism who assimilates the things... according to his proper structure". (Piaget, 2003, p. 30). Based on this ground we believe that a child, during its development, generates interpretive skills, which are developed in individual and intersubjective codes of deciphering messages, which viewed in the perspective of future, surely do not exhaust the interpretive practice merely in the comportment of naming. On the other hand, we share the point of view that science, in case it is not crippled, is not exhausted in a quantified rendering of sense data, but ondulates between phenomenalistic subjevctivism and ontological objectivity, aspects that are transcended if it is approached under the historical - cultural perspective.

1. Ontology, subjectivity and knowledge.

Surely knowledge, especially science, has the character of construction of explicative normative models, whose semantic value is assessed instrumentally, through the quantified, statistical corroboration of predictions, or their compliance with the facts, constituting a separate world. But we oppose to its approach as a "logistic" activity, in the sense of logical positivism depraved of any ontological substantiation, since, according to our point of view this would ignore the meditative or interpretive features salient in it. It would be, of course, futile to attempt to give a rigorous logical proof of the existence of the external would. Since Kant we know that this would lead us to antinomies. But what we want to stress, is that the statements of the negative form about external reality, as e.g is the statement "trees do not exist", hint an indirect conception of what, e.g a "tree" is. To mention Merleau - Ponty, in order to demarcate the context of this indirect insinuation, "to say that perception is, and has always been, an "inspection of the spirit", is to define it, not through what it is giving to us, but through this, that among its constituents resists to the hupothesis of non existence" (Merleau - Ponty, 1964, p. 61). What we want to stress with the foregone citation, is that perceptive data, hint the

positing of the ontological question. True it would be dogmatic to negate the fact that our knowledge of the world cannot be established on final principles. But on the other hand we state our position that thought is impossible without the questioning of its ontological foundations and furthermore, citing once more Merleau - Ponty, the treading of the path of making "the perceptive faith to interrogate itself" (Merleau - Ponty op. cit. p. 138).

The above-mentioned positions do not intend to abolish the programs of the sciences of nature and society. But it must be clear that ontological interrogation is necessary for the integration of scientific knowledge and education, and also that positivistic phenomenalism having as its consort the demand of a yes/no answer, is more dogmatic than the ontological quesrtioning as it evolves in the history of science, education and culture. At this pont can be raised the question: can this position annihilate science through the destruction of the knowing/learning subject?

An undermining of subjectivism would give emphasis to the need of an aesthetic enhancement of the world. On the other hand this would have made weaker the limits of the distinction between the interior and the exterior, the action and its effect. We mean by this that the category "distinction" is less fruitful than that of process. This diversifies our attempt for an ontological emphasis on knowledge from the Aristotelian "contemplative life", which was founded on firm, eternal principles. As stated Vico, commenting in a pessimistic tone the difference between ancient and modern thought (i.e. the thought as proceeded from Renaissance until the Enlightenment) the ancient philosophers "did not trod as the physicists groping, but as the architects who would construct an immense building" (Vico in M. Fumaroli (ed.), 2001, p. 438).

By the foretold we do not intend to doubt about the fact that in knowledge are involved active subjects. But we think that it would be unfruitful to accept the existence of an extramundane, or even transcendental subject, which in turn is the foundation of an individualistic approach to the question of identity. Since we do not intend at this point to explore this problem, but only the educative approach to it we deem the most fruitful is that of J. Bruner, according to whom the "self becomes "dialogiue dependent" designed as much for the recipient of our discourse as for intrapsychic purposes" (J. Bruner, 1990, p. 101). We agree with the position of Piaget cited at the begin-

ning of this paper, that the child assimilates the world according to "his proper structure"; we only stress that this structure is mundane.

On the other hand Piaget's position which is giving a ground to the constructivist concept of "cognitive autonomy of the subject" is connected in spite of its mundane constitution, with that of the kantian critical rationality, which is the fruitful element of the transcendental philosophy. Citing P. Ricoeur, we agree with him that what makes sense of the transcendental subject "lies in the concept of judgment conceived one time as a capacity (or a faculty), and the other as a performance" (P. Ricoeur, 2004, p. 44). But we emphasize the fact that these mechanismzs have a mundane substrate, which in its psychological aspects presuppose the inter-subjective interaction of the subject. Speaking about intersubjectivity one must have in mind, that the mechanisms of the recognition of things is not identical with that of personalities, since according to Ricoeur their recognition is an experiance "not only of confidence but also of complicity" (P. Ricoeur, op. cit., p. 101). Thus subjectivity presupposes, on this ground, an aspect, which is ontological social and cultural.

2. Discursive analysis and dialogue.

What follows from the foregone argumentation is the fact that the ontological appropriation of the world is a multidisciplinary task, which cannot be intergrated, if education wants to lead humanity to self-knowledge, without a form that combines argumentation with a meaningful discourse, open to the field of culture. By this we do not intend to identify science and culture; this would ignore the formalized character of the first and would lead to the impoverishment of the emotional content of the second.

Although this demarcation is obvious and even commonplace we must admit that in the contemporary state of civilization, and especially of education, its positivistic absolutization, i.e its approach as a difference between sense and non sense, which views reason as the eradication of emotion, from the point of view of education would be prosaic or even dangerous. Speaking about danger we do not speak in utilitarian terms but in terms, of learning performance and even more of the capacity of contemporary civilization to attain its cognitive, social, and cultural target, which is the elaboration of an integrated, and at the same time polyphonic in its components, world view, according to which humankind will attain self-knowledge.

Distanced from positivism on the one hand, and relativism but also from "monophony" on the other, we do not intend to give to our approach the character of a descriptive vulgarization or a claim of the acquisition of a "final" truth. We beleive that this "refinement" of knowledge is always a process under construction, whose inception was the discovery of fire, writing and drawing, and has been sealed by such different thinkers as Plato, Montaigne and Piaget. But we also want to stress, together with Bruner, the emergency of an occasioning of an interpretive turn in the sciences of man - we mean a way of thinking that would be a turn to "a more interpretive approach to cognition concerned with meaning making" (J. Bruner, op. cit., p. 2), having always in mind to avoid an identification of meaning with naming, in the sense that we deem that this interpretive approach constitutes itself an attempt for an integrated discourse about the world, which consists in an autonomous form of life that potentially can create in its turn other forms of life.

We follow, at this point, the distinction drawn by the French linguist E. Benveniste between discourse and text viz. the character of the articulation of written language, according to which text proceeds in the third, while discourse in the first person. As mentions G. Gennette, this distinction is related to that between mimesis and the meditative forms of language, who transmit notional reflection. In the second case "there is no representation, no fiction, only speech that is invested directly on the discourse of work". (G. Gennette: 1969, p. 62). But Gennette is conscious of the fact that there is almost always a certain portion of narration in the discourse, and a certain portion of discourse in the narration (G. Gennett: op. cit., p. 65). Furthermore J. Kristeva hints that, although in an insinuated form, narrative has always an indirect dialogical, plotted form: "The dialogical play, as a correlation of signs, the dialogical permutation of two signifiers for a signified, is performed at the plan of narrative, without being exteriorized in the textual manifestation, as does in the case of a novel" (J. Kristeva 1969, p. 98).

The previous statement hints that the accomplished narrative is the outcome of the interaction between discourse and text, but also that in these two forms of writing exists a latent dialogical, or even fictive element. Of course a conceptual exposition cannot be directly "polyphonic", in Bakhtine's sense, but one has to acknowledge the fact that it cannot be the subject of an interpretation of the yes/no form, and we asses as fruitful the opinion of Kristeva, about the exi-

stence of a laternt dialogical - fictive element in it. This opinion can be traced back to Plato, and we state emphatically the following fragment from Plato's "Sophist": "Foreigner: So, intellect and discourse are identical; but the internal dialogue inside the soul, implemented without voice was not dubbed intellect? — Theaetetus: Of course yes. (Plato, Sophist 263e).

In the case of writing a dissertation, or a text for educative purposes, one must always have in mind that this form of writing "must have a movement, and this term is preferable to that of plan" (G. Gennette: op. cit. p. 35). This is one more indication of the dialectical character of the discourse. In brief, we state that because of this, its meaning cannot be "purely" conceptual in a strictly univocal sense. By this we mean that this meaning is in its turn one, at the same time discursive/dialogical narrative, and the process of signifying, which of course is a thematical and normative process, which follows the path of an open historically determined course.

3. Science in a Multiscience Perspective.

What is science when we refer to science education? This question may be curious for conventional science educators, because for them science is science. Ogawa (1995) adopts a rather broader definition of science; that is, 'a rational perceiving of reality' where 'perceiving' means both 'the action constructing reality and construct of reality' (p. 588). Caution should be taken that the 'rationality' in this context never means Western modern rationality alone. If 'rational' is the correct term for behavior in accordance with rules, there can be a kind of rationality in each culture. Then he distihnguishes three types of 'science'.

The first type, 'indigenous science' is defined as 'a culture-dependent collective rational perceiving of reality', where 'collective' means held in sufficiently similar form by many persons to allow effective communication, but independent of any particular mind or set of minds (p. 588). It is the science in a certain culture. A specific cultural group, not a specific individual, holds indigenous science.

The second type, 'personal science' is the science at the personal level and defined as 'a rational perceiving of reality, which is unique to each individual' (p. 588).

The last type of science is Western modern science, which is defined as 'a collective rational perceiving of reality, which is shared and

authorized by the scientific community' (p. 589). Only the scientific community itself justifies western modern science. All other institutions have been excluded from the 'inquisition' of scientific justification, and are expected to accept it without objections or doubts. While the former two types of science pertain to the every-day-life world, characterized by a human vitality and purpose found in the descriptions and explanations of what scientists called natural phenomena, Western modern science pertains to a Cartesian materialistic world in which humans are seen in reductionistic and mechanistic terms (p. 589). While indigenous science and personal science treat the everyday-life world, Western modern science treats the scientists' theoretical world. Thus, we science educators are just in the multiscience setting.

4. The need of integration.

Glen Aikenhead's perspective on how students make sense of their natural world widens even further if we consider the worldviews that students possess. Cobern (1991, 1993, 1994b) draws upon anthropology to hone a model of worldview comprised of seven "logico-structural categories" (self, other, causality, classification, relationship, time, and space). Worldview "provides a special *plausibility structure* of ideas, activities, and values, that allows one to gauge the plausibility of any assertion" (1993, p. 57). Worldviews are culturally validated presuppositions about the natural world. To understand a student's worldview is to anticipate what meanings in a science curriculum will appear plausible and which will not. Seen as a "fundamental organization of the mind" (Cobern, 1991, p. 42), worldview connects with cognitive psychology and lends itself to fruitful investigations into various worldviews, including those of Western science. However, as a *culturally dependent* fundamental organization of the mind, worldview suggests a broader perspective on science education: learning science as *culture acquisition.*

The view of learning science as culture acquisition affords an intuitive, holistic, and rich appreciation of students' experiences in a science classroom (Costa, 1995; Hawkins and Pea, 1987; Maddock, 1981; Swift, 1992; Wolcott, 1991). It is a practical extension of constructivist theories and plausibility structures. Driver's social constructivism has also moved towards a perspective of culture acquisition: "Learning science in the classroom involves children entering a new community of discourse, a new culture" (Driver, Asoko, Leach, Mortimer and

Scott, 1994; p. 11). Research into personal, social, and worldview constructivism will continue to contribute significantly to the broadened conception of learning science as culture acquisition; for example, respectively, the work of Driver, Leach, Scott andWood Robinson (1994), Solomon, Duveen and Scott (1994), and Lawrenz and Gray (1995).

The cultural perspective proposed in this paper recognizes conventional science teaching as an attempt at transmitting a scientific subculture to students (Hawkins and Pea, 1987). But cultural transmission can either be supportive or disruptive (Baker and Taylor, 1995; Battiste, 1986; Urevbu, 1987). If the subculture of science generally harmonizes with a student's life-world culture, science instruction will tend to support the student's view of the world ("enculturation"). On the other hand, if the subculture of science is generally at odds with a student's life-world culture, science instruction will tend to disrupt the student's view of the world by trying to replace it or marginalize it ("assimilation"). The distinction between the enculturation and assimilation forms of cultural transmission is central to the cultural perspective that we are proposing for science education. Enculturation appeals to students who are science enthusiasts while assimilation attempts to dominate the thinking of students. Both enculturation and assimilation require cultural border crossings into the subculture of science (Aikenhead, 1996).

5. Narratives as alternative media to teach science.

A common cultural setting in science education is the use of narrative stories. McCloskey (1990) suggests that there are two dominant ways by which people come to understand a topic - by metaphor or narrative (or models and histories) and that different fields tend to be dominated by one mode, for instance metaphors dominate physics whilst narrative dominates biology. Whilst this may be true for certain domains, there are other fields where both metaphor and narrative play important roles, for instance in engineering education, where both mathematical models and case studies are used to good effect by educators. It is also debatable to what extent a metaphor can be viewed as a narrative structured in a specific manner. Bruner (1996) has been a long-time advocate of the use of narrative in education, particularly science education. He has proposed three primitive forms of 'meaning-making', which involve an individual's spontaneous inclination to

engage in a dialogue with material, to impose some form of organisation upon it and to make comparisons with an individual sense of the conventional. He suggests that narrative meets the needs of these three modes well:

"Stories are the vehicles par excellence for entrenching the first three modes of meaning-making into a more structured whole".

Narrative has a broader significance than education. It has been shown that experts in any field tend to embody their knowledge in the form of narrative. It can be argued then that to become knowledgeable in a domain is to become familiar with its narratives, and to construct your own relevant ones.

Narratives also have an important cultural significance. Whyte (1981) states the study of narrative involves: "reflection on the very nature of culture and possibly even on the nature of humanity itself".

Others have suggested that narrative is a means by which we interpret out notion of self, for instance Brooks (1985) claims: "Our lives are ceaselessly intertwined with narrative, with the stories that we tell, all of which are reworked in that story of our own lives that we narrate to ourselves...".

Similarly Fisher (1987) has proposed a 'narrative paradigm' wherein he suggests that stories are the method by which people impose order and reason upon the world. By framing events in a story it permits individuals to interpret their environment, and importantly it provides a framework for making decisions about actions and their likely outcomes. Individuals create new stories for themselves which "better account for their lives".

The challenge to science communication is to establish a bridge between science and the general public. To this end it is necessary to translate science into some common language that allows the reader to become interested and excited about scientific information.

If we are to educate society in and about science, we have to treat equally all of the cultural media of science. We have to consider, in particular, science fiction, science fantasy, drama, and other forms of narratives that include science as a theme, which are cultural expressions of the history of science in our society-receptacles of scientific knowledge and important resources for science communication. In a broader sense, those narratives represent an imposrtant means for science communication to transmit and recreate information in an accurate, memorable and enjoyable way.

6. A case study: Teaching the concept of time.

In order to expand science education to the horizon of culture we have to reconsider our teaching approaches to the fundamental topics, as it is the topic of time.

In the case of time, as one of the fundamental categories of thought (Piaget 1969, Ogborn & Mariani 1995), we carried out a researching program for three years in Athens. The research question was: how could we help pupils to reconcile their own; subjective; and relativistic; perceptions about time to the typical; conventional; objective; and homogenous; time of the society.

In the first phase of our program, we recorded pupils' conceptions of time, following the Piagetian method of clinical interview. According to the Piagetian perspective, the four categories of thought - object, space time and causality - have those constructing mechanisms that will be uselful in constructing relevant concepts, providing cognitive economy. Furthermore, concepts, such as historical time, longitude, growth, and measurement of time, requirr re-combination to give unity or to make a whole. For this, we try to show the inter-relationships explicitly among the above concepts by being able to cross-refer to relevant fields where appropriate.

At the second phase of our program we expanded our study to the social constructivist field; and we tried to help pupils to make a cognitive progress in small steps; or according to Vygotsky to scaffolding their ideas about time; that is to say to enrich pupils' conceptualization of time.

We designed a research program to study a curriculum including teaching strategies adapted to childern of 9-10 years of age. Children performed tasks related to different disciplines, (History, Science, Techonology etc.). Simultaneously, we anticipated children to develop cognitive skills, such as observation, comparison, classification, correlation, communication etc. The procedure followed the steps of action research.We gave a query to the children of four classrooms to find out their ideas about time. Then we teach the topic of time, interdisciplinary, for two months, using 20 worksheets. During teaching, both teachers and external observers were keeping records concerning the cooperative process and the development of skills.We also made video and audio records. After teaching, we gave to children a similar query and another one three months later. By elaboration of the data we reconstructed the curriculum to be more effective.

At the third phase we created open learning envrironments (Roth, 1995), and we used learning strategies, such as dialogues (Lemke, 1990), argumentation (Toulmin, 1958, Walton, 1996), academic controversies (Johnson & Johnson, 1995) etc. Pupils exchange their ideas, they were telling stories about time, and they argued using many types of justifications. They challenged each other; but also they negotiate their ideas and make a synthesis that made meaning to them.

The first outcomes of this project show off the necessity of integration through interdisciplinarity, about fundamental topics such as time. Besides, children develop skills (they estimate and measure durations more successfully; they make right successions of events or actions, even they do not observe them directly; they can correlate dimensions such as length and time). Furthermore, they expanded their perception about linear and cyclic time, through cooperative learning; arguing; and also challenging each other. They also improve attitudes about their sociocognitive roles in their group. Pupils conceptualize time in two dynamic/interactive ways: one subjective (psychological time) and one objective (social time that reflects the time of the classical/Newtonian Physics).

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