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EQUAL AND UNEQUAL. ORTHOLINGUISTIC BASICS OF THE COMPARATIVE METHOD

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1 Inquiring for a Method

Starting point of the following considerations is an observation at German schools. It signifies following: Pupils who are introduced to any kind of science are in general just able to reproduce the knowledge given to. The ability to go further than just reproducing the knowledge is hardly ever evident. These learners do not understand the science. They can not make use of the learned. They are unable to apply it to an analytic process. The limitation of the learning results being mainly restricted to factual knowledge is not only a German speciality. But Germany in comparison to other countries lies world-wide below average when it comes to the ability to apply the acquired knowledge at school (BAUMERT et al. 2001).

The two authors of this paper have developed with their research team a course in the area of elementary mechanics. The course is being tested in three countries, Germany, Poland and Hungary. The experiment serves to test the educational objectives. The didactics especially designed for the course is supposed to lead to learning results which – in the sense of the taxonomy of BLOOM et al. (1973) – go beyond only reproducing knowledge. The didactics is also supposed to be applicable internationally.

This paper serves as methodical preparation for the international study. Its subject is the method of the comparative educational science. That is the comparative method.

The descriptions of the comparative method vary. According to the different research areas and theoretical positions the spectrum extents from historical comparisons to studies of literature up to empirical analyses. In essence its task is to describe relations as equal and unequal (HILKER 1962, p. 100). The purpose of this paper is to determine the terminology for the everyday expressions "equal" and "unequal" so that conclusions for the design of the international empirical study can be made.

2 The Ortholanguage as Basis

The design and the carrying out of any empirical study vary according to the chosen paradigm. The study prepared in this paper is based on the Constructivism that has been found by KAMLAH and LORENZEN (1973) and LORENZEN (1987) and has been further developed by JANICH (2001). To differentiate from Radical Constructivism the position will be called Methodical Constructivism. An encyclopaedic description gives MITTELSTRAß (1980, 1984, 1995, 1996). The Methodical Constructivism has

been chosen as an epistemological position which involves the attempt to introduce science in understandable, circle-free, and non-dogmatic procedures.

The comparative method of the study is distinctively based upon the scientific language of the Methodical Constructivism. This language is called "ortholanguage". The following is to represent the ortholanguage and its most important principles in the use of the comparative method.

2.1 The Predication

The development of the ortholanguage starts with an activity that ensures it will be understood. In the most simple case it is a gesture with which can be pointed at something. This specific ACT is called SHOWING GESTURE[1]. To simplify the wording that what can be pointed at is called "OBJECT". In the case of an advanced linguistic understanding the SHOWING GESTURE can be accompanied by words that are chosen from the everyday language such as "this is.....". For example we can point at the left OBJECT in table 1 and say simultaneously: "This is the sign of definition". With example and counter-example the use of the phrase "sign of definition" can be trained. For this purpose it is first pointed at the right and then at the middle OBJECT of table 1 with the words "this is no sign of definition".

⇋	≈	≠

Table 1: OBJECTS for constructing a language using a SHOWING GESTURE and the linguistic act "this is.....".

In Methodical Constructivism the following differentiations have been introduced. We may point at an object and say simultaneously: "This is a pencil". An example where a person is mentioned could be: "Socrates is a philosopher". And with an animal it could be said: "Felix is a cat". In all three cases words are being referred to OBJECTS, in the first case the word "pencil", in the second case the word "philosopher" and in the third case the word "cat". This process of referring words to OBJECTS is called "PREDICATION". The word that has been referred to the OBJECT is called "PREDICATOR". Instead of saying "a word is referred to an OBJECT" in Constructivism it has been agreed to say that a PREDICATOR is assigned to an OBJECT.

The most simple sentences that are understandable without a SHOWING GESTURE have the following form:

(1) N_1 is p_1.

In (1) "N_1" stands for any PROPER NAME (in the example: "Socrates"), "p_1" for any PREDICATOR ("Philosopher"). This applied results again in:

(2) Socrates is a philosopher.

[1] In this paper the relevant ortholinguistic TERMS are written in small capitals.

Instead of N_1 and p_1 other letters can be used for other PROPER NAMES and other PREDICATORS, e.g.

(3) N_2 is p_2

for "Felix is a cat".

The copula "is" can be abbreviated with "ε", the copula "is not" with "ε'". Therefore (1) can also look as follows:

(4) $N_1 \varepsilon p_1$.

Expressions as "N ε p" are called "ELEMENTARY SENTENCES". When the assigning of the PREDICATORS has taken place correctly we deal with a TRUE STATEMENT.

Explicit agreements are made to avoid communication problems about STATEMENTS. The form of these agreements can be made clear by the request not to call Socrates a cat. Formalised the request reads:

(5) Go from the STATEMENT "Socrates is a philosopher" to "Socrates is not a cat".

Using the symbol "$\Rightarrow$" instead of the expression "go from … to …" the sentences in (5) look as follows :

(6) $N_1 \varepsilon p_1 \Rightarrow N_1 \varepsilon' p_2$.

If in (6) the abbreviation for PROPER NAMES (N_1) is replaced by a variable for PROPER NAMES (x) it results as follows:

(7) $x \varepsilon p_1 \Rightarrow x \varepsilon' p_2$.

Line (7) presents a generalisation of (6) as far as validity is claimed to be independent of a specific name.

PREDICATORS whose use is standardised as shown above are called "TERMS of a scientific language".

The previous comments about the ELEMENTARY SENTENCE have to be extended as follows for further considerations. In an ELEMENTARY SENTENCE a PREDICATOR is being assigned or denied to one or more OBJECTS. The PREDICATION is presented linguistically in a standardised form through three components. To these components belongs first of all a system of NOMINATORS (like PROPER NAMES, in the previous symbolised by "N", or DE-SCRIPTIONS represented with the help of an INDICATOR). The PREDICATED OBJECTS are being substituted in the STATEMENTS through the NOMINATORS. To the components of the PREDICATION belongs secondly the group of the COPULA namely the TO BE COPULA (ε, "Seinskopula"), the OCURRANCE COPULA (κ, "Geschehniskopula") and the ACT COPULA (π, "Tatkopula"). The third component of the PREDICATION is the group of the PREDICATORS to which among others belong the OBJECT PREDICATOR (e.g.: "the item of the physic test", symbolised by "q"), the OCCURRENCE PREDICATOR and the ACT PREDICATOR (e.g.: "solving the item of the physic test", symbolised by "p_5 q") as well as the ACT APPREDICATORS (e.g. "quick", symbolised by "r"). An ELEMENTARY SENTENCE such as "Alexander K. solves the item of the physic test quickly" looks as follows with the agreed symbols:

(8) $N_3\ \pi\ r\ p_5\ q$,

whereas the act copula "π" can be read as "doing": "Alexander K. does solve the item of the physic test quickly". The TERM "TRUE" is a PREDICATOR on a meta-level, called META-APPREDICATOR.

2.2 Beginning in the Living World

The preceding explanations had to show that in Methodical Constructivism the elements and rules of the scientific language can be introduced free of prerequisites and gradually understandable. The constructive building-up of the language starts on the pragmatic level with sentences which are assumed to be known. From these sentences the building-up proceeds via the semantic level to the syntax. INHETVEEN (1983, p. 1) describes this proceeding as a three-step-method. To avoid the mistakes of other scientific positions the building-up starts explicitly not in reference to the terminology of these positions. The beginning is rather placed in the living world ("Lebenswelt"). Applied are terms of the everyday language.

An example[2] from a biology lesson may illustrate such beginning in the living world. The class watched the film "life in the water". At the end of it the teacher gives the pupils the assignment to prepare a report about their favourite animal of the film. The class has two favourites and can not yet decide on one and therefore watches the film once more. The comments are: "This is a swordfish" (favourite no. 1), "this is a whalefish" (favourite no. 2). With the second expression the teacher allows the pupils for the time being to name the animal by using colloquial language and to put it in the category of fish. After the whale has emerged as the winner of the favourite role a differentiation of fish is being made: Whales reproduce like mammals. The word "whalefish" is from now on avoided and the standardised use of a specialised term defined. The class decides to differentiate the TERM from the colloquial language expression by small capitals as WHALE.

3 The Terms of the Comparative Method

3.1 Intention and Extension

The STATEMENT "$N\ \varepsilon\ p$" says as agreed that the PREDICATOR "p" has been ASSIGNED to an OBJECT N. The STATEMENT can be read: The PROPERTY p has been allocated to the OBJECT N. Or: N has the PROPERTY p. In the above example "$N_1\ \varepsilon\ p_1$" it is stated that Socrates is a philosopher. In other words the PREDICATOR "philosopher" has been ASSIGNED to Socrates. It can also be said: Socrates has the PROPERTY of being a philosopher.

Another example[3] is "$N_4\ \varepsilon\ p_4$". In this case N_4 describes the number 2 and "p_4" stands for "positive whole number smaller than 5". "$N_4\ \varepsilon\ p_4$" means then: "The number 2 has the PROPERTY (the PROPERTIES) to be a positive number, a whole number and a number smaller than 5".

[2] The example according to KROPE et al. (2000, p. 25).
[3] The example according to THIEL (1989, pp. 11f.).

To be a positive number, a whole number and a number smaller than 5 are the PROPERTIES of the OBJECT N_4 and are expressed by "$N_4 \varepsilon p_4$". These PROPERTIES of the OBJECT N_4 are being expressed by PARTIAL PREDICATORS which are being summarised by the PREDICATOR "p_4". As PARTIAL PREDICATORS they determine its INTENTION. "INTENTION" are called the PROPERTIES expressed by the PREDICATOR.

The PREDICATOR "p_4" in "$N_4 \varepsilon p_4$" has further more an EXTENSION. The EXTENSION is determined by the OBJECTS (the numbers 1, 2, 3 and 4) which fall under the PREDICATOR "p_4": "EXTENSION" describes the class of OBJECTS which show the PROPERTIES of the PREDICATOR.

To sum it up it can be said: The PROPERTIES expressed by a PREDICATOR are called "INTENTION" (in the colloquial language: Content), the class of OBJECTS which show this PROPERTY are called "EXTENSION" (in the colloquial language: Extent).

Also in the further above used example sentence (8) ("Alexander K. solves the item of the physic test quickly") a PREDICATOR is ASSIGNED to an OBJECT. Also this PREDICATOR consists of various PARTIAL PREDICATORS which are expressed in the colloquial language by "physic", "item", "test", "solve" and "quickly". These PROPERTIES are the INTENTION of the PREDICATORS in (8) whereas the class of OBJECTS which belongs to the PREDICATOR is its EXTENSION. The exact answer to the question which PROPERTIES are concerned with r, p_5 and q can however be answered only after a terminological clarification.

An example for using precise TERMS instead of misleading colloquial language expressions is given in the study of dogmatism (KROPE and LORENZ 1993). In the study the TERMS central for the analysis have been defined on the basis of the Methodical Constructivism introducing the TERM "DIALOGICAL" as follows: A DIALOGICAL behaviour of a person which refers to the association with texts when dealing with the TRUTH of (descriptive and prescriptive) STATEMENTS has been described as T-DIALOGICAL. A DIALOGICAL behaviour which refers to the association of one person with another when dealing with the TRUTH of (descriptive and prescriptive) STATEMENTS has been described as P-DIALOGICAL. In reference to the association of a person with texts it has been said:

$$\text{dogmatic} \leftrightharpoons \neg \text{ T-DIALOGICAL}$$

with "$\neg$" as a symbol for "not" and "$\leftrightharpoons$" as a symbol of definition. In words: A person who is not dealing with texts DIALOGICALLY in regard to their TRUTH is DOGMATIC.

In regard to the function of orientation of a person with other people it has been said:

$$\text{authoritarian} \leftrightharpoons \neg \text{ P-DIALOGICAL}.$$

In words: A person who does not orientate other people DIALOGICALLY in regard to STATEMENTS when it is about the truthfulness of (descriptive or prescriptive) STATEMENTS is called AUTHORITARIAN. On the basis of this terminology in the study of dogmatism STATEMENTS about DOGMATIC (p_6)

and AUTHORITARIAN (p_7) behaviour of a test person such as Christian S. (N_5) have been formalised as

(9) $N_5 \pi p_6$

and

(10) $N_5 \pi p_7$.

3.2 Two-place Predicators

The so far discussed PREDICATORS are called ONE-PLACE PREDICATORS. They are always only ASSIGNED to one OBJECT. In "$x \varepsilon p_1$" the PREDICATOR "philosopher" is entirely ASSIGNED to Socrates. In the STATEMENT "Platon is a pupil of Socrates" in comparison two OBJECTS (Platon and Socrates) are associated with each other due to the PREDICATOR "pupil of". This RELATION is formalised by

(11) $x, y \varepsilon p^0$

with p^0 as a TWO-PLACE PREDICATOR. The high-ranking index is supposed to express the TWO-PLACENESS while the low-ranking index in the previous examples is supposed to express the ONE-PLACENESS. In RELATIONAL STATEMENTS like (11) it is said that two OBJECTS marked through a TWO-PLACE PREDICATOR stand in the RELATION xRy.

3.3 The Relation of Equivalence

In the following three PREDICATOR RULES will be specified which are necessary for the definition of the EQUIVALENCE RELATION.

A TWO-PLACE PREDICATOR p^1 is called "SYMMETRIC" if following requirements are fulfilled:

(12) $x, y \varepsilon p^1 \Leftrightarrow y, x \varepsilon p^1$,

whereby the double arrow in line (12) is indicating that the transitions from one partial STATEMENT to another is not only valid in reading direction but also in the opposite direction. An example for a SYMMETRIC RELATION is:

(13) x, y ε married $\Leftrightarrow$ y, x ε married.

A TWO-PLACE PREDICATOR p^2 is called "TRANSITIVE" if following requirements are fulfilled:

(14) $x, y \varepsilon p^2$ and $y, z \varepsilon p^2 \Leftrightarrow x, z \varepsilon p^2$.

An example for a TRANSITIVE RELATION is:

(15) x, y ε related and y, z ε related $\Leftrightarrow$ x, z ε related.

A TWO-PLACE PREDICATOR p^3 is called "REFLEXIVE" if following requirements are fulfilled:

(16) $\Rightarrow x, x \varepsilon p^3$.

Line (16) deals with an unconditional prescription. It says that an OBJECT equals itself.

A TWO-PLACE PREDICATOR describes a RELATION OF EQUIVALENCE if it is simultaneous SYMMETRIC, TRANSITIVE and REFLEXIVE.

3.4 Equality

Sentences which describe SYMMETRIC, TRANSITIVE and REFLEXIVE RELATIONS in a defined area are called "EQUAL". EQUALITY is given through an EQUIVALENCE RELATION.

The EQUALITIES which stand in the foreground in comparative empirical studies are the IDENTITY as well as the INTENSIONAL and the EXTENSIONAL EQUIVALENCE.

To begin with the IDENTITY. For the RELATION OF IDENTITY "I" is valid: Is xIy, so "x" and "y" are two different names of the same OBJECT G. The IDENTITY follows the rules of the REFLEXIVITY and the SUBSTITUTABILITY. The latter says: If x and y are IDENTICAL and if a STATEMENT about x is valid then it is also valid about y. Because SYMMETRY as well as TRANSITIVITY follow from REFLEXIVITY and SUBSTITUTABILITY IDENTITY (as all EQUALITIES) is an EQUIVALENCE RELATION. As distinguished from the below described EQUALITIES IDENTITY is also called a "TOTAL EQUALITY".

For IDENTICAL STATEMENTS following example is given. Two scientists make and describe independent observations to check the objectivity of their research work. They compare the records of their last experiments and come up with the STATEMENTS "$N_5\ \pi\ p_6$" (for "Christian S. behaves DOGMATICALLY") and "$N'_5\ \pi\ p'_6$" (for "Krischan S. behaves NOT T-DIALOGICALLY"). First of all they know from conversations with their test subjects that Christian S. is called "Krischan" by his friends. Secondly they know from the based study of dogmatism that "NOT T-DIALOGICALLY" is the definition of "DOGMATICALLY". According to the rules of REFLEXIVITY and SUBSTITUTABILITY the STATEMENTS "$N_5\ \pi\ p_6$" and "$N'_5\ \pi\ p'_6$" can be said to be IDENTICAL.

Besides the IDENTITY the INTENSIONAL EQUIVALENCE is a relevant EQUALITY for comparative empirical studies. An example is the just mentioned use of the TERMS "DOGMATIC" and "NOT T-DIALOGICAL". The EQUIVALENCE RELATION expressed in examples like this is also called "SYNONYMITY".

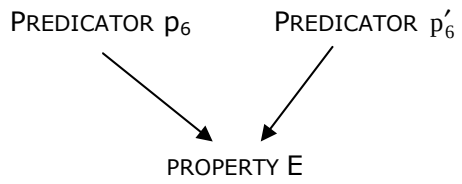
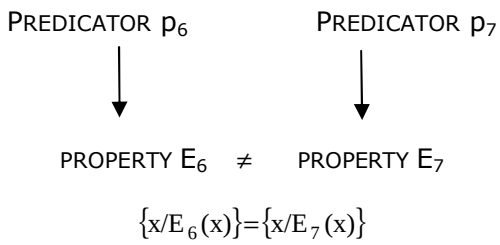
INTENSIONAL EQUAL	EXTENSIONAL EQUAL
	

Table 2: The difference between EXTENSIONAL and INTENSIONAL EQUALITY. The arrow is to be read as "describes". It means in reference to the preceding examples: p_6 – DOGMATIC, p'_6 – NOT T-DIALOGICAL, p_7 – AUTHORITARIAN. Explanations in the text.

Finally to the EXTENSIONAL EQUIVALENCE as the last EQUALITY mentioned here. FORMS OF STATEMENTS that are being fulfilled by the same OBJECTS are called "EXTENSIONAL EQUIVALENT". If humans (x) who behave DOGMATICALLY ($x \pi p_6$) at the same time behave AUTHORITARIAN ($x \pi p_7$) then "$x \pi p_6$" and "$x \pi p_7$ " are being called EXTENSIONAL EQUIVALENT FORMS OF STATEMENTS. TERMS that are EXTENSIONAL EQUIVALENT represent IDENTICAL classes of OBJECTS.

The difference between INTENSIONAL and EXTENSIONAL EQUALITY is shown in table 2. By means of the illustration it becomes clear why INTENSIONAL and EXTENSIONAL EQUALITIES are also being called PARTIAL IDENTITIES.

4 Consequences

4.1 Language as Reference Level

How can scientists assure that in a comparative empirical study comparable is being researched?

To answer this question it could be useful to recommend a procedure that might arouse the appearance simply to be above any doubt. It is about relating immediately and without detour to what the study is about. In the case of this procedure the object of scientific finding is looked at in a realistic view as an independent fact and is taken as the reference level. Assumed that a scientist wants to let pupils explain what happens physically when two of his students stand on the car park of his institute opposite of each other on skateboards and one pulls the rope the other one has tied around her hip. The seeming unproblematic possibility to show what it is about is the use of a SHOWING GESTURE. The scientist points with his finger to the scene on the car park in front of his window without even saying a word about it. In this way he could present the structure of his experiments at the respective place of summit. This scientist would be in the company of those scientists of the satire of SWIFT in which after the abolition of the language everything they wanted to talk about with each other they had to carry in big sacks with them on their back (SWIFT 1990, pp. 282 – 284).

The problem of this procedure is the assumption of a term free basis of scientific knowledge. This assumption is forbidden for the planed empirical

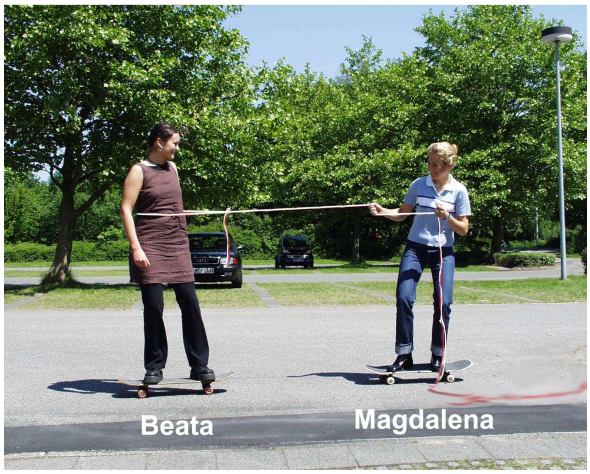
study. The assumption is not shared with Methodical Constructivism. "EQUALITY" as explained in the previous relates to STATEMENTS. In the following it is asked for the linguistic means which in a comparative empirical study can guarantee comparability.

4.2 Limitations of Living World Utterances

In the study to be prepared the acquisition of skills in the area of elementary mechanics is supposed to be analysed in an international comparison. To assure the objectivity the analysis is being carried out with test items of the multiple-choice type.

Instruction
In the following you will find an item. In the item you are being asked a question. Underneath the question are four answers. Which answer is the most applicable one from the physical point of view? Please cross just one answer.

Item 7
Two people (Beata und Magdalena) stand opposite each other on a skateboard. There is a rope tight to Beata's belt. Magdalena pulls on the rope. What happens?



a) Magdalena pulls Beata towards her.
b) Beata offers Magdalena resistance.
c) Just Magdalena exerts strength.
~~d~~) Magdalena and Beata exert strength to each other.

Table 3: Item 7 of the mechanics test, German version.

The mechanics test developed for the study includes a total of 13 items. Every item has only one correct solution which is chosen from four alternatives. In table 3 a test item is described together with the instruction. The right answer is marked (~~d~~). The elements of a multiple-choice item are the problem in the head, the illustration of the problem as well as the answers. The wrong alternatives, a, b and c, are supposed to be so attractive that they distract from the right answer. The distraction function gave the wrong alternatives the name "distracters".

The mechanics test shows a peculiarity. With the help of the terminology of the elementary mechanics two alternatives per item are formulated on an ortholinguistic basis. For the item in table 3 that are the TERM "EXERTION

OF STRENGTH", its introduction as a TWO-PLACE PREDICATOR and the formalised definition "$F(K_1, K_2)$" for "body K_1 exerts a strength towards body K_2 and in reverse". The introduction of the TERM "EXERTION OF STRENGTH" starts in the course of mechanics in the living world. Therefore two alternatives in each item are formulated in an everyday language. These everyday language phrases present a problem in an international comparative study. The problematic nature of it is illustrated in the following example. On a conference in Hungary the test item of table 3 was introduced to the staffs teaching at school and university. To describe the represented situation in the item alternative b has been used as an everyday language STATEMENT which pupil in Germany make the most use of: "Beata offers Magdalena resistance". The expression proved to be problematic in the lecture because the translator stated not to know how to translate it. Following her information in Hungarian it is for example said of a democrat he offers resistance against an undemocratic ruler. The picture however represents an unpolitical situation and therefore the expression "resistance" is unsuitable.

To analyse the outlined problematic the expression "living world" is being used. This is an expression that above all the philosopher Edmund HUSSERL (1976) made known. With the expression "living world" the area of pre-scientific experiences can be distinguished from the scientifically conveyed experiences. In the study the TERM "life worldly" takes place as a synonym for "pre-scientifically".

Which kind of pre-scientific experiences a person makes can depend on various factors. To the determining factors could belong the gender, the age and the place of residence. These factors can form different living worlds. Male pupils could make different pre-scientific experiences than female pupils, young people different ones to older people and the people in Hungary again different ones to the people in Germany. They belong to different living worlds. They can gain different pre-scientific experiences from the world which can be reflected in different habits of the daily used language. The differences can be so big that young people from one district can not understand young people from another district when they use their everyday language. In general we most likely chose for pre-scientific explanations our own language rather than the one of a foreign world of living.

The influence of the living world is also to be expected in test results. As above mentioned the wrong answers in a test item have the function to distract from the correct answer. After the comments about the living world following is to be assumed. If the wrong answers come from a person's living world these answers are more attractive and likely to be chosen as if they would not come from their living world. In other words: The item becomes more difficult because the right answer is less frequently marked; and opposite. These circumstances have already been confirmed in pilot studies but still are supposed to be clarified in more detail in a main analysis.

4.3 The Design of the Study

In the study the expectation is to be tested that the course can internationally impart skills that rise above the level of only reproducing knowledge. The basis for this check up are the items of the mechanics test which each time contain two life worldly and two ortholinguistic formulated alternatives. The limits set to life worldly STATEMENTS leave comparisons through STATEMENTS about INTENSIONAL EQUALITY appear inappropriate when the factors determining the living world are not to be identified. The achieved scores of the participating countries can not directly be compared with each other to clarify the question.

To find an answer pre-test-post-test-experiments with test groups and control groups are being carried out (compare table 4).

Group	**Pre-test** expected are:	**Intervening Variable**	**Post-test** expected are:
Test group	life worldly solutions	instruction	ortholinguistic solutions
Control group	life worldly solutions	[no intervention]	life worldly solutions

Table 4: The design of the study.

Formally the design can be represented as follows:

$$\not{R} \quad \begin{matrix} \text{test group:} & X \rightarrow Y_1 \\ \text{control group:} & \neg X \rightarrow Y_2 \end{matrix}$$

Whereby X describes the instruction that takes place between pre-test and post-test, the negation sign $\neg$ describes the missing intervention between pre-test and post-test, Y describes the learning-growth between pre-test and post-test and the arrow the (assumed) causal factor. The two rows with the formalised representation of the design are to be read as follows:

- From instruction (X) follows a learning result Y_1.
- From missing instruction ($\neg$ X) follows a learning result Y_2.

Due to financial reasons the analysis is carried out with spontaneous groups. These are groups of learners who participate voluntarily in the study. Usually the leader of the analysis has neither acceptance and cancellation in his hands nor the allocation of the test- and control group. The crossed out "R" (~~R~~) says that the groups are not being randomised. Since the groups do not represent real random samples according to the systematic of CAMPBELL and STANLEY it is dealt with a pre-experimental design[4].

The design says that the question of the study is supposed to be clarified trough STATEMENTS about the EXTENSIONAL EQUALITY. "EXTENSIONAL EQUALITY" means in connection with the international comparison: The empirical study enables to give a STATEMENT about to what extent the test persons in the participating countries change their answer behaviour from pre-test to

[4] The contribution of CAMPBELL and STANLEY is being cited in the German translation by SCHWARZ (1970).

post-test. And namely in the case of a successful course in the sense that at the beginning all test persons mainly gave life worldly answers. At the end of the study the answers mainly turned out as follows if the experiment was successful:

a) Above all ortholinguistic solutions in the test groups.

b) Now as ever above all life worldly solutions in the control groups.

5 Conclusions for the Comparative Method

The following discussion takes place exemplary. Afterwards the possibilities of generalisation will be outlined.

To be able to determine the EQUALITY and the INEQUALITY of STATEMENTS or respectively TERMS by the means of the comparative method firstly the INTENTIONS and EXTENSIONS of the individual TERMS (representational moments) are to be determined. But secondly also the general operational ways (operational moments) of the TERMS which through the entire system of the TERMS (theory, paradigm) are being codetermined. For the everyday expressions as already emphasized this definition is problematic: Life worldly expressions are ambiguous. They are context dependent or respectively context open. Therefore its operational and representational moments can not easily be determined. For the elementary mechanics this can be seen from numerous international analyses as well as from our own previous results. On the one hand the results show that life worldly knowledge in regard to movements of materialistic bodies has culture invariant characteristics. This can be explained from homogeneous regulations of actions within this living world. On the other hand differences are noticeable even between subjects of the same cultural circle. The living world TERM of strength can for example firstly be discriminated from a TERM of resistance and secondly be related to a PROPERTY, a kind of substance (object) or a RELATION. Various distinctions in form of a PROPERTY-, a substance- and a RELATION-thinking have been discovered as (subjective) differences. Also in regard to the differentiation of resistance and strength varying importance occurred. They extended from a strict differentiation to an identification in specific contexts.

The determination of these circumstances between the TERMS of strength as well as between these TERMS and the TERM of resistance is as far as that goes difficult because these differentiations are in general more implicit than explicit and sensitive context depending. This can be seen for example with explanatory problems to which the specific meaning is orientated by the most meaningful seeming ways of solutions or rather solutions. Scientifically equivalent problems can with this have as a result different life worldly explanations. The hereby thorough valuations can be determined through more extensive, possibly cultural depending sense constitutive contexts of different kinds. An example from the more recent history of physics is supposed to make this more clear. In contrast to the symmetry claims of the western natural scientists with explanatory problems of the weak interaction the Chinese physicists were the ones who predicted and proved the violation of the reflections symmetry

(SIMONYI 1990, pp. 519 ff.). SIMONYI assumes that the decisive difference is to be looked for in the cultural valuation of this symmetry which can be reflected in the different cultural symbols, the mirror symmetrical cross and five-spikes-star on one hand and the non-mirror-symmetrical YAN-YIN-symbol on the other. In that case identical INTENTION would be given by the difference in the EXTENSION through cultural speciality. This however only becomes clear by operating with the principles.

One consequence of this study is to strictly aim the comparative analysis at the results of the learning process namely the acquisition of the physical theory. For this the life worldly expression of the execution of strength is being formally specified as a TWO-PLACE PREDICATOR. With this little modification one gains a partial specification of the life worldly causal principle to a principle for a self-referential acquisition of the physical theory (initial concept). The acquisition is developed by an explanatory program that can be worked on step by step. For the analysis of EQUALITY and INEQUALITY in all it can be differentiated between three essential areas whereby this study is being confined to the two first ones:

- Acquisition of the initial concept (specified causal principle).
- Further development of the initial concept.
- Application of the acquired physical theory.

In the first case those life worldly term systems are EQUAL that lead to a successful acquisition (EQUIVALENT concerning the basic acquisition skill of the initial concept). This EQUIVALENCE refers to the operative moment concerning this special context. INEQUALITY can arise from on one hand the quality of the initial concept and on the other through the particularity of the life worldly term systems which have not yet become noticeable. Suitable is valid for the second case. Developing problems could arise here for example by holding on to the substance interpretation in specific contexts which are determined by epistemological conceptions, cultural or subjective-emotional assessments. Here then exists an INTENTIONAL INEQUALITY. In both cases the INEQUALITIES according to this procedure are not taken into consideration if they do not lead in the areas of further development and application to INEQUALITIES. Arising INEQUALITIES are being analysed by means of specific intervention methods. EQUALITY and INEQUALITY result here analogous to the preceding.

A generalisation of the results is only bound to a particularity of the life worldly term systems of which use has been made in this exemplary analysis: It has been assumed that the life worldly term systems have a common characteristic that can be ortholinguistically specified. In our special case this was the life worldly expression of the execution of strength. If such a characteristic does not exist first of all in a different way a common ortholinguistic starting point has to be established.

The conclusions that can be made for the comparative method from the previous remarks are summarised in three points:

- The language and not what is talked about is the reference level in a comparative empirical study.

- The basis for assessing EQUALITY and INEQUALITY are the STATEMENTS of a strictly standardised language. That is the terminology.
- The ortholinguistic terminology allows the consideration of the living worlds about which a comparison is carried out.

6 References

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