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The Up-To-Dateness of a Constructivist Educational Science

1. The topic

This contribution deals with the crisis of modern science and with an attempt to remove the crisis[1].

Basis is the Methodical Constructivism. That is a philosophy of science, which was founded in the 70ties by WILHELM KAMLAH and PAUL LORENZEN. Its beginning traces back to EDMUND HUSSERL (1859-1938). The philosopher pursued a revision of theories to remove their basic crisis. The book „Logische Propädeutik. Vorschule des vernünftigen Redens" is regarded as the contemporary beginning point. The first edition was published in 1967. The constructive paradigm is represented in the present at several German universities with different main focuses. A comprehensive representation of the program is shown in the four volumes „Enzyklopädie Philosophie und Wissenschaftstheorie" published by JÜRGEN MITTELSTRAß between 1980 and 1996.

More familiar then the Methodical Constructivism is the Radical Constructivism. Authors like v. FOERSTER, v. GLASERFELD, MATURANA, VARELA and WATZLAWICK belong to the radical paradigm. The following presentation refers to the Methodical Constructivism. The shortcomings of the Radical Constructivism (JANICH 1992) advise to differentiate between the two paradigms.

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[1] This contribution contains a revised version of the lecture given 2005 at the University of Gdansk on the occasion of the 70th birthday of Prof. Bolesław Niemierko.

The Methodical Constructivism exercises an influence on natural sciences and mathematics. For example a constructive theory of time (JANICH 1980), a constructive geometry (INHETVEEN 1983) and a constructive logic (INHETVEEN 2003) has been developed. Similar developments in the empirical social sciences are still in its infancy. Among them is a constructive theory of educational measurement (KROPE 2000), a study on constructive evaluation (KROPE et al. 2002) and a study on the development of terms (KROPE and WOLZE 2005). According to this basis, the following focuses on the constructive foundations of empirical educational science.

2. God as starting point of knowledge

In the year 1654 the Chevalier de MERE asks the mathematician and physicist BLAISE PASCAL (1623-1662), why it should be advantageous to bet on the appearance of the six in four throws on a dice, but disadvantageous to bet on the appearance of the double six in 24 throws with two dices in a game. PASCAL corresponds with his mathematician colleague PIERRE de FERMAT (1601-1665) about this inquiry. The answer is: The two different probabilities are 0,518 and 0,491 (SACHS 1974, 436).

This beginning of the theory of probability was 350 years ago. It marks a radical change in the search on the origin of truth. Once more 1000 years before AURELIUS AUGUSTINUS (354-430) tried to prove his theory about the creation of the cosmos. According to the Christian philosopher God creates the world out of nothing. Before creation there was neither matter nor time. If time is related to creation, God is beyond time. The question about the when of the creating moment of the world becomes useless. Matter, time and form are the factors, which constitute the world. God created one part of being in its final form, another part that changes. This doctrine explains the world, without falling back on other reasons for the creating activity than God. According to AUGUSTINUS God is the starting point of truth.

3. Nature as starting point of knowledge

Whereas AUGSTINUS regards knowledge as a window to divinity, FRANCIS BACON (1561-1626) considers it as a way to rule the nature. By using scientific methods, nature could be utilized for human beings. Induction is regarded as the proper method of science. The experimental procedure starts with collecting observations. According to BACON knowledge is a true image of nature without misrepresenting ideas.

Whereas BACON designs a method for the organisation of nature, RENE DESCARTES (1596-1650) yields the conceptual frame for the transformation of nature into a resource. With the universal laws of mathematics he tries to decipher and manipulate the secrets hidden in the nature. He recognizes that every being is subjected to the order and the standards of mathematics. Consequently there have to be general laws for explanation, the laws of the universal mathematics.

The works of BACON and DESCARTES show the two fundamental directions, in which the search for scientific knowledge goes. The advocates of pure empiricism like BACON, HOBBES, LOCKE, BERKELEY and HUME suppose sensory perception to be the basis of knowledge. Only single objects and phenomena are true. Correct use of reason enables to order them and to get inductively conclusions. In contrast the main supporters of rationalism like DESCARTES, SPINOZA and LEIBNIZ claim the possibility to recognize the structure of reality through the true principles of thinking. The logical order of the world allows perceiving the structure of the reality deductively. Model are the mathematical methods with the possibility of drawing conclusions from proof axioms.

Modern empirical sciences seize these two directions and combine them. The Logical Empiricism connects experimental methods with mathematical logic. Scientists who follow the Logical Empiricism try to abolish the controversy between empiricists and rationalists. On the one hand knowledge about reality can only be achieved through experience. On the other hand logic secures the correct use of statements and the steps from one statement to another. In this paradigm scientific findings are an image of reality. Not God, but nature has become the starting point of knowledge. This view of science, which is supported by names like RUDOLF CARNAP, CARL G. HEMPEL, MORITZ SCHLICK and PATRICK SUPPES, is still decisive to an empirical educational science.

4. The failure of the empirical program

In the Logical Empiricism the problem of a rational foundation of science is unsolved. The sociologist HANS ALBERT describes the difficulties regarding the rational basis of science with the term „Münchhausen-Trilemma“(ALBERT 1975, 11-15, 183-210). Accordingly every attempt to establish science has three equal problematic alternatives. The first one is the regressus ad infinitum with a never ending chain of arguments. The second unacceptable alternative is the vicious circle, in which sentences occur as their own reasoning foundation. Thirdly, problematic as well is the dogmatic start of a science, where arguments in the very beginning are meant unnecessary. The insecurity about the foundation of science questions the results, procedures and aims of the Logical Empiricism.

The failure of the empirical program leads to a retreat on activities inside the theories. This kind of science is limited to the interpretation of mathematical-logical descriptions. For this restriction of the validity of statements HANS ALBERT introduces the term „Modellplatonismus“ (ALBERT 1967).

In the program of the Logical Empiricism a theory is created by introducing so called basic terms (BUNGE 1967, 483 seqq.). These are symbols of a language system, which do not possess a reference to reality. BUNGE (1967, 483 seqq.) describes non interpreted symbols like ⊗, #, x, t or e as linguistically abstract. These symbols represent a meaningless basis of a language system. With their help axioms can be developed, which are still formal conditions as well. Combined with syntax rules, they represent the feature of a theory which is described as axiomatic and abstract. It has no empirical relevance.

An example for an axiomatic theory is the classical test theory. The majority of tests and questionnaires which are used today are constructed on the basis of this theory. But even written and verbal examinations often are founded on its pattern, because of the lack of qualified alternatives.

The classical test theory formalised by GULLIKSEN (1950) is an abstract theory. The most important conditions of this theory can be described in three axioms. The first axiom says that every observed test score (x) obtains a true score (t), which depicts the constant feature of a test person. According to the second axiom, the measuring is affected unsystematically by an error score (e). The third axiom expresses the idea that an obtained test score x may be conceived as a combination of a true component t and an error component e according to the equation x = t + e.

The classical test theory is abstract, because essentially it represents nothing else then a collection of arithmetic statements. Arithmetic sentences do not state anything about „our universe“. They are just a game with symbols. The fundamental difficulties with the interpretation of a test result, which occur to pupils, students, parents and teachers, are attributed to the non interpreted theoretic language. This can be shown by the symbol for „true“. According to SUTCLIFFE (1965) there are different interpretations of the symbol for „true“. One possible interpretation is the so called classic (for t) and another one the so called platonic (for t´) interpretation. The different interpretations entail different methods for calculation. In the case of classic interpretation, t and e are considered as uncorrelated. Consequently the item score variance is assembled out of the variance of the true score and the error score according to the equation: $s_x^2 = s_t^2 + s_e^2$. In the case of platonic interpretation a correlation is supposed. Thus for the computation of the item score variance the covariance has to be taken into account according to $s_x = s_{t'}^2 + 2\mathrm{cov}(t', e)$. The choice of the appropriate interpretation depends on the epistemological preconditions. But a logical decision about these preconditions is impossible as is described in the Münchhausen-Trilemma.

Modellplatonismus prevents a regular reference to the practice of examinations. The classical test theory confines itself to the mathematical description of methodology of tests. No connection to reality is claimed. If pupil A achieves 30 points in a test, pupil B 20 points and pupil C 10 points, a proper information about the relationship of numbers can be given. One pupil achieved more points than the other pupil. One pupil achieved three times more than the other one, and so on. But there are no rules explaining the meaning of the score points outside the area of numbers. To give explanations and to draw consequences would be the job of practice-oriented experts. But in the traditional empirical science of education there is no suitable theoretical foundation available. Educational diagnosticians are millionaires without ever washing the dishes.

5. Language as starting point of knowledge

To remove these difficulties, the Methodical Constructivism develops a scientific language beginning with everyday language. Instead of axioms speech acts are introduced, the correctness of which scientists are able to prove. The following explains this method exemplary with the term „true“.

What is a “true proposition”? Previously the word “true” has been used without saying what is to be understood by it. I shall make up leeway now. But when clearing up the term, I shall do it without the usual axiomatic procedure, because undecided propositions would be the result. It will be determined constructively instead (according to LORENZEN 1974, KROPE 1988). In accordance with the constructive method it will be formulated by the use of everyday speech from the very beginning. The constructivist begins on the pragmatic level, with sentences understood by anybody. When clearing up a term, he proceeds from these sentences via the semantic level to the syntactic level of a scientific language.

Let me begin with a simple speech act. I say: “This is a circle”, “This is a square”. Imagine, please, that my cat Felix is standing at my right-hand side. Then I can say: “This is a cat”. I practice these sentences with you by showing you the usage with the help of appropriate objects: “This is a circle”, “This is not a circle, this is a square”, and so on: “This is short”, “This is long”, “This is rotating”. In any of these small sentences I say something about an object. Pointing at the objects I apply words such as “circle”, “cat”, “short”, “rotate” to them. These words are called “predicators”. The procedure is called “predication”.

In predicating complete sentences such as “This is rotating”, “This is a cat” are used. In doing so, the word “this” is accompanied with the gesture of showing, which I use to point at another object each time. If the object, which I am pointing at, is a person, then it is common practice to replace the gesture of showing by special words, that is to say by proper names. I need not say any longer: “This is a cat”. Now I can say: “Felix is a cat”, or: “Peter Krope is a professor”. Of course the use of proper names is also common practice with other objects such as towns, rivers, countries and animals.

The simplest sentences that can be understood without a gesture of showing, have the following form:

E is p.

Here the letter “E” represents any proper name, e.g. “Felix”, “p” represents any predicator, e.g. “a cat”. If we put in the words, we get:

Felix is a cat.

Instead of “E” and “p” other letters can be used for other proper names and other predicators, e.g.:

E_1 is q

for

Peter Krope is a professor.

The copula “is” can be abbreviated through “ε”, the copula “is not” through “ε’”. So the sentences can also have the following forms:

E_1 ε q

and

E_1 ε’ p.

Sentences of the form “E ε p” are called “elementary sentences”.

As far as I have evolved the elementary sentences, they can give rise to misunderstandings. The reason for this is the fact that the predicators, which are contained in them, have only been defined by examples and counter examples in my lecture so far. Therefore disagreements how to use these predicators may appear again and again in a discussion. In order to reduce these difficulties, another arrangement has to be taken. What it will be like, I am going to show with the two predicators “cat” and “professor”. I ask you to pay attention again to this. The arrangement begins like this: I simply ask you not to call Felix “professor” and not to call myself “cat”. The request is reasonable, because, in our time, a cat usually cannot be a professor. Now I formalise again and formulate my request like this: “Transit from the proposition ‘Peter Krope is a professor’ to the proposition ‘Peter Krope is not a cat’”. In this combination of words two already known elementary sentences appear, that is to say firstly: “E_1 ε q” (for “Peter Krope is a professor”) and secondly: “E_1 ε’ p” (for “Peter Krope is not a cat”):

$$E_1\ \varepsilon\ q \qquad\qquad E_1\ \varepsilon'\ p$$

Let us use the symbol ⇒ for the expression “Transit from... to...”. So the combination of the two elementary sentences, completely formalised, looks like this:

$$E_1\ \varepsilon\ q \Rightarrow E_1\ \varepsilon'\ p \qquad (1)$$

If we replace the abbreviation for the proper name (E) by a variable for proper names (x) in the formula, then we get formula (2):

$$x\ \varepsilon\ q \Rightarrow x\ \varepsilon'\ p \qquad (2)$$

Formula (2) is, to a certain extent, a generalisation as compared to formula (1), because it claims validity irrespective of a definite name. If you do not object and follow my request in the future (the request is innocent and there is no reason not to follow it), then this formula will express a rule, according to which, in the current situation, the two predicators are to be used. The rule is: if the first affirmation has not been denied, then it is forbidden to deny the second affirmation. It is one of many rules and admittedly a very simple one. Rules like these, which standardise the use of predicators, are called “predicator rules”.

Those of you who still apprehend misunderstandings concerning the use of the two predicators may doubt the proposition in question and take the offensive. Let us call the person who attacks a proposition “opponent” and the person who defends it “proponent”. The opponent only needs to choose a proper name, from the variability range of x. Let us say, he - to simplify matters - chooses “E_1” at the beginning. Thereby he binds the proponent to defend the sentence “Transit from ‘E_1 is q’ to ‘E_1 is not p’”:

$$E_1\ \varepsilon\ q \Rightarrow E_l\ \varepsilon'\ p.$$

The proponent does not find the defence hard. Since there is a rule available for the proposition, it can be defended against any opposition. So the opponent may agree: “Why, yes! That's right! These are the formulas no. 2 and 1!” This agreement may be formalised in formula (3):

$$(E_1\ \varepsilon\ q \Rightarrow E_l\ \varepsilon'\ p)\ \varepsilon\ \text{true}. \qquad (3)$$

The word "true" was introduced as predicator by formula (3). In words: a proposition is true, if rules can be given according to which it can be defended against any opposition.

The introduction of „true“ presents two constructivist principles. Firstly: The basis of the scientific language is the everyday language. The vocabulary, the syntax and the semantic are developed with reference to every day life. Secondly: Every step of the development is well-founded referring to everyday situations which are beyond doubt.

What are the consequences for the empirical educational science? Because of the constructivist procedure results of tests become understandable. The problematic assumption that a term is comprehensible through itself is not longer needed. The connection of speech acts with practical situations supports the application of scientific findings.

In the Methodical Constructivism language is an understandable condition of the possibility to do scientific work.

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