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On the diversity of humans – scientific and educational considerations

Starting point and questions of research

Biology education should contribute in a significant way to an adequate attitude and behaviour toward human diversity and heterogeneity. Therefore, this issue should be made a topic of biology education.

The most important questions of the following considerations are:

– Which theoretical frame should be the basis of learning and teaching the subject?
– Which concepts and conceptions are adequate for promoting the learning of diversity and avoiding simplifying schemata of thinking?
– Which topics of biology instruction are essentially linked with the issue of human diversity?

Educational background

Towards meaningful learning: The Model of Educational Reconstruction. The theoretical and methodological frame of the study is the Model of Educational Reconstruction (Kattmann et al. 1997; Kattmann, Duit, Gropengießer 1997; Duit, Gropengießer & Kattmann 2005; Komorek & Kattmann 2008). Science learning is mainly conceptual learning, it concerns conceptions of structures, processes, events and their interpretations by scientific theories. The core of the model of Educational Reconstruction therefore contains the scientific conceptions and student conceptions of the same topic in order to construct adequate learning environments. Consequently, the model integrates three well-known tasks of educational research: (1) the investigation into students' perspectives on a chosen subject, (2) the clarification and analysis of science subject matter, and (3) the design of learning environments or teaching-learning-sequences (see fig. 1).

These areas of research are the strongly interrelated components of the model. For example, the design of learning environments or teaching-learning-sequences is obviously influenced by the results of the two other components. However, within the model the attempt to design learning environments or teaching-learning sequences also influence the investigation of students' pre-instructional conceptions and the analysis of science subject matter from the very beginning of this recursive process. Another characteristic of the model is the balance it establishes between the scientific view towards a certain subject on the one hand and the students' perspectives on this subject on the other hand. From a constructivist perspective science content and students' conceptions are considered to be equally important for learning and teaching and thus for the process of Educational Reconstruction. Another core feature of the model is that it promotes the interplay between research and practice of science teaching and learning. Therefore, it is suitable to guide a creative designing process towards proposals for teaching-learning sequences based on empirical research.

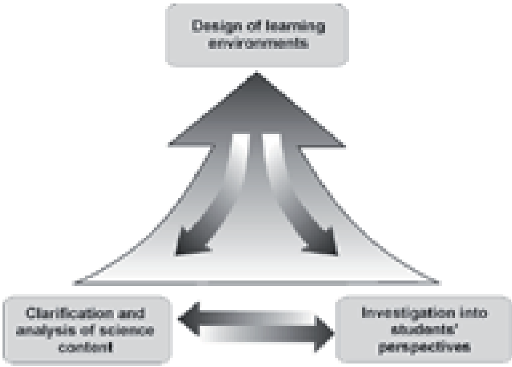

Fig. 1. Model of Educational Reconstruction

The model also meets the need to bring science related issues and educationally oriented issues into balance when teaching-learning sequences are designed. In so far the model has been developed as a theoretical framework for studies about whether it is worthwhile *and* possible to teach particular content areas of science fruitfully. It is a key assumption of the model that the curriculum developers' awareness of the students' point of view may substantially influence the reconstruction of the particular science subject. The results of the research already conducted within the paradigm of Educational Reconstruction clearly show that detailed knowledge of students' conceptions enables curriculum developers to handle science content more adequately. A series of studies, which were conducted in the frame of the model, clearly show the relevance of student conceptions and the importance to relate them with the concepts of the disciplines (cf. Kattmann, Moschner & Parchmann 2001 et sqq.).

Toward a constructivist view of learning: Conceptual Reconstruction. The Model of Educational Reconstruction corresponds to an understanding of learning in which the leaner plays the active and dominant role. Conceptions of the students therefore are means of understanding and of equal importance for meaningful learning as clarified scientific conceptions. In this view learners are understood as autonomous constructors of their own mental structures.

Teaching is promoting learning – otherwise it is in vain. *Learning* means that old conceptions are transformed into new ones. By this, the old conceptions are abolished and at the same time preserved in the new ones. By considering its preconditions, learning is always re-learning. This is a difficult process, but more easily learning is not to be achieved. Because learning in science is mainly conceptual learning, it can be characterized as *conceptual reconstruction* (Kattmann 2007).

This term conceptual reconstruction should be understood as a substitute for the familiar but misleading term of "conceptual change". After the suggestive article of Posner et al. (1982) on "conceptual change", the term was modified by the authors themselves and others towards "conceptual growth" or "conceptual enrichment" (Strike & Posner 1992, Tyson et al. 1997, Vosniadou 1996, Duit & Treagust 2003). However, the original version, which was derived from the process of scientific revolutions (Kuhn 1970) and accordingly referred to the substitution of everyday conceptions by scientific ones, still continues to be dominant in the minds of more than one researcher. In a constructivist view, conceptual learning should merely be described as an active process of the learner rather than as a struggle of conceptions. The "contradiction" and "struggle" of conceptions are metaphors which make conceptions actors in their own right. This understanding is even implied in the Piagetian terms of "assimilation" and "accommodation".

Instead, the label *Conceptual Reconstruction* stresses the role the learner plays in re-structuring her or his own conceptions. The concept includes processes which might be described as revolutionary (discontinuous) if and when conceptions are re-organised fundamentally, or as developmentally (continuous) if and when conceptions are modified or linked together in a new way. Furthermore, the concept of conceptual reconstruction also relates to learning processes in which learners develop their mental structures by forming new conceptions of their own imagination and experience. The concept of conceptual reconstruction is in accordance with the "cognitive reconstruction of model knowledge", proposed by Dole & Sinatra (1998), in which the student's cognitive engagement is stressed as a precondition of conceptual learning. In short: Conceptual reconstruction is not just a new label but a new concept consistently based on a constructivist view of conceptual learning (cf. Duit & Treagust 2008).

A highly important means of teaching in order to promote conceptual reconstruction and thereby to improve learning, is the offering of attractive conceptions to the learner. In the following, these conceptions which open the door for meaningful and sustainable learning, are called *keys to conceptual reconstruction*.

Constraints of understanding: Pitfalls of simplicity

In the field of human diversity conceptions of students and scientists are often alike, because both are heavily influenced by every-day conceptions (cf. Janßen 1998, Kattmann 1999). Consequently, both can be clarified together with the same analysis. Because clarification aims at learning and teaching, it leads to key-conceptions for conceptual reconstruction, which are also formulated in this section.

Generalisations and the schemata which are linked with it serve as tools of orientation in a complex and diversified world. But generalisations are dangerous too. Unavoidably, generalisations are connected with a loss of information: individuality is lost in average. If this circumstance is not reflected on, the instruments of generalisations will become pitfalls of simplification. Simplicity then evokes the reification of abstract types, such as "human races", "levels of culture", "role of sexes". Explicitly or implicitly valuation is nearly unavoidably linked with this process and runs into ideologies like racism, sexisms or "clash of civilisations". The means of simplification are: types, linear curves, dichotomies and mean values.

– *Types* are ideal images or statistically derived kinds (classes) which displace the diversity of individuals. The forming of types is based on putting individuals with similar features together into one unifying class concept. A weaker form is the orientation towards prototypes (Rosch et al. 1976). Whether they are type of races, students, teachers or sexes, types exist in our brains only. In biology the forming of types is especially inadequate, because variability, spread and continuity of features in groups and between groups are neglected. Furthermore, typology should be fundamentally abolished by evolution, for evolutionary change will alter any type and push it out of existence. In biology types are only instruments which help to describe taxa and to reconstruct the history of phylogenetic groups. But regularities, laws or at least the so-called principle of conservation (conservation of the species or "race") cannot be deduced from types.

The key to conceptual reconstruction lies in the perception of diversity of individuals as concrete and real objects, while types are simply crude abstracts.

The forming of types is also the basis of other pitfalls of simplicity:

– *Linear curves* play a dominant role in interpreting the phylogeny of some organisms which are valuated as "higher" than others, e.g. humans (cf. Groß & Gropengießer 2008). "Tendencies" in a phylogenetic line are called "anagenesis" or "orthogenesis" to make believe that an imaginative law presses the development to a higher level of existence. Examples include the interpretation of the phylogeny of horses and especially of humans. A precise analysis reveals the opposite: Fossils do not point to linear evolution upwards to of *Equus* or *Homo sapiens* but to a radiaion into several directions and many lines. The fact that only one species or genus has survived till now baffles us into thinking of directed and linear evolution to the living one. If there is a diversity of several species, this idea does not emerge: no one speaks of higher forms of ruminants or a direct evolution to mice.

The key to conceptual reconstruction is the perception of the fan of phylogenetic radiation, which spreads in many directions.

– *Dichotomies* divide the diversity of processes and modes of living into seemingly incompatible alternatives. Then, intermediate forms and evolutionary continuity are often neglected or treated as marginal. This is true for the dichotomy of sexes, where the overlapping of features and, even more seriously, intersexes are excluded. This also applies to the politically motivated racist dichotomies of "Blacks" and "Whites" or "Coloureds" and "Whites".

The key to conceptual reconstruction is to endure ambiguity, commonalities and overlapping of seemingly excluding opposites.

– *Forming mean values* is often an instrument to reduce diversity to simple-mindedness in order to get homogeneous types. Thereby the spread of features is ignored. Once formed and statistically saved by significance, the loss of information is often not reflected on, but is usually followed by far reaching scientific assumptions, e. g. the deduction of sex role from typical features or the ability of groups from IQ values.

The key to conceptual reconstruction lies in the awareness of variation and in reflecting on the significance of normal distribution.

If connected with the social valuation, the pitfalls of simplicity give birth to dangerous consequences. This is true for the superiority of "man" over "woman" or "cultural" over "primitive races". The image of the strangers emerges from the image of one's self: a positive self-image of one's own group creates a negative image of the out-group (hetero-stereotype). This is why stranger images (racial or sexual stereotypes and prejudices) do not fit reality, i. e. they do not tell us anything about the features of the out-group (and naturally also of the in-group) (cf. Kattmann 1980).

Pitfalls of simplicity are not the causes of such social valuations, but they tend to strengthen them. Consequently, the starting point of educational measures is not the valuation itself, but the formation and usage of adequate categories of knowledge.

Designing learning environments: paths of understanding diversity

It's not the task of this study to present teaching units or provide detailed advice for teaching. Instead, some principles of learning and teaching, i.e. elements of learning environments are offered.

Interpretation of normal distribution. The variation of features and commonalities of groups can be illustrated by *overlapping curves of normal distribution* (bell curves). But theses illustrations need additional interpretation and explanation (fig. 2).

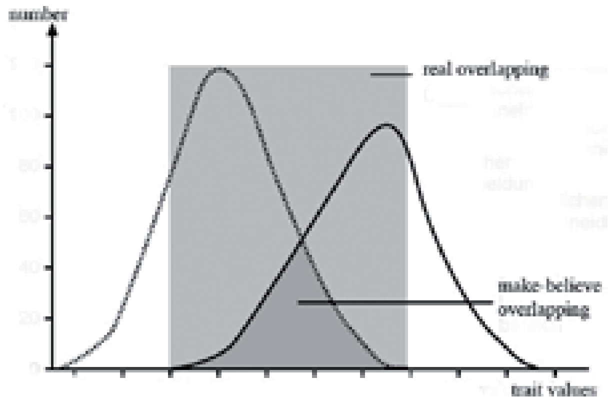

Fig. 2. Overlapping bell curves

Due to the perception of the bell curves, the overlapping zone will be defined by the nearly triangular area which is formed by the lower part of the left branch of the right curve and the right branch of the left curve (make-believe overlapping). But the real zone of overlapping includes the parts of both curves which share the same values. The real overlapping zone in Figure 2 exceeds the mean values and demonstrates that they do not tell us anything about the individuals of the two groups (i. e. sexes or races or any other division with the same distribution pattern).

Levels of racism and the history of cultures. "The revolution in our thinking about population genetics and molecular biology has led to an explosion of knowledge about living organisms. Among the ideas that have been profoundly altered are concepts of human variation. The concept of *'race'* carried over from the past into the 20th century has become entirely obsolete. ... There is no scientific reason to continue using the term *'race'*" (UNESCO workshop 1995). The concept of race has no genetic basis: The patterns of DNA and genetic traits are not distributed along the assumed barriers of the continents and do not correlate with any classification of the so-called races (Cavalli-Sforza, Menozzi & Piazza 1996, Cavalli-Sforza 1997, Templeton 1999, Pääbo 2001, Royal & Dunston 2004, Serre & Pääbo 2004, Stix 2008).

Nevertheless, racists create their races, motivated by their own interests. The classification of human groups is a fundamental source of racism (table 1). It should be stressed that the division into groups, and not their evaluation is the first step of racism, which culminates in the crimes of genocides. The cohesion of the levels and the consequences should be discussed in the classroom.

Tab. 1. Levels of racism and the consequences for human life

Levels of racism	Measures of racists
Purity Races differ in their essence; races must be kept pure.	Segregation, apartheid, ghettoes
Superiority Some races are of minor values, the own one is the highest one.	Social discrimination, political suppression
Selection Races can be improved or they degenerate. The own race must be improved by positive selection and preserved from elements of other races by negative selection.	Sterilisation programs, eugenics
Cleansing Strangers are a threat. They have to be eliminated from the own area of life.	Expulsion ("ethnic cleansing"), murder, genocide

To prevent racism it is not enough to deny the existence of races. One has to explain the overt differences between cultures, which were formerly linked to different mental abilities of the populations or "races". It is therefore of highest importance that an alternative explanation is offered to the learners. After Jared Diamond (1997), different biographical conditions made the difference: Agriculture, and as a consequence complex civilization, emerged primarily only in areas inhabited by plants and animals appropriate for domestication. These data should be used in biology teaching to paint a correct picture of the development of human populations and cultures (Kattmann 2009).

Preventing reification. In accord with the keys of conceptual reconstruction in biology education *inclusive thinking should be promoted*. Inclusive thinking seeks to combine opposites to one whole, e.g. not to treat male and female features as excluding alternatives but to stress that they are complimentary components of each person (Schaefer 1984). This should be an effective instrument against the reification of dichotomies and group characteristics.

Reification of types can be avoided if methodological preconditions and constructs of our knowledge are reflected on. This leads to the differentiation between *reifying and reflected knowledge* (Jelemenská & Kattmann 2006). In the US, sickle cell anemia is often called "black disease", because cases of illness are frequent among Afro-Americans. The misleading and dangerous consequences of such reification of race can be demonstrated by the case of a poor little boy, who was nearly mistreated by his doctors due to his light skin.

"As the following example illustrates labelling of this disease on the basis of the phenotype (skin color) resulted in serious health consequences to individuals who are not phenotypically 'black' but have the relevant genetic variants. An 8-year-old boy, phenotypically European, was presented with acute abdominal pain and anemia (hematocrit 0.21). Although his body temperature was only 37.9°C surgery was considered. A technician [accidentally] found red corpuscles with hematolytic characteristics in a smear. Surgery was cancelled after the results of a subsequent sickle preparation were found to be positive, and the child was treated for previously undiagnosed sickle cell anemia. His parents were from Grenada and were of Indian, northern European and Mediterranean ancestry. This case highlights the idea that ancestry is better indicator than 'race' or 'ethnicity` of whether one carries the markers of sickle cell anemia" (Rotimi 2004).

Because the samplings are often oriented toward "race", a leading scientist proposes the following statement to be included in each study on human populations: "Allelic frequencies vary between any selected human groups – to assume that those variations reflect 'racial categories' is unwarranted" (Duster 2005). This could be a reminder also in biology lessons.

The overall method to avoid the pitfalls of simplicity and prejudice towards humans is discussion among learners: It is much better to speak of race than to be silent about racism.

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On the diversity of humans – scientific and educational considerations

Abstract

Diversity is a major factor in education and also an issue of human biology and biology instruction. The educational and the disciplinary aspects are connected by the aims of respecting the other and of accepting one's own identity.
The aim of the contribution is to act against the schemata of generalization, i.e. typological and linear thinking and the restriction of knowledge to dichotomies and mean values, in order to promote the awareness of the variability of humans and the reflection on stereotypes towards groups of humans of different geographical and cultural origins or gender. Based on the Model of Educational Reconstruction and a constructivist view of learning, topics of learning are analysed und interpreted in order to lead to a meaningful learning of the subjects. Results of research in science and science education will be used for educational purposes by pointing out key conceptions for learning and teaching diversity.

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