EDUCATION FOR COGNITIVE DEVELOPMENT

PROCEEDINGS OF THE THIRD INTERNATIONAL SYMPOSIUM ON ACTIVITY THEORY

E. Bol, J. P. P. Haenen & M. A. Wolters (eds)

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CONTENT

IV. School subjects

Retrospection

EDUCATION FOR COGNITIVE DEVELOPMENT: INTRODUCTION TO THE PAPERS.

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The Netherlands

The papers of the proceedings have been written for the symposium 'Education for cognitive development', held in Utrecht, The Netherlands, from 19-21 June, 1984. This symposium was the Third International Symposium on Activity Theory and was preceded by similar symposia in 1982 in Espoo in Finland and in 1983 in Aarhus in Denmark (Hedegaard et al., 1984).
The aim of the symposia is to create a forum, where scientists exchange ideas, theoretical insights, and empirical data with regard to activity theory in human science. Especially a dialogue should be created between scientists from Eastern European countries and Western countries. The creation of such a forum could enhance the application and development of the activity theory on learning and teaching.
Another aim of these and forthcoming symposia is to create an opportunity for a critical dialogue between advocates of activity theory and of other theories. Therefore, speakers were invited, who are not strictly refering to activity theory, but to ideas and research related and relevant to this theory.

Sociohistorical theory

The sociohistorical theory was introduced by the Soviet scientist L.S. Vygotskij (1896-1934). A basic notion of this theory is the concept of activity. This concept presupposes a search for the causes of historical and genetic development, especially of higher mental functions and consciousness in phylo- and ontogenesis of man. Vygotskij noted that in order to understand mind and consciousness it is necessary to move beyond their immediate sphere and to consider them as an outcome of the assimilation of social experience and of the societal life of man. That means that man's consciousness is social and cultural by its very nature. From the moment of birth the human infant lives in a social world in which experience is always mediated through relationships with adults. Psychological functions and the means that mediate it are viewed as emerging out of the child's social interaction with adults (Wertsch, 1981). These functions emerge in the social context and are gradually transformed 'inward'. Human beings always live in a double world (cf. Cole in this volume). For Vygotskij (1983, p. 145) 'each function in the child's cultural development appears twice upon the scene, on two levels: first social, next psychological, first

between people, as an interpsychic category, next within the child, as an intrapsychic category. This applies both to voluntary attention, logical memory, the development of concepts and the development of will.' This 'general developmental rule' stresses the importance of upbringing and education. How the individual child develops will depend upon its social, historical context and how well this is mastered in the course of upbringing and education. So the sociohistorical theory has far-reaching consequences for education as a basic factor in the child's cognitive development. Therefore, the theme 'Education for cognitive development' has been choosen for the symposium. The central question of this theme is: How should education be organized in order to stimulate the cognitive development of pupils? This question has been mainly elucidated during the symposium from an activity psychological point of view. Activity psychology has acquired a vast body of knowledge on learning and teaching, and has developed an useful theoretical framework to improve educational practice. The proceedings should give the reader an impression of what it means to adopt an activity approach.

Activity

Vygotskij's sociohistorical theory nowadays is be considered as an influential one. His theory is widely acknowledged, but has not gone without criticism (Talyzina, 1981; Sutton, 1983). All this brings about different interpretations and views, not only of details but also of basic notions like activity. The concept of activity remained implicit in Vygotskij's work and was made explicit later by A.N. Leont'ev and P.Ja. Gal'perin. They streamlined Vygotskij's theory by focussing upon the real activities relating man to his/her environment.
'Activity' in this context is a philosophical and psychological concept developed in marxism. Activity means man's goal-oriented interaction with the environment and the aim is to transform this environment. In marxism the emergence of consciousness and personality are considered as a product of people's interaction with their material world. Thought appears in the course of actually shaping the world and the making of things. In other words, the process of labour and production takes precedence over knowledge (Popkewitz, 1984).
However, activity is not discussed explicitly by the various authors in this volume. Bol gives in his retrospective chapter a more fundamental analysis of the problem of activity and tries to shed some light on this basic notion.

Much of the research presented at the symposium 'Education for cognitive development' has been conducted for its significance to the development of the concept of activity and its application in education. Next to this topic the contributions involve substantive

innovations on the concept of motivation, development through instruction, the implication of instructional settings on cognitive development and last but not least education in the Third World.
The contributions have been divided into four sections:

1. Learning activity and instruction;
2. Education in the Third World;
3. Motivation;
4. School subjects.

1. Learning activity and instruction

Joachim Lompscher from the Academy of Paedagogical Sciences of the GDR presents the work and findings of his large-scale project on the formation of learning activity. He is one of the leading GDR psychologists and works together with members of the sociohistorical school in the Soviet Union (e.g. Davydov, Markova). According to Lompscher, the critical point in the acquisition of knowledge and competence through instruction is the quality of the pupil's own learning activity. Learning activity has not only to be evoked, organized, directed etc., but it has to be systematically formed and acquired. The macrostructure of learning activity consists of the learning object, the learning subject performing learning actions on the object, certain means and conditions of this kind of activity. The theoretical determination of learning activity necessary for the acquisition according to concrete goals and conditions of personality development has to keep in mind the interrelationship between all elements of that macrostructure.
Although the main purposes of Lompscher's paper were of a theoretical nature, the relevance of the methods, principles and results of the study for actually dealing with pupil's learning cannot be overlooked. The methods used by Lompscher and colleagues have shown possibilities for contributing to the actual and systematic formation of learning actions in various situations. The results indicate that young children can be given instruction (cq. cognitive training) in which they participate voluntarily and in which they step-by-step interiorize important cognitive repertoires. They also indicate that this is fairly universal across different pupils with different types of problems. Included in the studies presented by Lompscher were pupils who had severe learning problems and yet who learned well in the instruction procedures employed. These and the general findings encourage the wider employment of the 'systematic formation of learning activity' approach.
In reporting the preceding experimental results, Lompscher gives some special attention to the teaching strategy of 'ascending from the abstract to the concrete'. This was done in part because of the significance this strategy has for general conceptions of cognitive development. Lompscher suggests that cognitive development comes about largely or entirely through learning in an instructional setting in which the ascending teaching strategy is used. It also appears that pupils are prepared to receive this strategy and bene-

fit from it at an earlier age than has been generally thought.

If cognitive development is considered a process in which intellectual tools are interiorised by the child, schools have the task of stimulating this development. When will teaching be developmentally productive, i.e. which types of teaching content will optimally foster children's cognitive development? In the view of Carel van Parreren, who introduced the sociohistorical theory in The Netherlands, 'developmental instruction' is teaching general concepts and priciples, as well as strategies and attitudes for using them while coping with problems. Developmental instruction implies a deliberate choice of this content goals.
Perhaps more important yet are the special instructional guidelines developmental instruction requires. Apart from the ascending teaching strategy mentioned by Lompscher, Van Parreren reports on five guidelines which are well worth the effort of careful reading. These guidelines concern the ways along which the content goals (concepts and principles, strategies, attitudes) are acquired. For example, learning concepts, principles and strategies is only effective if the pupil knows what he has learned, i.e. he must keep an overview of this action potentialities in order to use them in different situations. In addition he has to select realistic goals for himself, he should plan and evaluate his actions, so he learns to master the regulation of his own motivational and goal-setting behaviour.
Another guideline is centered on teacher behaviour, but not on teacher traits (such as attitude or 'warmth') nor on detailed descriptions of the teacher's behaviour. Teachers, in the view of Van Parreren, are good ones, if they function on two levels at the same time: a level of performance (i.e. their direct interaction with pupils) and a level of reflection (evaluating the proceedings in the light of the lesson-plan). Teaching and monitoring one's own activity together places a heavy burden on the schoulder of the teacher.
These instructional guidelines should function in future on two levels as well. First it should be a help for the teacher in the classroom and second it should guide the researcher in designing instructional environments so that usefull information can be gathered to determine what aspects of programs or teaching devices are crucial in affecting outcomes. It is at the classroom, rather than at the school level that one is likely to detect differences that matter in education. Differences that are capable of improving, but also depressing children's performance beyond what their socio-economic status might predict.

Fichtner (F.R.G.) defines 'learning' and 'learning activity' as different didactic phenomenoes and determines their differences and their particular qualities by analysing the specific historic contexts of their developments.
The historic basis for the development of 'learning' is the corre-

lation of writing and school in the first advanced civilisations of former times. First forms of instruction and school are related to writing. Here, for the first time, 'learning' becomes the chief purpose of actions and as such realized.
Though writing is, in many ways in this historical period, centre of teaching- and learning-processes, this intellectual potentiality has no effect on 'learning'. It remains receptive, reproductive and passive. It seems that 'learning' has maintained this quality up to the beginning of the 19th century.
'Learning activity' as an active process shows the following factors: consciousness towards one's own activity, reflection as well as generalizing. Its factors have been developed not within the structures of school learning, but on quite a different level: the development of modern sciences, the sciences becoming practical in the context of capitalistic industrialization.

When we consider the features of learning activity as defined by Lompscher and Fichtner, the development of this activity, fits within the aims of developmental instruction and its guidelines mentioned by Van Parreren.
Jules Zimmer (USA) reports on one of the content goals of developmental instruction, namely rules. His data complement in some way Van Parreren's presentation by describing how a mathematical rule such as the commutative principle is understood by children. Besides rules, Zimmer focusses on representation and imagery, two other concerns that have been emphasized by activity psychologists. The data presented by Zimmer are based on children's responses to various arithmetic problems. The implications, however, are generated in reference to the concepts explored.

2. Education in the Third World.

Although systematic observations of educational functioning in cultures other than the United States and Europe have become more frequent during the last decade, the selection of a research site is occasionally based on convenience rather than the special characteristics of the educational system. This opportunistic attitude is due, in part, to the lack of strong theory and insufficient understanding of the foreign local factors which make it difficult to plan investigations that capitalize maximally on the unique characteristics of the educational system of that culture or in most cases the lack of it. This is one of the reasons why we are glad that Meyer and Verbunt made an effort to tackle a complex set of problems involving basic psychological processes in Mozambique and Guiné-Bissau. Few researchers attempt this; most prefer to gather and correlate data in the comfortable confines of their own culture. Meyer and Verbunt are more daring and, to our mind, very interesting. And even though it was after all a very depressing

report of the state of affairs in Mozambique and Guiné-Bissau, this is often science's way of getting on. We are still hopeful that this research will encourage other investigators to try to understand the effects of education on cognitive development. It should be noted however that cross-cultural research has shown (Sharp et al., 1979) that we need no longer assume that the fact that people are economically under-developed or under-educated bears any close relation to their cognitive development. That does not mean that there is no relation between education and development.
On the contrary, it is still the problem of criteria of evaluation. As long as we use the traditional cognitive tasks instead of real-world activities as evaluation criteria we do not really investigate the important consequences of education on cognitive development.

Upon these and other general issues have been reflected by Reuven Feuerstein (Israel) and Michael Cole (USA).
Feuerstein developed the so-called theory of structural cognitive modifiability dealing with the problem of low cognitive performance. His ideas about the nature of intelligence and the awakening of dormant cognitive recources are being adopted in many classrooms around the world. Like Vygotskij (1962), Feuerstein criticizes the use of traditional intelligence tests and he developed the Learning Potential Assessment Device (LPAD), an assessment procedure that bears only the vaguest resemblance to other measures of intelligence. With this procedure he has carried out research on the causes of cognitive deficiences of youths of twelve years and older. He distinguishes between learning from direct exposure to the environment and mediated learning, whereby the adult intervenes between the person and the environment. According to Feuerstein, it is not direct learning but mediated learning that counts for cognitive development.
This theory forms the basis for Feuerstein's remedial program Instrumental Enrichment, which seems to have good results to help low performers improve their cognitive skills (Chance, 1981).
With respect to educational problems Feuerstein conceptualized his notion of modifiability as relating to two major dimensions: cultural differences and socio-cultural deprivation. Cultural difference is defined as a condition resulting from the encounter between two cultures in which one of them has to change in order to adapt itself to the culture which is considered as dominant by some if its specific cultural parameters - linguistic, technological and socio-economic. Cultural difference can be defined in terms of distances between the two cultures requiring more or less radical and dramatic changes in the culture which has to adapt itself to the dominant one. It is hypothesized on the basis of the theory of mediated learning experience that the culturally different individual or group, by virtue of having a strong cultural patrimonium, will show a high level of modifiability and adaptability irrespective of the cultural difference between the dominant and the subordinate culture.

The second condition, cultural deprivation, is defined as an alienation of the individual or group from their own culture and it is hypothesized that modifiability and adaptibility to the new culture will be significantly less efficient. This is so because the individual or the group has not been subjected to models of behavior and to opportunities for meaningful learning in the original culture. These difficulties may be prevalent even in the conditions of smaller distance of the various parameters from the dominant culture.
Feuerstein has outlined the significance of these theoretical considerations for the education in the Third World and has given suggestions for educational goals, policy and techniques to realize in the individual a higher level of modifiability.

Michael Cole has begun his lecture by making a comparison between the ideas of Feuerstein and his own. Besides this, he has draw up a list with general basic concepts that were bothering a lot of speakers at the symposium. From the sociohistorical point of view he has given a couple of provisional definitions of concepts like mediation, culture, language and development. With these definitions in mind Cole has shed some light on education and cognitive development in the Third World.
After comparising the traditional Bush School in the south western part of Africa with Euro-American education, he has summarized his research on the cognitive consequences of formal education in Mexico. The central question of this research was: What kind of influence has age and/or schooling on problem solving tasks like free recall and syllogistic reasoning? The conclusion of his research has been casted by Cole in a more general idea, which is consistent with the tenets of the sociohistorical theory.
There is a sense in which education produces cognitive development. But introducing Euro-American education in the Third World, you introduce also a system in which education creates alienation from the real culture. This circumstance brings Cole to some warning and discouraging remarks on the 'underside' of education for cognitive development.

3. Motivation

Van Parreren made motivation one of his guidelines; Lompscher mentions learning motivation in relation to communication and cooperation between pupils and Sven Thyssen (Denmark) actually manages to accomplish an experimental-longitudinal research project in the elementary school concerning motivation. In this project, the procedures were effective in producing and maintaining attention and good work habits over long periods of time. This is ordinarily difficult to produce with an elementary school child. Of special significance, also, was the fact that it did not require long daily periods, or a large contribution in total time. When teachers' classroom practices give the pupils the opportunity to engage in

joint activities, to take initiative, and to engage in activity without the presence of the teacher, pupils frequently will use the opportunity.
This is exactly what Thyssen systematically introduced and encouraged. In the second and main stage of his project, pupils in a group alternately had the function of group leader. The group leader had the function of the teacher - governing the activity of the group. What this project, especially because of this stage, does show is that the procedures have been successful in establishing environments in which children do indeed initiate much of the activity. It is shown that elementary school pupils become 'initiators' in some lasting sense, and it is shown that the occurrence of child-initiated activity facilitates learning in general.
With respect to academic achievement we have available a body of technical knowledge on criterium-referenced tests. With respect to openess to learning, a spirit of investigation, an improvement in learning motivation however, we have no history of succesful measurement. So it is very difficult to show what the quantitative results of this project are. Nevertheless it seems obvious that any pupil who practiced these activities over several years of school would be positively affected by the experience. Perhaps at a future time our ability to measure these outcomes will better match our intuitions concerning their importance.

In activity theory the concept of motivation has a central position and Pentti Hakkarainen (Finland) gives an analysis of this position with respect to learning activity.
In activity psychology a hierarchy of various types of activity is conceptualized and every period of human development is motivated by a particular leading or dominant activity. The change of the type of dominant activity is connected with change in motivation. Motivation has two main sources in the activity frame-work: 1) the relation between different activity types, or the relation between the dominant activity type and life activity as a whole, and 2) the mechanism of the formation of the dominant activity type. The combination of these two factors presupposes the formation of the 'collective subject' of activity.
The specific motivation of learning activity is based on the need of theoretical consciousness. The development of this need is based on the psychological products of play activity (imagination, symbolic function), and limited possibilities for the realization of their potential. The development of learning actions forms the basis for the development of motivation as a didactic concept.

4. School subjects

The school subjects which were given special attention at the symposium were: mathematics, history, biology, mother-tongue and polytechnical education.

4.1 Mathematics

We are far from understanding what cognitive resources children use as they work on arithmetic problems. The purpose of the study of Harry Osser (Canada) is to aid the development of a model of arithmetic problem solving. This work is guided by Action Theory (Von Cranach & Harrè, 1982). In the study, children (8-11 years old) were given a series of arithmetic tasks from their school books, and as they worked through these problems they were interviewed. The questions were designed to reveal the extent of each child's academic, socialcognitive and metacognitive competence, and the interrelations between these types of knowledge as the child engages in problem solving. The content of the interviews is examined with reference to three classes of factors: (1) Subject variables, which include some of the child's cognitive abilities and personal goal system; (2) Situational variables, these refer to the classroom rule systems that serve to regulate both overt behaviour as well as the cognitive activity that underlines school behaviour; and (3) Task variables, which concern the processes by which the cognitive system manages itself, for instance by providing information about the demands and difficulties of the task at hand. These results were analysed in discussing the proposed model of children's arithmetic problem solving.

In the psychology of mathematics education proportional reasoning is one of the major research fields closely related with the work of Piaget. During its development it became obvious that some of the original formulations of Piaget had to be abandoned. In the case of proportional reasoning this seems especially true for the Piagetian concept of stages of development. Whereas the refutation of the stage concept was primarily based on empirical evidence, Piaget's neglect of the mediational or instrumental aspects of thinking has been criticized mainly on conceptual grounds, especially in comparison to Bruner's approach. In fact, the question of how thinking is shaped by the media and instruments it uses, is significant to the psychology of mathematics education. It is highly desirable that a research strategy following this question tries to relate very general psychological characteristics of activity and information processing to pupil strategies of acting and thinking that are directed by didactical models, media and instruments.
Falk Seeger (FRG) summarizes some results of a running research project on proportional reasoning: results of conceptual analysis and a preliminary empirical study are reported. A word problem test using percentage tasks was administrated to an experimental and control group of 13 - 15 year old students. The experimental group received a test form with an introductory task using a visualisation or an operator approach.

4.2 History and biology

Based on Davydov's educational theory, an experiment with fifth grade children has been carried out in history/biology in a Danish elementary school (Mariane Hedegaard, Denmark). The teaching has been oriented at the development of a germ-cell model which combines the concept of evolution and history.
The result of this experiment is compared and evaluated together with a Finnish experiment in history teaching (Yrjö Engeström, Finland), also based on the theory of activity as the key stone for development of theoretical thinking.

4.3 Mother-tongue

Irina Koskinen, teacher educator at the University of Helsinki, observed mother-tongue lessons in special demonstration schools, which belong to universities and in which teacher education in Finland takes place.
The aim of this observation was to find out how the child's creative activity is taken into consideration during lessons of student teachers.

4.4 Polytechnical education

Rob de Jong (The Netherlands) summarizes the results of his research on the influence of structuring the learning environment on technical problem solving. This research has been carrying out within the running research project 'Thinking and Doing'. The central question of this project is: In which way can children (12 - 14 years old) learn to solve general technical problems systematically and consciously?
Three instructional methods are distinguished in the literature about problem solving. These methods (algorithmic, action structuring, self-discovery) differ in the degree of structuring the learning environment.
In accordance with these methods three curricula are developed. The influence of these curricula on technical problem solving is examined in a comprehensive school.

Methodological remarks

In our society, school undoubtedly is the most pervasive institutional influence on children's development. Research done on schooling differ in their degree of attention to the actual educational processes involved.
Three types of research on schooling can be identified (Resnick and Leinhardt, 1975). One, program evaluation research is concerned with the relative effectiveness of two or more instructional programs implemented across a number of schools and classrooms. This research, until now, has rarely detected significant differences in

impact between programs. A second type of research can be termed school-comparison research and a third type of research is centered on teacher-behaviour. None of these three lines of research on schooling have yielded information that can guide those interested in designing instructional environments that will optimally foster children's cognitive development, i.e. developmental instruction.
Within this context a 'process' approach is needed. Such kind of research has been called a teaching or formative experiment and involves the development of a teaching strategy to stimulate children's learning activity. It proceeds according to some predefined goal and seeks to assess the effectiveness of the strategy and the theoretical foundation. Depending upon the research question, the investigation may be with individual children, small or large groups (cf. Davydov & Markova, 1983; Popkewitz, 1984).
In this kind of research in educational practice there is always the methodological problem to be considered. If one is to study education and school practice, one must be prepared to accept many uncontrolled variables. One cannot expect perfectly matched treatment and control groups, for example, since pupils in real schools are not randomly assigned to educational treatments. Further, educational treatments will never be implemented with the degree of control that can be obtained in the laboratory. Even when two teachers are implementing the same educational program there will be variations in their actual behaviour. These variations are brought about by their own histories and predilections and quite often by responses of the particular groups of children in their classrooms that year. Not only there will be variations among teachers, there will be variations in the behaviour of the same teacher at different times, so that even detailed records of observed behaviours will show only a sample of what the classroom environment is like, in contrast to the exhaustive history of events usually recorded in the laboratory. Nevertheless, interpreted with care, significant and sometimes strong conclusions concerning educational practices on pupils can be drawn.
Several authors in this volume are using the formative experiment as a method of inquiry to study teaching and learning from an activity psychological point of view. This kind of research is promising and one of the challenges for activity psychologists is the further development of a theory of formative experiments and the implementation of the results of such studies in school practice.

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I. LEARNING ACTIVITY AND INSTRUCTION

FORMATION OF LEARNING ACTIVITY - A FUNDAMENTAL CONDITION OF COGNITIVE DEVELOPMENT THROUGH INSTRUCTION

Joachim Lompscher: Academy of Pedagogical Sciences of the GDR
Berlin

The acquisition of social knowledge and competence through instruction is one of the main conditions of personality development in childhood. The influence of instruction on personality development first of all depends on how and to which degree the learners are made the real and active subjects of the acquisition process. The quality of learning results does not directly depend on the teacher's activity - how he teaches the pupils, how he explains, demonstrates etc. the learning material.
On the contrary the critical point is the quality of the pupils' own learning activity - how they themselves work on the learning material in intellectual and/or practical ways, how they perceive and process, what the teacher, the text or other information sources offer. One of the crucial tasks of teachers, therefore, consists in creating the necessary conditions for the necessary learning activity of the pupils. What does that mean?
Instructional situations include a fundamental contradiction: The pupils are to reach new levels of competence and performance, but the necessary psychic presuppositions do not exist yet or are insufficient. If these presuppositions were totally formed, learning and its pedagogical organization would not be necessary at all. But the problem is, that these necessary new knowledge, skills, attitudes etc. cannot be acquired in another way as in that same learning activity, directed towards those new levels of competence and performance.
In other words: The psychic presuppositions for the solution of new learning tasks must be formed in each pupil in the process of solving these same learning tasks. Learning activity has not only to be evoked, organized, directed etc., but it has to be systematically formed and acquired. This is a very complex problem. Here I can deal with a few aspects only (for more details cf. Lompscher, 1979, 1981 a, b; 1982 a, b, c, d; 1984 a, b).

Macrostructure of the learning activity

As each kind of human activity, learning activity has a macrostructure, consisting of four main elements (fig. 1):

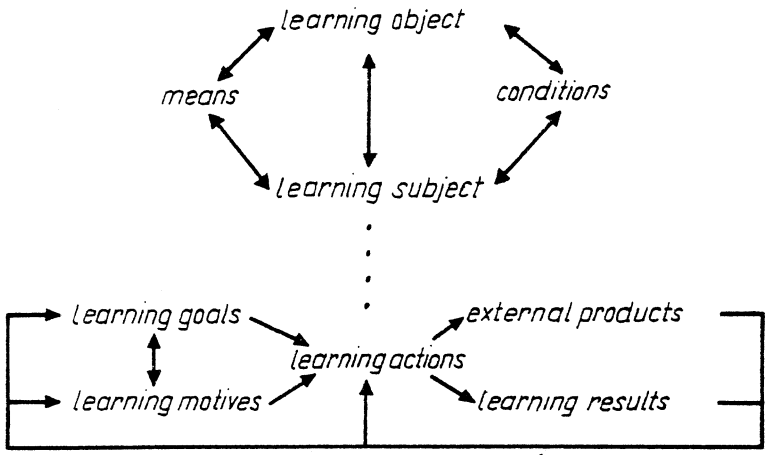


Fig. 1 Macrostructure of the learning activity

- The learning object (or material) to be acquired - especially selected and elaborated part of social knowledge and competence on different levels of complexity and generalization. Content and structure of activity are determined first of all by its object. Therefore analysis and formation of learning activity must start with the analysis of the objective traits and demands, substance and structure of the learning object.
- The learning subject actively performing actions on the learning material, transforming the object in intellectual and/or practical ways and changing himself in that process. The learner's activity is directed by certain goals and motives and has two kinds of results - external products as modifications of the learning object or its representatives and learning results in the true sense as modifications of his own psychic presuppositions.
- Each activity is characterized by means, used by the subject in order to affect the object for reaching his goals. As a rule, means are already results of human activity, and they can fulfill their role only by being incorporated into the subject's action structure. Extremely formulated, the learner's action are the main means of his learning activity. External things as tables, books etc. become learning means only to such a degree as the learner acquires adequate methods and techniques for using them.
- The quality and success of the learning activity in a high degree depends on the conditions, under which that activity goes on and is organized and systematically formed. This aspect comprises the problems of communication and cooperation, of pedagogical leadership and pupils' independence, of mental and physical load etc.

The theoretical determination of the necessary learning activity

according to concrete goals and conditions of personality development has to have in mind the interrelationship between all elements of that macrostructure. Thus the learning material on the one hand must not be determined or passed on to the pupils without an analysis, what kind and structure of learning actions is necessary for the acquisition of that material. On the other hand, the performing of learning actions is not an end in itself.
They serve as means of the acquisition of knowledge and competence and therefore cannot be determined, organized and elaborated independently from the learning material or be mechanically added to it. An increasingly independent, responsible and creative learning activity cannot be formed without the mastery of learning actions by the pupils adequate to the objects, goals, and conditions of the concrete instructional process. These learning actions must be acquired and formed systematically, in order to fulfill the role of means of learning activity.
At the beginning, they are part of the learning object and then gradually they get learning means. External, practical actions of different kind and structure and interiorized in this process, and learning strategies and techniques, concept systems, modes of thinking and behaving, attitudes etc. are formed. For each instructional process, especially for the introduction into new fields and object areas, it is necessary to determine the adequate learning actions. Three tasks must be solved here, mutually connected with each other:

- The analysis of the objective demands of the learning object towards the practical and/or intellectual activity, directed to its acquisition. This concerns logical and psychological aspects, specific for the different object areas or general for all of them or for groups of them (e.g. natural or social sciences, languages, arts). Instances for such object-oriented aspects are the character of features and relations, of rules and methods in a field, levels of abstraction and complexity of the object to be acquired, opportunities of external and/or internal operations with the objects, proportions of relevant and irrelevant elements in task structures etc.
- The analysis of the subjective presuppositions, objectively necessary for the mastery of those demands. That means , which cognitive structures and procedures, which levels of competence and independence, which kind of attitudes etc. must be acquired, in order to master the objective demands of the learning object E.g., the acquisition of scientific concept systems and the formation of dialectical, creative thinking in the pupils is impossible without the systematic formation of theoretical level of cognitive structures and procedures in the pupils (in contrast to a one-side empirical level - cf. Lompscher, 1984a).
- The analysis of the pupils' actually existing subjective presuppositions for concrete goals of knowledge and competence, e.g. their knowledge structures and procedures for operating with and generating of knew knowledge, the degree of mastery of practical,

verbal and cognitive strategies and techniques, their concrete learning goals and motives, attitudes, emotional sensibility and volitive characteristics.

This real level of cognitive, motivational, emotional and social development, including the interindividual differences on one level, must be brought into interrelationship with the objective demands and the goal criteria. On this basis it is possible, then to determine theoretically the character and structure of learning actions to be formed as means for reaching the next level of development, for promoting the children from the zone of actual performance to the zone of next development, as Vygotskij said.

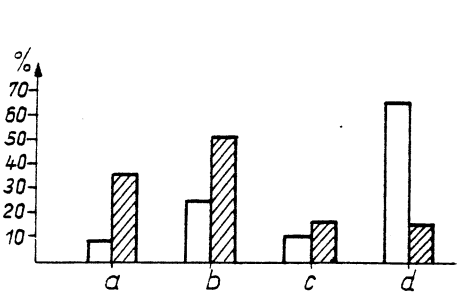
System of learning actions

Therefore, a promoting instruction has to consider - as differentiated as possible - the actual psychic presuppositions of the pupils, but it has to be oriented towards presuppositions not yet or not sufficiently developed, according to new objective demands of the learning object. So, we elaborated an introduction into natural science in the fourth class, where we systematically formed a system of learning actions, necessary for an active acquisition of concepts and methods in this field:

- derivation of problem questions, based on goal and situation analyses and revealing of contradictions;
- formulation of assumptions, based on the actualization of knowledge, search for new information, formation of analogies etc.;
- planning of observations or experiments to test the assumption, including the derivation of testable consequences, formulation of an idea for the testing with the help of given or selected or independently determined materials, planning of concrete steps with the help of symbols, rough drawings and verbal representation;
- real carrying out of the observations or experiments, stating and fixing the results;
- deciding about finishing or continuing the process, based on comparison between results and assumptions, formulation of answers;
- control and evaluation in the course and after the solution process, self reflection.

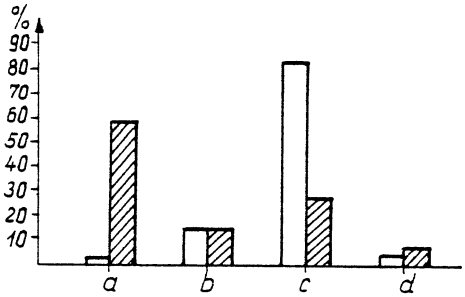
In biology and physics (both in the fifth class) these learning actions were applied to the appropriate learning objects and further developed in this process. So, in physics special cognitive operations were formed for the transition from the phenomenological level to the model level in order to enable the pupils not only to describe physical objects and processes, but to explain them, too - on an elementary level, of course, using the model of the particular structure of physical objects.

The systematic formation of learning actions such as observing, describing, modelling, explaining (in the form of mutual transition between observable and unobservable features) led to an essential



Explain! A dense body gets liquid by increase of heat energy, because

a) it melts
b) it is heatened.
c) the distance between particles gets smaller.
d) the particles get freely movable in a liquid body.



Explain! The volume of a body increases by increase of heat energy, because

a) the body extends.
b) the body gets liquid.
c) the distance between particles gets larger.
d) the particles move more quickly.

□ experimental classes (5 th class)

▨ control classes (6 th class)

Fig. 2 Identification of adequate explanations of physical phenomena

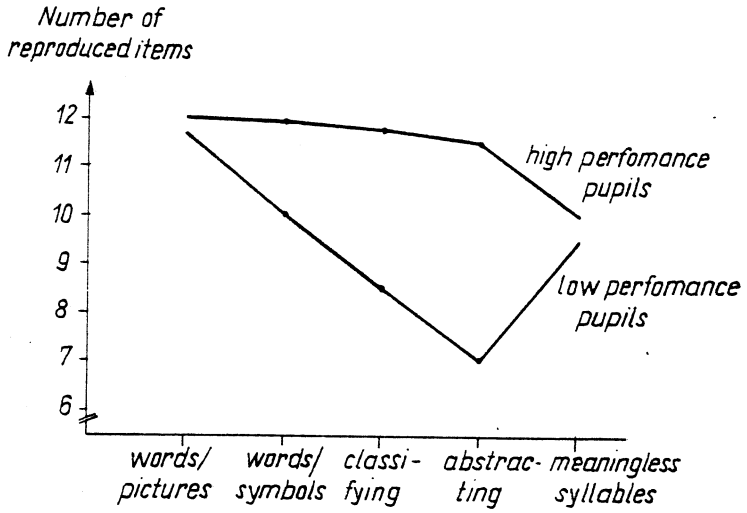


Fig. 3 Memory effects in dependency on the intellectual task level (short term effects)

modification of thinking processes in the children. 60 - 80% of the experimental classes were able to form physical concepts on a theoretical level, whereas pupils in control classes, even older ones, predominantly remained on an empirical level. The control classes received knowledge about the particular model, too, but without systematic formation of the necessary learning actions.
Among other tasks, the pupils had to identify the adequate explanation for several physical phenomena, e.g. the change of the state of aggregation or of the volume of physical objects by increase of heat energy (fig. 2). There is a highly significant difference between our experimental classes (5th class) and the control classes (6th class).
High perfomance pupils of the control classes reached the theoretical level spontaneously, without a special formation of the appropriate learning actions. But the majority of the pupils failed in this regard. The results of the experimental classes show the principal possibility to reach this level, though not yet all pupils reached it really.
In the framework of this experiment we did not have the possibility yet to analyze the interindividual differences and their causes. But other investigations show, that such an analysis reveals ways, how e.g. low performance pupils can be brought to higher levels of knowledge and competence.

Low performance pupils

Some years ago we studied some phychic peculiarities of such pupils (Lompscher, 1978). We selected pupils of seventh classes, who had difficulties in learning for several years, but moved on to the next class each year. We selected only pupils with relatively positive learning attitudes, low intelligence values, but without disturbances of attention etc. They were compared with a group of high performance pupils concerning the solution of different memory tasks (fig. 3).
The memory effects of the low performance group show a strict dependence on the intellectual task level: Pair associations between words and pictures are memorized as well as by the high performance group, but already pair associations between words and symbols and especially tasks of logically mediated memorizing (through classification and abstraction) are mastered significantly worse, whereas serial learning of meaningless syllables shows even better results as those tasks, but again without significant difference to the high performance group.
Thus, these low performance pupils were characterized not by a bad memory capacity, but by a strong tendency to mechanical learning, which led to a large decrease especially in long term memory curves. In order to overcome this tendency, we formed learning actions appropriate for such tasks in individual sessions with these pupils. After five sessions (20 minutes each) the low performance pupils reached a level, not significantly different from that of high performance pupils (fig. 4).

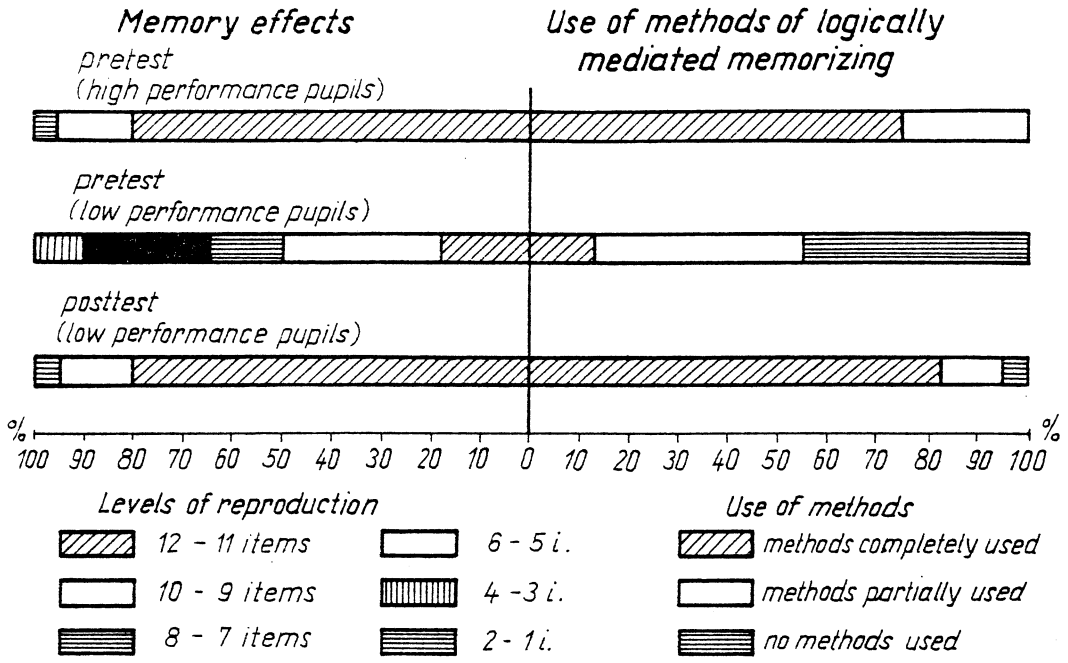


Fig. 4 Relationship between memory effects and use of methods of logically mediated memorizing in high and low performance pupils

The main conditions of this change I will show later on. Now I will only add, that the pupils used the acquired methods of effective, logically mediated memorizing after 8 weeks and even after one year. This is, of course not sufficient for overcoming the remainder in school, but it is an essential presupposition for the acquisition of the knowledge and competence necessary for that process. Another group of such pupils was trained in the same cognitive operations (first of all, classification and abstraction), but these operations were not made conscious as means of memorizing. The tendency to mechanical learning was not overcome in this group, though the performance in the trained cognitive operations was improved significantly.

The formation of learning actions is closely connected with learning attitudes, goals and motives. One of our investigations in low performance pupils was directed towards the modification of negative learning attitudes of such children. Eight lessons with small groups (4 pupils in each) were carried out in one learning object

field (mathematics). The learning activity was systematically organized and formed and the social status of these pupils was changed. We reached not only high effects in knowledge and competence, but also an increase of activity forms and levels and a significant modification of attitudes towards the object field and the concrete topic and even towards school learning at all. This was the case especially in those experimental groups, where we made conscious not only the objective learning goal, but the personal importance in the sense of Leont'ev (1979).
It is impossible to go into particulars of these investigations, and I will not deal here with the very complex and broad problem of low academic performance and interindividual differences in learning. In this field a number of investigations were carried out in the GDR and the USSR for the last years on different aspects of this problem (cf. e.g. Witzlack, 1973, 1982; Menčinskaja, 1974; Berge et al., 1975; Babanski, 1977; Zetlin, 1980; Drefenstedt, 1981 Breuer, 1982; Babing & Berge, 1982; Matthes, 1983 a, b; Kessel & Göth, 1984; Clausz, 1984).

Main conditions for the formation of learning actions

In the context of my topic low performance pupils serve as an example for a general approach toward the fundamental contradiction of instructional situation I spoke of at the beginning. In my opinion, the main problem is to find out conditions, under which the learning activity of the pupils can be formed systematically. The formation of learning actions for the mastery of concrete classes of learning tasks is the starting point in this approach.
Which are the main conditions of that process? On the basis of out investigations, I would mention, first of all, the following ones:
1. Learning task situations and formation of learning goals;
2. Formation of general orientation bases appropriate for large classes of learning actions;
3. Practical action performance and step-by-step interiorization;
4. Organization of co-operation and communication between the learners.

I do not want to reduce the whole problem to these aspects, but I will concentrate on them here.

Learning goals appropriate for a high quality and effectiveness of learning activity are oriented towards the acquisition of concepts, strategies etc., in other words, towards the psychic modification of the own personality and activity. External products as modifications of the learning object or its representatives serve in that goal structure not as an end in itself, but as means for self-control. Such learning goals arise form task situations going beyond the learner's psychic presuppositions in some degree and regard.
Under the teacher's guidance the objective task demands have to be analized and the own presuppositions to be evaluated with regard to these demands. Thus the learner learns to determine the area

or direction of what has to be acquired in order to master such tasks (not only this one!). The analysis orients him towards a whole class of learning task situations and their general and essential features. A learning perspective arises, which then can be concreticized and differentiated in special tasks, aspects, steps. In their substance, such learning task situations are problem situations,and problem solving is the starting point as well as one of the main lines in the process of the systematic formation of learning activity.
Our experience with learning experiments in whole classes, small groups and with individuals convinced us, that the formation of appropriate learning goals in the subjects is a necessary prerequisite of all efforts for a systematic formation and high effectiveness of learning activity.
If appropriate learning goals are formulated, the question is, how to reach them - what kind of actions must be performed in which way, which conditions have to be regarded etc.

The learner needs an orientation basis for the necessary learning actions. As shown the investigations of Gal'perin (1967, 1972, 1980) and many others, including our own investigations, orientation bases fulfill their function best, if they consist of all necessary conditions and aspects being important for the effective and successful action performance, but in a general form valid for a large class of objects and tasks. Such an orientation basis must not be simply given to the learners as a completed ready instruction, but it has to be elaborated by the learner themselves (under the teacher's guidance, of course).
This is a complex problem solving process, too, directed towards the determination of necessary methods for reaching certain goals. In a starting phase this is possible only in a general form, which then consecutively has to be concreticized according to the different contents, structures and conditions of learning tasks in an object field. So we elaborated orientation bases for several classes of memory tasks with our low performance pupils or for the acquisition of fundamental concepts and appropriate learning action in several object areas as mathematics, natural science, history, mother tongue, foreign language.

Such metacognitive knowledge and reflection have great relevance for the formation of learning activity, but it is, of course, insufficient. Learning actions will be acquired only by really performing them. Dependent on the learner's presuppositions and on the objective demands of the learning object learning actions may be performed on different levels of interiorization/exteriorization.
An important condition for the formation of subjectively new learning actions is the determination of practical or materialized action forms adequate to the substance of the learning object.
This gives the learner the possibility to perform the action in all details, to see all modifications in the object and conditions

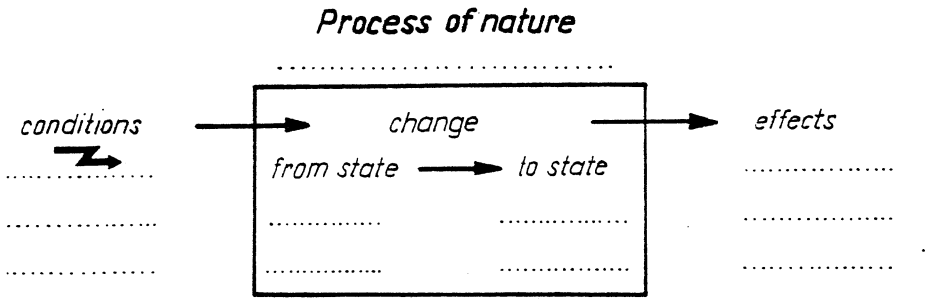


Fig. 5 Learning model for the analysis of processes of nature (4th class)

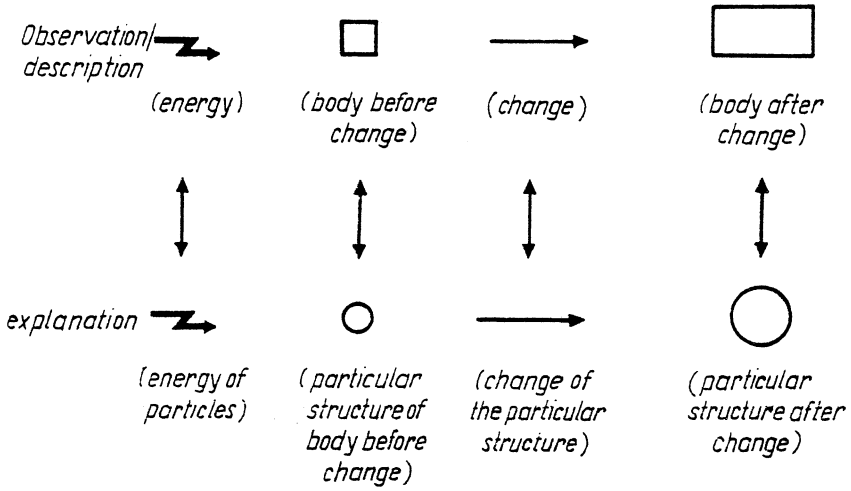
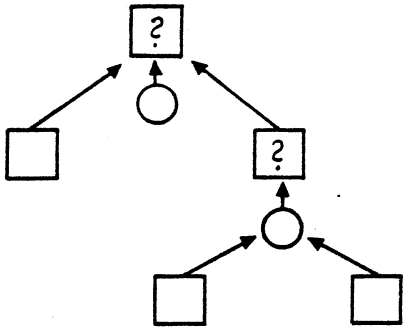


Fig. 6 Learning model for the explanation of physical processes (5th class)



? unknown quantities

given data

operator

Fig. 7 Learning model of relation ships between quantities in mathematical tasks (5th class)

according to his own actions on them, to experience immediately the consequences of nonregarding certain aspects or steps, to learn to control himself etc. For instance, for the acquisition of syntax in a theoretically founded way fourth graders needed practical manipulating with real sentences and simple symbols (cf. Lompscher, 1982 c), and for the acquisition of a general concept of mathematical functions it was useful for them to start with practical manipulations in a system of coordinates (Lompscher, 1982 d).
Gal'perin (1967, 1972), Talyzina (1981), Davydov (1982) and others described a lot of different acquisition processes starting with practical or materialized actions and step-by-step interiorizing them accoring to the concrete objective demands, instructional goals and subjective presuppositions of the learners.

I want to point here only one aspect in this context - the role of models as a certain medium stage between external and internal action levels. Models in forms of graphical schemata, symbols etc. are more or less abstract representations of the most essential features of a learning object and/or learning action, but at the same time they are immediately given for perception and manipulation.
On the one hand, they are results of learning activity, revealing the fundamental structure of learning object through analyzing and abstracting its essential features and relations, on the other hand they are very important means of further penetrating into the learning object as a concrete manyfoldedness. Here models play the role of orientation bases for analyzing concrete objects from a general point of view, for solving concrete learning tasks and performing appropriate learning actions according to general rules and methods.
In all our instructional experiments such models were very useful for the pupils. But they had to be elaborated by the pupils themselves (under the teacher's guidance) in the course of analyzing the learning task situation and the fundamental features of the learning object and to be sufficiently simple for reproduction and operation, containing only the most important aspects and/or steps, relevant for the object field and valid for a diversity of concrete phenomena and situations.
The introduction into natural science, e.g. was based on a 'learning model of the process of nature' (fig. 5), which then was differentiated into models for analyzing biological and physical processes, e.g. a model for the explanation of physical processes (fig. 6). Another example is the modelling of relationships between quantities as a necessary step for finding the adequate mathematical equation in mathematical tasks describing real situations (fig. 7).

Acquisition of knowledge and competence as results and prerequisites of human activity is never done by an isolated, abstract individual. Co-operation and communication between people is one of the

essential conditions of each kind of learning activity. A special case is the co-operation between the learners themselves, beginning with the pair situation.
In a special experiment in fourth classes we formed mutual control and evaluation of learning actions as elementary forms of co-operation (Person, 1983).
The main steps were the following ones:

1. Elaborating of an orientation basis for mutual control and evaluation concerning results of individual learning actions.
2. Application of this orientation basis to simultaneous, action attending mutual control and evaluation, using different symbols and other forms for performing and fixing results of such control. The partners were mutually responsible for results of learning actions and for the way of getting them. This was the prerequisite for the next step.
3. Formation of mutual deliberating on how to master new learning tasks before beginning the individual actions (planning, formation of anticipative control and evaluation).
4. Formation of co-operation in the sense of division of labour - one partner prepares or continues or uses the action of the other in order to reach a common goal.

The special formation of co-operation led to a higher level of quality and independence of individual learning actions in the object field (in this case - grammar) and to higher levels of individual and co-operative problem solving, of consciousness and selfreflection according to actions (cf. Lompscher, 1984 a).

Another investigation was carried out in order to test the possibility of forming problem solving strategies (heuristics) through co-operation, in a special dialogue situation (Schöszer, 1982; Köster, 1983). A general orientation basis for goal-means-conditions-analysis in problem situations was elaborated with pupils of fourth classes and experimental groups of different co-operation forms (in pair situations) were organized:

- first group: stable division of functions between problem solver and a controler;
- second group: permanently changing division of the same functions;
- third group: stable division of functions between a problem solver and an opponent (also including control function);
- fourth group: permanently changing division of the same functions.

Thus we varied the functions and the kind of co-operation during the time of experimental sessions. The experimental groups were compared with two different control groups:

- first group: pupils without any special formation of learning activity ('traditional' instruction);
- second group: pupils of experimental classes with teaching strategy of ascending form the abstract to the concrete, but without special formation of problem solving strategies.

After the formation experiment the subjects had to solve different

problems individually, e.g. a relatively difficult interpolation problem (starting and goal situation are given, transformation operations have to been found). The mean number of necessary steps until solution (fig. 8) differs between the groups.
Control group 1 had the largest difficulties, experimental group 4 the smallest. The permanently changing division of functions obtained better results than the stable division (compare group 1 and 2, 3 and 4), the introduction of the more active opponent's function in comparison with the controler's function led to a higher quality of problem solving (groups 3 and 4 in comparison to groups 1 and 2, results of opponents and problem solvers in group 3).
I shall inform you of the control group 2 later. A strategy analysis was carried out and showed the same picture (fig. 9).
The most effective strategy - strategy I - was found most often in experimental group 4 and not at all in control group 1. The opponents in group 3 and the controlers in group 1 reached higher levels than the problem solvers, the permanently changing division of functions was more effective than the stable one.
The results of control group 2 significantly differed from control group 1 and reached the same level as problem solvers in experimental group 1 and 3, with regard to the mean number of solution steps even better. These pupils did not get a special strategy training, but they participated in the experimental instruction in natural science and mother tongue grammar. Based on the ascending from the abstract to the concrete, this instruction influenced the cognitive development in the same direction as the special strategy training.

This is not surprising, because the teaching strategy of ascending from the abstract to the concrete (cf. Davydov, 1977, 1982, 1984; Davydov et al., 1982; Lompscher, 1982 c, 1983 a, 1984 a) integrates problem solving as well as other aspects of systematic learning activity formation I told about. In the very first phases of a learning process a conceptual macrostructure comprising the essential features and relations of the learning object is formed. The internal representation of such macrostructures or - if you want - general schemata results on the own intellectual and/or practical activity of the learners. This gives them the possibility to learn consciously from the very beginning, to have in mind the whole learning object and the perspectives of its cognitive penetrating, to form learning goals actively and to put them into practice by own learning actions.
This teaching strategy creates optimal conditions for
- embodying the concrete special data in memory in the frame of general and essential features and relationships,
- for an implicit repetition and systematic training,
- for a step-by-step differentiation and concretization of abstract schemata and thus
- for a successful acquisition of new knowledge and competence.

Under these conditions the learning activity of the pupils - even

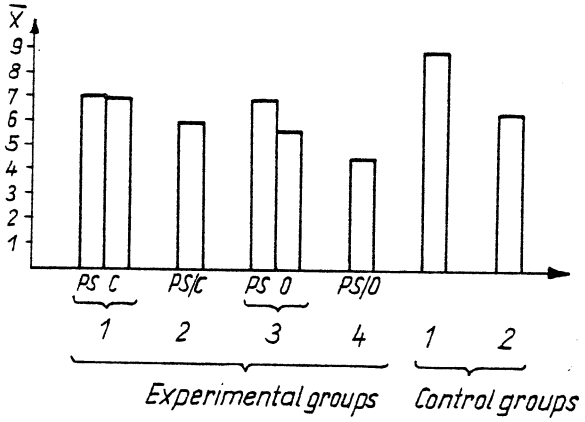


Fig. 8 Mean number of necessary steps until the solution in experimental and control groups (4 th class)

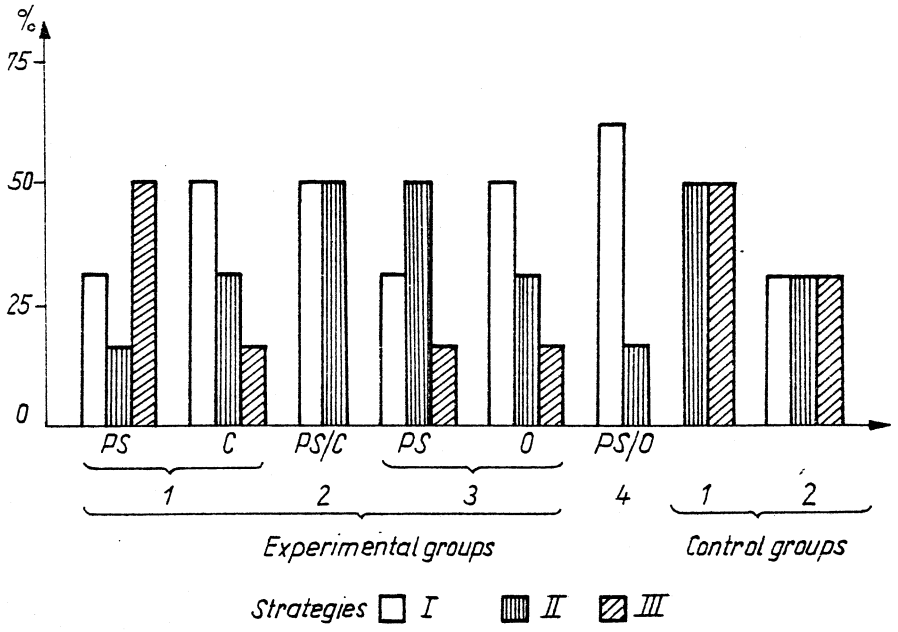


Fig. 9 Proportion of strategies in solving an interpolation problem (4 th class)

in younger classes - can be directed towards the acquisition of the substance of a learning object and of the methods for its revealing. As experimental data in the USSR and in the GDR show, this teaching strategy promotes the development of a scientific, dialectial thinking and cognitive motivation, of activity and independance, of cooperative learning forms etc. In my opinion, nowadays the ascending from the abstract to the concrete is the best strategy for a systematic formation of a high effective learning activity, because this strategy is consequently directed towards the learners' own activity and its pedagogical guidance, creating favourable conditions for their personality development by integrating the essential aspects of that process, which in other strategies or theories are often handled completely isolated.

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DEVELOPMENT THROUGH INSTRUCTION

Carel van Parreren, The Netherlands

Cognitive development may be viewed in different ways. Piaget saw it as a quasi immutable process. Though he did not consider it biologically determined in a strict sense, the only environmental influences he acknowledged were such as to be in the reach of any normal child in any normal environment. So called 'logical-mathematical experience' would be the only form of learning that influences development, and this cannot, according to his view, be equated with 'experience in the sense of action of the external milieu' (Piaget & Inhelder, 1969). The learning processes that are necessary for development the child would go through without external help, purely by way of analysis of the results of its own actions.
In a view like this, no role can be reserved for teaching as a factor in development. Quite another view of the process of cognitive development is possible however: Vygotskij's interpretation, which sees cognitive development as interiorization of cultural and intellectual forms of action (Vygotskij, 1978). If we adopt this theory, teaching comes into view as one of the prime movers of development, because it is largely through teaching that cultural contents are transmitted to the child.
Not every form of teaching will productive in this respect, however. Of course teaching always implies exposing cultural content before the child, but not every such content furthers cognitive development. There are contents and ways of teaching that are developmentally productive, whereas there are others that are not. If we want to realise a truly developmental instruction, the question arises what are the means by which the child may develop himself. (Develop himself, because in Vygotskij's view (1962) the child is not a passive receptacle of the contents of teaching, but has to be active; his desire to 'grow up' is essential for development.)
In answering the question of means that further cognitive development, we are nowadays in a far better position than Vygotskij was in his time. Developmental research and experimental teaching programs in the Soviet Union and in other countries (also in the Netherlands I am proud to say) have shown that three types of teaching content in particular may stimulate pupils in their cognitive growth.

The content-goals of developmental instruction

First of all they should be taught general concepts and principles.

Cognitive development means the elaboration of a hierarchical structure of action potentialities (Van Parreren, Assink & Borghouts-van Erp, 1983). This means, that specific actions get within the child's reach because they have a basis in more general action potentialities, which are at his disposal already. Relating specific actions to more general ones, which traditionally is referred to as 'insight', is the essence of cognitive development. This capacity for constructing ever larger and more comprising hierarchical structures of potential action also distinguishes man from the animals.
Teaching can only be developmentally productive when it capitalises on this human capacity. We do not enhance development by teaching pupils algorithmic procedures for solving problems with certain defining features, but only by making clear to the child on which principles and with the help of what general concepts a problem may be mastered. Only if we teach such principles and concepts we may hope that pupils will move forward in their development.
However, the mastering of theoretical principles and concepts is not enough. Pupils also must know how to use them in concrete situations. They need methods to cope with the problems they are confronted with in schooltasks as well as in everyday situations. Here we hit on the second prerequisite for developmental instruction: the necessity to teach pupils strategies. Strategies for solving problems, but also for detecting problems, for discovering hidden questions (Doblaev, 1982). Further strategies for working on long term tasks, tasks that need more time and are more complicated than the average school-exercise. And most of all the pupil needs strategies for the main long-term task he is confronted with in schools i.e. learning strategies.
There is a third demand that instruction must meet in order to become truly developmental. Pupils not only must know general principles and strategies, but it is essential that they also experience the need to use these results of learning, i.e. they should integrate these learning results into their own personal repertoire of actions. Božovič (1968), one of Vygotskij's pupils, discovered that even pupils who show perfect insight in the solution of a problem when writing their test papers, often proceed in quite another and more primitive way in normal everyday situations. Questioned about the reason why they do not use the procedure they learned in school they answer, that that is the scholastic way, but that they prefer their own ways! This means that developmental instruction must also include the formation of pupils' attitudes to use the general principles and strategies they have been taught.
So far about the content-goals of developmental instruction. If we now consider the ways along which these goals can be attained, a multitude of problems arises before us. These problems first of all concern the concretisation of the above mentioned general goals. What general principles and concepts should we select and in what sequence should they be taught? Can they be attained by all pupils, or must we exclude the so called mentally retarded children? Meaningful and workable answers to these questions require a list of

priorities regarding knowledge and skills considered basic for all pupils. Subsequently an analysis has to be made which brings to light the cognitive requirements for these forms of knowledge and skills, as such, but also for the process of learning them. Only through such an analysis it can become clear how a developmental course of teaching has to be arranged; at least for normal pupils. For the mentally retarded new problems arise: can we reach the same cognitive goals with them, and in what way should we proceed with these handicapped pupils?
From the concretisation of goals we thus come to the problems of the teaching-learning process. In this respect, though we have made great strides since Vygotskij - I only remind you of the important discoveries Gal'perin (1969) made in designing his stepwise instructional procedure - still much has to be done.
But instead of dwelling on these aspects of my theme, I prefer to draw your attention to some other conditions for developmental instruction I wrote about in Dutch some years ago (Van Parreren, 1982). At the time I referred to these conditions as 'guidelines for developmental instruction'. I distinguished between the 'what' and the 'how' of developmental instruction; the guidelines would concern only the 'how', whereas the instructional goals I mentioned before would form the answer to the 'what'-question.
At this moment, I don't think the guidelines concern the 'how' of teaching only. But even without an exact definition of their relative status with respect to the content-goals, I think the guidelines are worth-while to discuss here. Therefore, I shall recapitulate for you, as an international audience, what I said before in Dutch. Only in some minor details I shall diverge from my former exposition.

The guide-lines

The first guideline, as I now see it, still maintains a more or less close relation to the content-goals of developmental instruction. Learning general concepts, principles and strategies is only effective if the pupil knows which things he has learned, i.e. he must hold a clear overview of the action potentialities he has at his command in order to use them freely. The situation may be compared to that of the skilled worker and his tool-box. In order to do the jobs that are asked from him, the worker has to know the assortment of tools that is in his box as well as the operations that may be performed with their help. Just the same is true for our pupils: they have to know which principles and strategies they have learned and to what ends they may be used. Only under this condition they will have the full profit of what they have learned. Knowledge of one's own cognitive resources requires that in school attention is directed to this aspect of the learning process. Learning results, once acquired, have to be consciously integrated into the pupil's cognitive repertoire. Therefore, it is also necessary that this repertoire is well organised. Too often pupils have

no overview over the possibilities they really could realise with the help of some principle which may be found in their memories, but of which the retrieval is hampered by the fact that a good organisation of their memory content is missing.
A simple example of this aspect of teaching may make things more clear. I take it from the former Soviet psychologist Lev Landa (1976). Solving traditional plane geometry problems often requires the pupil to demonstrate the equality of two line segments in a figure. For this it is very helpful when pupils have a clear overview of the different ways in which the equality of line segments may be proved, i.e. by demonstrating equality and similarity of triangles, or by showing them to be opposite sides of a parallellogram, or chords on equal angles in a circle. In most geometry courses such themes are never treated together however, but widely apart. Only if the teacher regularly helps the pupils to organise their knowledge in this respect, 'operational' command of their knowledge will come about. They can retrieve those pieces of knowledge that are relevant in an effective way, in and out of context.
The following remark seems important in connection with this conscious organisation of learning results. In order to organise learning results in a proper way, naming is extremely effective. Now with respect to principles and concepts, which belong to the content matter of the school subjects, this is usually done. In the previously mentioned example it was quite easy to communicate the essentials to you, because all of us have learned what is 'equality and similarity of triangles', what are 'opposites of a parallellogram', and so on.
But with strategies, even when they are discussed explicitly during lessons, it is far less common that they are given names. Yet this is very important: only when teacher and pupils can call certain procedures by their names, it is possible for them to discuss the relevance of using them in a certain instance. Names raise objects to greater awareness for those who know and use them. This also applies to such abstract and elusive objects as strategic procedures. By introducing names for the principles and strategies the pupils acquire during learning, the whole learning activity ascends to a higher level of consciousness. Through this pupils will be stimulated to reflect on their own activities. They reach the level of metacognition - and as is well known, this is a very important aspect of cognitive development (Brown & DeLoache, 1978).

From what I have told you so far, it might be concluded, that developmental instruction stresses things that can be transmitted to the pupil without leaving much room for the child's own creativity. This is not true, however. The application of strategies for instance, cannot be turned into a scheme which may be used with algorithmetic precision. In every concrete instance not only the choice of a strategy but also its realisation require flexibility and inventivity from the side of the pupil.
But apart from this, creativity is no less valued by adherents of

developmental instruction than by proponents of most other educational doctrines. Since developmental instruction lays so much weight on the learning of rules like principles and strategies, and since rule-governed behavior seems to be the opposite of creative activity, we have a problem here. My next, the second guideline, deals with this problem.
As a matter of fact creativity and the following of rules are opposites. Creativity can even be considered to be the breaking of rules. How, then, can we at the same time stress the teaching of rules and the fostering of creativity in our pupils? In my opinion the solution to this problem lies in a specification of different kinds of rules. Ordinarily pupils are taught several kinds of rules without any indication of the dignity of the different rules. What I mean with dignity of a rule may be explained best by studying some kinds of rules which are being taught to pupils regularly.
First we have the rules that spring from the subject matter that is being taught. (These rules are sometimes called laws.) An example is the commutative law of elementary arithmetic, which says that inversion of terms is allowed in addition and in multiplication but not in subtraction or division. This kind of rules are in fact logically or empirically proved regularities. If you break a rule like this, the result, at least from the accepted standpoint of science, will be false.
A second kind of rule has to do with methods or strategic procedures. An instance, also taken from arithmetic, forms the procedure for adding numbers the sum of which exceeds ten. In order to add 5 to 8 for instance, pupils are being taught to split up 5 in to 2 and 3 in order to complete 8 to 10. The next step then is adding the remaining part of the number of 5, i.e. 3, to 10, which is easy if the pupil knows the properties of the place-value system. Here we have no mathematical law, although the procedure may be legitimated by a mathematical demonstration. Essentially the rule prescribes a way of operating. There are other ways in which sums like the one mentioned may be solved, as is well known to you, because as adults we seldom use the above mentioned procedure. Now if a pupil does not make his additions according to the rule of completing tens, he does not do something which is false, but something that at worst is not efficient. (Though some reservations may be made with respect to the efficiency of the rule of completion-to-ten.)
A third kind of rule has to do with communication and cooperation within the classroom. Again from mathematics I take the rule, that, once a quantity has been named x, it is not sensible to use x for another entity so long as teacher and pupils are engaged in the same problem. (Immediately when the problem is dropped however, the symbol x may be used for any other magnitude).
What is the result of breaking a rule like this? Here, neither the truth nor the efficiency of a procedure are at stake; instead, dropping the rule leads to confusion.
A last kind of rule I should like to mention (in fact there are

some others) has essentially a conventional character. One of my mathematics teachers taught us to write 'q.e.d.' under a demonstration. A rule like this has at best an esthetic value; it has to do with things which are considered neat or pretty within a certain community. Someone who violates such a rule exposes himself as not belonging to the community.
Now what can we conclude from this enumeration of rules and the consequences of breaking them? First and foremost, that we should make pupils familiar with the differing dignity of rules. Only by understanding the kind of authority a certain rule embodies, pupils can see what happens if they do not act according to such a rule. So their creativity becomes more self-conscious: they can anticipate the cost of creatively diverging from a given rule. No authority is absolute, not even the authority of logic. But there is a large difference between violating logical rules and diverging from what is considered elegant in a certain community. Only by seeing and experiencing these differences pupils can become creative in the proper sense of the word, i.e. able to discover something which is not only new, but also valuable.

My third guideline concerns the pupil's motivation to learn and the ways in which we can preserve or even enhance it. As is well known, part of the problems in the domain of learning motivation has its origin in bad teaching from a cognitive standpoint. Learning tasks or home assignments for which the pupil is unsufficiently prepared, unclear or summary explanations during the lessons, drilling of algorithmic procedures without showing the algorithm's rational basis and so on, are reliable methods to ruin the pupils' motivation.
But there is more to the problem of learning motivation. Learning in school is a long-term affair, and it is one of the most difficult requirements, especially for young pupils, to maintain motivation during prolonged activities.
Some educational innovators have given pupils the opportunity to choose their own tasks and work upon them according to their own schedules. But here a characteristic difficulty shows up: to think out a sensible task which one can probably complete within a reasonable period of time is something that has to be learned. Many pupils and even university students are not able to regulate their own task behavior in a sensible and realistic way. Everybody knows people, sometimes of high ability, who can hardly ever complete an essay or a publication, or who set unrealistic high goals for themselves, or who show discouragement with every set-back. Such people have never mastered the regulation of their own motivational and goalsetting behavior. Therefore, an important guideline for developmental instruction is to show pupils how they can choose realistic goals for themselves, how they should plan and evaluate their activities, and in what cases tasks better could be abandoned or at least modified. Since adults who are competent in this respect may differ individually in the ways they regulate their own moti-

vational attitudes, it seems best not to prescribe one system for all pupils, but to give individual help, and correct such ways of planning and evaluation that are certainly detrimentous to a smooth realisation of the goal. Setting up a fixed and rigid time-schedule for instance, may be useful for some students, but may do more harm than good for many others. Individual observation and support form the side of the teacher may also add to the pupil's self-knowledge: he learns to see his own strong and weak points (e.g. a tendency to overperfection or rather to neglect details).
It is a pity that psychologists until now have treated the problem of learning motivation far more with regard to the question which allegedly fundamental forms of motivation have to be tapped (e.g. achievement motivation, affiliation and so on) than that they have investigated the role of the dynamic interaction between teacher and pupil in the regulation of task-motivated activity. Insofar that they have investigated it, most of the time they have restricted themselves to a few fashionable topics like level of aspiration and frustration-tolerance.

The fourth guideline has direct relevance for the interactional process in the classroom. Though the teacher has to plan a lesson beforehand, he should abstain from realising his plan at any cost. Indeed, teaching requires a very high degree of flexibility form the teacher. During the lesson he has not only to remind himself of his plan for the lesson, but he must continually evaluate whether the pupils keep pace with him. Only when that is the case, the teacher may carry on with his lesson-plan without modification. But often things go another way during a lesson. Especially with good lessons, which stimulate pupils to think over every new step the teacher introduces, they often show unexpected reactions. These must not be ignored by the teacher, but should bring him to a mustering of his prearranged plan; can he still proceed in an unmodi fied way? Or should he join in with the ideas one or more pupils have raised? How will he, if he chooses the latter line of conduct, still reach the central goal he has set with this lesson? and so on. All such things the teacher has to reflect upon while the lesson is going on. At the same time he has to keep control over the proceedings in the classroom is order not to let things go out of hand. This means that teachers, in case they will be good teachers, have to function on two levels at the same time: the level of performance (i.e. their direct interaction with the pupils) and the level of reflection (evaluating the proceedings in the light of the premeditated plan for the lesson). In Dutch I call this form of functioning 'tweesporigheid', which perhaps could be translated as two-track functioning (German 'Zweispurigkeit'). Of course, teaching and monitoring one's own teaching activity, while at the same time pupil reactions have to be attended to and interpreted, is a very demanding job. It is, therefore, fully understandable that so little good teaching is met with. But form time to time we do see good teaching, so it does not exceed the limits of human functioning.

Where some people manage to do something in a spontaneous way, we can hope to make explicit their intuitively managed technique, in order to be able to teach it to others.

I come to my last guideline. I think it is the most self-evident one; nobody in the audience will be surprised when I mention it, and still I see it neglected in education too often. This guideline says that the teacher's fundamental attitude must be to make himself dispensable. Pupils should become self-reliant as early as possible. Properly speaking this guideline is not independent from the foregoing ones, for the pupils' self-reliance will result from good, developmental teaching. If content goals are set according to the ideas of developmental instruction and if the other guidelines are followed, pupils will become less teacher-dependent than they are in traditional schools.
Of course there is more to say about this aspect of teaching. Self-reliance of the pupils is not only heightened if the teacher's attitude is in accord with it, but also the teaching methods are influential. I remind you of Gal'perin's concept of complete orientation in the teaching-learning process, which also is beneficial to self-reliancy of the pupils (Gal'perin, 1969). Gal'perin and his coworkers have shown this in several studies. It also transpires from Davydov's experimental teaching programs, that - without precisely following Gal'perin's ideas - are arranged in such a way that pupils may act upon an orienting base that is complete or as complete as the subject-matter allows (Davydov, 1982).
Of course every teacher has the idea that he has to educate young people to find their own ways, but factually teaching-methods often form an impediment to the pupils' self-reliance instead of furthering it. Stressing one's own authority or infallibility, underestimating the pupils' abilities, unnecessarily emphasizing their mistakes are, though regularly criticised in textbooks of education, perpetrated even more often. But also a seemingly reverse attitude may hamper the pupils' independency: if the teacher provokes too strict an identification in the pupils with his own person, he makes them emotionally dependent. Pupils should identify themselves not with the teacher as a person, but as a personification of adult culture. Through this form of identification they will strive to incorporate his forms of activity. And the interiorisation of cultural forms of activity does not necessarily fixate and block development, but can stimulate it in the direction of greater self-sufficiency.
There is also a more practical reason why the promoting of self-confidence and self-reliance are valued in developmental instruction. Most aspects of developmental instruction require a more individual approach to the pupil's learning processes than can be realised in the ordinary classroom where the teacher is the only person who does the teaching. Therefore, we should create a teaching-learning community in our classroom in which older and/or more experienced pupils help and stimulate others, i.e. take some of the

teacher's load on their own shoulders. Cooperative learning is a theme which nowadays is investigated thoroughly in several countries.
I think that developmental instruction will not only profit from the outcomes of this research, but that true developmental instruction will only be possible if we can draw upon the teaching as well as upon the learning capacities of our pupils.

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LEARNING AND LEARNING ACTIVITY - TWO DIFFERENT TYPES OF LEARNING IN SCHOOL AND THE HISTORICAL-SOCIETAL CONTEXTS OF THEIR DEVELOPMENT

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To have a start, I would like to state three, probably apodictic, negations:
'Learning activity' cannot be invented or simply be found by chance and afterwards be shaped into systematic theoretical concepts.
Nor does 'learning activity' represent a pedagogical idea as such, that can be explained in terms of the history of pedagogical thinking, for instance in terms of 'self-activity' in Rennaisance-pedagogy.
Nor is 'learning activity' being developed out of learning in school in some evolutionary and immanent way, as for example out of growing complexity of the organization and institution of instruction and school.

'Learning activity' rather represents a fundamentally new type of learning in school, being fundamentally opposite to a thousand-year-old tradition of learning in school.
As to overcoming receptivity and passivity of learning in school, learning activity can be regarded as a relatively new result of a societal process which has been lasting up to now.
Instead of monocausal and linear deductions, I intend this statement to be understood as a proposition to analyze highly complex relationships and mediations, as there are for example:
The formation of an entirely new kind of learning in school is caused and advanced by objective societal necessities by a concrete-historic problematic situation and the structure of its demands; but what, however, are such necessities? What in detail is to be understood as 'cause' and 'advance'? Necessities are created by the humans' societal activity itself, that is: each problematic situation as well as the prerequisites for solving it and the means to do so.
For this development, I do regard the process of economical, political and ideological emancipation of the burgeois society as a concrete historical background.
French Revolution and industrialization are indicating a process in the course of which scientific knowledge and its social function are above all changed fundamentally. Scientific knowledge becomes relevant for practical usage to a general social extend. In the same time, and for the first time in the world history of school and instruction, education becomes a problem of educating masses. A gene-

ral, public and compulsory educational system gets developed in different forms.

My central hypothesis now reads:
The concrete historical background, the societal context of this epoch functions as a means to figure out a new type of learning in school: the 'learning activity'.
Instead of drawing linear deductions or reductions, we have to analyze highly complicated arrangements. The following comments try to illustrate this complexity and to interprete the historic point of view as one possible way to a closer comprehension of the outlines of learning activity. In the context of this perspective, learning activity primarily represents a didactic category with an epistemological character, but not a category in the psychology of learning. This does not mean that psychology - in particular a psychology of cognition - is irrelevant or subordinate for its analyzis and definition and that the didactics request a dominant position in this matter. On the contrary: With the help of the didactic perspective, I want to demonstrate that didactics as well as psychology refer to real facts and are in need of an intensive interdisciplinary cooperation.

I want to divide my reflections into three major steps: At first, I briefly refer to the historical relationships of the schools and instruction coming into being. This serves the purpose to derive a characterization of learning in school as a type of learning being defined by a direct fixation on the object and therefore by receptivity and reproductiveness. As an excursion, I then will outline the relationship of literacy and learning in the European Middle Ages; this will serve the purpose to prepare the question as to the special quality of learning activity. In a third step, I want to illustrate this quality, referring to the relationship of science, general education and learning activity in the early 19th century. This centers around the thesis: The constituents of learning activity have been developed without any relation to school or instruction in modern sciences and to its intellectuality.
The more urgently the following questions arises:
By which necessities and by which mediating processes has this new type of learning in school been developed out of intellectuality of modern science?

1. The historic relationship between writing, school and learning

Schools come into being anywhere people read and write. Reading and writing cannot be learnt by the way, by simply taking part, for example in working processes. To learn how to write and to guarantee that this knowledge is passed over, special organizations and arrangements are indispensable, and they are growing into instruction and school as history passes. Due to these organizations and arrangements, learning seems to come off the working processes and

the living-together in general, it seems to become an independant activity, and thus it renders itself independant insofar as it gets a main purpose of actions: Learning processes have become learning in school. This general characteristic has to be worked out more precisely. Which practical necessities and demands of written language give rise to these special organizations and arrangements? How do they determine the type of learning in school? The invention of writing was a solution to problems resulting from the necessities, demands and obligations of the earlier very advanced civilizations, namely resulting from the concentration of social cooperation and communication as well as the exploitations, oppressions and predominations connected to them. Writing merely contributes to debiting of deliveries, to registrations of credits and compensations. It also contributes to stockpiling and quantitative determination of products, to writing down capacities, volumes, amounts, sizes, incomes and deliveries of stock-material at each case. Writing and reading soon grow to an administrative skill which can no longer be learnt spontaneously. This can be seen even at the first sight at the complicated systems of written language alone. 'Workshops for writing and reading' very early develop into writers' schools and then into writing schools which then do not only give instructions in the skilled techniques of reading and writing but also - to a certain extent - their contents. In detail, a great many kinds can be made out and be described in terms obviously representing school for us, as there are: teacher, pupil, headmaster, special instructor, exams, class, classroom and so on (1).
To a remarkable extent, instruction and school emerge, being fully developed and perfected, at the very same time as do written language and the necessity of its transmission. We can assume two fundamental and relatively independant ways of the transmission of knowledge and experiences in the broadest sense as prerequisites.

I characterize the first way with the term 'transmission of handicrafts'. As being developed from the technical innovations of the neolithic revolution, this way of transmission keeps being embedded in an working- and production-connection; systematic and organized instruction here merely occurs as a by-product. At the same time, the transmission of skilled professional knowledge is directed to the single person. The formation of knowledge, abilities and skills aims at his future competences. This form of transmission was probably realized in already very early times and always under ordered circumstances.
The second way of transmission shows a completely different quality: here, systematic instruction is disconnected from 'seriousness' and from any connection to every-day life and working in a spatial and a temporal way. Initiation ceremonies can be taken as example for this. Nothing is produced here, there only is demonstration, but not a demonstration as how to do something, only a demonstration as how to behave. This 'demonstrating' can appear in quite different ways, but it is always directed to behavior in its social dimension.

Thus follows, that this orientation is never orientated to a single person, but always to the whole group. So it implies factors we comprehend by terms like socialization and education.

The necessity of a social transmission of writing now leads - as is my hypothesis - to a certain mediation of these two forms and by that way to instruction and school. Thereby very different components are adopted and put together newly. To examine this in detail as a historic-concrete process would be the task of a social history of school and instruction.
If this development now is regarded systematically, three constituents can be regarded which give expression to the fact that learning processes have been growing independent to be learning in school:

- Written language is a constituent for the spatial and temporal separation of learning processes. Together with a breaking away from practical contexts, there is a tendency to a fixing on the contents of writing and reading.
- The getting independent of learning processes to be learning in school also stipulates a connection of learning to teaching as such, to a professional instruction by a teacher.
- Dependent on written language, learning in school gets some promises to systematical arrangements and methods which forms these might ever have.

I now want to refer briefly to the further history of this connection of written language and learning in school. The research work on literacy analyzes history of writing not only as a process of handling the technical problems of recording or making available some information, but also as a historic process creating a new philosophy of life.
Especially the relations between the phonetic alphabet and the literacy of the hellenistic antiquity show that due to writing, language can be made a thing which really can be faced (2). Using a phonetic alphabet, writing was radically separated from each figurative symbolism. It has become a system of signs, no longer representing things but words in a way, that words are present visually all at once, can be divided into segments and be put together again. Since separating from a figurative symbolism written language no longer is a problem of representation. The letters of the phonetic alphabet no longer are symbols for facts, objects of a natural, social or divine order, but they are symbols for a process, namely symbols for the process of human speech.
So, there is no object being expressed but a relation to an object. Now it is possible to note down anything you can talk about. In principle, the system gets constructive by this simple possibility to combine. I do not want just to report on the literature on the present state of discussion about literacy, for my question at the relation between writing and learning in school, I would rather state the following results of this research work:

- Written language grows independent in an entirely new way. In contrast to an 'oral' culture, language develops a distinct tendency to decontextualization, to definiteness and explicitness. It is able to function as an autonomous and unambigious representation of meaning: language becomes text.
- A phonetically written language opens up a completely new potential of language: its metalinguistic function. Written language is an analyzis of language and at the same time it is an awareness of language. Wilhelm von Humboldt very early put this into the formulation: 'The most common effect of written language is that it fixes language and thus enables a completely different reflection about it'.
- In a way, the phonetically written language gives a new identity to language. It was ancient literacy, more exactly hellenistic philosophy, which first made use of this metalinguistic potential. Only on this level of writing cognition and its results can be made objects of reflection. Only on this level, the contents of concepts and operations as well as the concepts alone can be regarded and treated as elements and things. Proving evidence, defining or logical thinking always is thinking on a meta-level. Here is given an expression to a new quality of the relation 'thing-reality' as awareness and 'thinking to itself' as reflexivity.
- Showing a tendency to explicitness and clearness, the decontextualization of writing results in changes in knowledge and its social functions: Knowledge is getting explicit and thus an independant reality. Using these relations - in this context only briefly outlined ones - between written language, intellectuality and ancient literacy as a reference to instruction and school at that epoch will lead to the discovery of a striking discrepancy.

In contrast to instruction in the early very civilized cultures, a new quality of learning can indeed be found in Ancient Greece. This merely is evident in the differentiation of organizational and institutional elements, but as well in a new quality of methodicalness and systemacy of the learning processes, in a first step to a comprehensive curriculum as an educational cyclus and at last in the beginnings of a first professionalizing of the teachers. These changes, however, largely do not concern the type of learning in school, though instruction and school are intensively directed to writing as common literacy and no longer to writing as a technical skill, the intellectual potential of this literacy obviously doesn't effect the learning itself. No phenomenons, sympotms or promises can be found anywhere which might allow to draw conclusions to a fundamentally qualitative change in learning, as is shown in the careful and extensive research done by Marrou (3) and Nilsson. Learning remains reproductive and receptive, it is fixed immediately upon contents.
The intellectuality of hellenistic literacy is not functional for learning in school or more exactly: it is not functional yet. I

would like to consider a main reason for this, that there was not - respectively was not yet - given an objective societal necessity for being functional.
The common literacy certainly was an important constituent for the internal coherence of the antique cultures especially in hellenism. Its specific manifestations, especially philosophy and science did, however, in no way rise from immediate societal demands and necessities. They should rather be interpreted as manifestations of an intellectuality which only were onfolded on the background of 'leisure' in a slaveholding community. This exactly seems to differentiate basically the hellenistic intellectuality from very advanced civilizations. It has emancipated itself from purely technical needs and practical restraints and is motivated for the first time by obligations of its own problems, that is by a theorizing apart from interest and purpose. Obviously, on a totally societal level, hellenism did not see a reason to ensure and norm this intellectuality by an educational ideal.

2. Literacy and learning in the European Middle Ages.

In the European history, the Middle Ages represent that historical epoch, in which a new quality of relations between institutional and organizational and substantial components of school and instruction have been created during a time of more then 1000 years. In opposition to antique ages which had - in the opinion of Durkheim - teachers, but had no real schools (4), the Christianity realizes an extreme concentration on both, place and contents. The concentration on a certain place has its beginning in the monasteries which can be regarded as the primary institutional form of education in Europe. We need not refer to the historic development of this primary form to monastic or convent schools, to episcopal schools, cathedral schools, to the medieval university and at last to the college of 17th century. The concentration on a certain place is equivalent to an impressionately constant concentration on the subjects of the 'septem artes liberales' which lasted from the beginning of the Middle Ages up to the beginning of the modern times. The historical research on education used to characterize this concentration on the encyclopedia of knowledge, within which logic and language became the most relevant objects of learning as a system of purely formal studies, as, for example Durkheim says: 'The aim of education was to cultivate the intellect in what it most generally has ... only studies referring to humans can serve the purpose to cultivate a human being'. (5)

In my opinion, this interpretation is caused by a projection of our modern concepts of knowledge into the Middle Ages for our form-content-dichotonomy of knowledge has been assumed without saying. The so-called 'formalism' can be characterized quite differently in terms of what literacy is to the Middle Ages. In the Middle Ages, knowledge is the same as text in a comprehensive way. We cannot re-

late to the Middle Ages all of our today's linguistic understanding of texts as content-bearing whereby sign and denotation, representation and content have a different ontological status. For the Middle Ages, the text itself is the obligatory expression of knowledge.
In the Middle Ages, all objects are connected to each other universally and substantially, caused by a continous structure of analogy through the whole universe. This connection is pre-given ontologically and has been guaranteed by God as an absolute authority. Words and ideas have the same reality in this system of knowledge, the same ontological status as the objects have themselves. The famous initial verses of the 'sequence of roses' by Alanus ab Insulis (1120-1203) are to be taken literally: 'Omnis mundi creatura/quasi liber et pictura/nobis est et speculum'. Because of a homogenous and continous significance the entire reality is text and in the same time a mirror for the mankind. The universe as a book in which things are words, in which material representation moulds into an inseparable unit with meaning and in which the notion of words and things have the same quality. To reconstruct and understand this seems to be extremely difficult for our modern understandings. The reason may be the general categorial and methodological equipment of what is generally regarded to be knowledge in the Middle Ages (6).
We have reasons to assume that the Middle Age's way to comprehend that something is existing and how and why it is existing is quite different from our way today.

The concentration of the 'humaniora' on grammar, rhetoric and - above all - on dialectic, that is the concentration on the most general level of language seems very formal and to be supported by a concept of knowledge to which all reality is text. I would like to regard this as the kernel of the Middle Ages' literacy. It forms a tight, figurative unity of formal symbols, the content and the analogies connecting these symbols and the objects. In this figurative unity knowledge is - in principle - static and non-changeable analogies.
For the Middle Ages, the identity of knowledge and text at the same time is the adequate form of the obligations of knowledge itself. What really happened in instruction, especially in the faculty of arts seems to correspond to this statical conception. In the European Middle Ages, knowledge is understanding texts. Getting to know reality means to learn, what authorities wrote about it. The recitation of texts is the most important means of communication of scientific knowledge.
It forces a memorizing of what has been heard and an enormous techniques of recollection, especially when it wasn't allowed to make notes. Learning is a continous memorizing of given patterns, a moulding of an exemplary universality on the single, individual intellect: Learning is 'imitatio'. The constancy of knowledge is equivalent to a likewise non-developability of the learning person. After this, the relations between knowledge and learning are as unambi-

guous as they are fixed. The central principle in the medieval instruction, 'simultanity', is an expression of just this non-developability of both, subject and object of learning. There even is a complete lack of simple starts of a graduated instruction, and in the same way, it is unknown to arrange the subjects of instruction according to the grade of difficulty in mastering them. The principle of simultanity leads to a complete mixture of age-groups (7).

Something like a didactic problem of mediation cannot yet occur in this context. Also, there cannot occur the problem of a substantial connection between knowledge and learning, whereby contents do not remain externals to learning as such. Learning primarily refers to langual manifestations of knowledge, to what is the level of symbols for the Middle Ages. Keitel et al. characterized this fact as follows: 'It is not knowledge that is imparted but specific ways to express knowledge. Education thus is more or less regarded as a training for the social forms of knowledge and as unfolding the personality of a social elite.' (8)
There is still left the final question: Due to which prerequisites are relations between knowledge and learning principally problematic and which necessities cause such a getting problems and, at last: which social solutions to these problems are developed?

3. The relations between scientific knowledge, general education and learning activity in the early 19th century.

The modern sciences come up together with far-reaching changes in production and social conditions as such.
In the following, I am characterizing - on an epistomological level - components of intellectuality in modern sciences as an expression of a theoretic approach to reality. I suppose, that - in a completely different context - these components are relevant for the development of learning. I am confining myself to two complexes, namely the formation of a new quality of signs and concepts. The Middle Ages could not yet rise the question at how to gain new knowledge because of the prerequisites of its philosophy of life.
Being directed to acquire new knowledge, the new type of scientific work represents a complex change in the understanding of knowledge that is a based upon prerequisites as it is bearing various consequences. Connected to this, there is a change in the general attitude towards reality: the gaining of new knowledge means an active and constructive development of knowledge itself. This includes a concept of cognition as a proces of knowledge-construction. So, the relation of knowledge and activity, of product and process is basical for the formation of different disciplines in modern science. Cognition as active construction of meaning is dependant on specific means in a specific way, that is on symbols and systems of symbols. To achieve this, the figurative unity of sign and denotation has to be decomposed. The 'setting free' of the medieval signs, the decomposition of the seemingly so absolute identity of sign and denota-

tion, of knowledge and the way it is represented should be understood as a complex social-historic process, to which numerous different factors contribute as the manufacture, the arts, history of arts in renaissance, reformation and not at last printing. The connection and cooperation of these factors to 'set the signs free' are regarded to be still largely open to question.
The decomposition of this figurative unity means, that the signs no longer have the function to express a unity and a pre-given consistence, that has always been quaranteed by God. In a way, signs now have to find their new positions again and again, and that happens by active cognition. The connection between signs and denotations is no longer given in a concrete context of resemblance, it has to be reproduced again and again and always in a new way, in the activity of constructive and active cognition as it is. Signs become means to develop ideas and - more important - means to shape ideas.
On the other hand, reality as such can be organized in a quite new constructive way: as empiricism. With the help of signs, things can be differentiated from each other, can be classified and standardized. The manifold forms of standardizing knowledge enable and facilitate its development. Tables, schedules curves, maps, diagrams and models allow - to a previously unknown extent - to detect contradictions, to discover and record relationships but also to make changes and supplements, to clear off open points and errors.
As a result of this complex process of decomposition of the figurative unity, signs and systems of signs now are:
- variable possibilities of representation: there no longer is one obligatory expression of knowledge;
- means of enlargement, change and development of knowledge;
- means to a representation of knowledge for the purpose of an extraordinarily enlarge communication.

In the historic development of the single sciences, these new functions of the signs were realized in quite differently, always according to the task of problem to be mastered.
Had for example numbers been esthetic or sacral signs in the Middle Ages or something like 'God's thoughts', the concept of a variable for instance by Vieta or Descartes does not only mark any thought number but also a general relation to the unknown and thus only now these relations can be worked out for a productive and knowledge-enlarging activity. (9)

I now proceed to the second complex of intellectuality, the quality of conceptualization in the context of modern sciences. There are detailed analyses and studies of this topic, and so I only want to make a few remarks.
Otte suggested to regard the history of sciences as an increasing overcoming of empiricism in its broadest sense. The development of central concepts in the different scientific fields is able to illustrate this very well. Here, concepts are not related to things or to their features but to the relations between them. Now, you cannot easily find relations ready or visible, they always have to

be made up. They very strictly demand the activity of the subject of cognition. The shaping of these relations is basically dependant on signs and systems of signs. As it is shown by the historic development, the theoretical concepts' relationship to reality is more and more indirect, it is directly mediated by a more expanding network of relations to other concepts by a developing interdependance of theories.
The development of science in the 17th and 18th century on the whole was a relatively continous process whereas this has completely changed during the years from 1770 to 1850. The natural sciences and above all mathematics fundamentally changes as a result of the emancipation movement in the burgeois society. For the first time, science is practically relevant to an extent that concerns the whole society. They assume a completely new social position, a process that took place differently in the different European countries.
At an epistemological level, the resulting problems of usage and application can be characterized as problems of a systematic representation, problems of substantiating scientific knowledge and above all as problems of its instructability. As said by Jahnke, scientific knowledge now has to be able to function - so to speak - as a guarantor of its own correctness. (10) Especially on two levels that are getting increasingly interdependant during the historic development, it becomes clear, that scientific knowledge had become relevant for practice and that it has become an own social reality to a considerable degree. On the one hand scientific results and methods are utilized for material production and administration in an immediately social way, on the other hand, they are becoming an object of education in a now establishing public educational system. These tendencies, characterized here very abstractly, realized themselves very differently and partly contrary in the different European countries during the turn of the century. In Prussia, the total breakdown of the state (Jena-Auerstedt 1806) led to an extensive re-organization of the political, economical and social structures as well as of the actual educational system.
In contrast to the development in England (Lunar-Society) and France (Ecole Polytechnique), Prussia's being non-developed and behind the time with regard to the economical and political circumstances, caused the fact that sciences could not be used immediately for political and economical emancipation; they only could function if mediated by education for a future social reality. A consequence of this also was, that the independancy and relative autonomy of the educational system could be made a topic much more definitely and intensively just in aspects of educational policies, school-organization and instructional practice than they could in other European countries. How this effects in particular the Prussian educational reform, I want to illustrate with the help of some of Wilhelm von Humboldt's (1767-1835) ideas.

Humboldt's conception of general education neither is an abstract pedagogical idea nor is it a privatistic, individual and burgeois

model of learning in school. His conception is closely related to extremely critical socio-political situation of his time and just derives its clearness, consistence and practical significance from this relation. The conception of general education by Humboldt and other representatives of the neo-humanism can be seen as an intentional strategy of constituting the burgeois society by means of 'scientification' of all practical areas. Firstly this was to be realized by educated individuums disposing of knowledge in the broadest sense (11). The pedagogic in enlightment, especially the utilitarists, requested an direct orientation of instruction on field of practice being apart from school and of economical use. For Humboldt and other representatives of neo-humanism this orientation was no longer to be supported.
As a specific achievement of Humboldt in this historic situation is to be considered the question at the universality of education. Humboldt thinks it necessary to prefer a common action-regulating device as education for each individuum instead of immediately useful single skills with a direct reference to given fields of practice. THe educated individuum, the subject developing its individuality, does not mean a retreat to inwardness and privacy. Much more education for Humbolt is a 'connection of our Ego with the world to the most general and the freest interaction'. Universality of education represents the necessity of a generalized relation of the individual to the society as a whole.
The radicalness of the conception of general education at Humboldt finds its equivalent in a - up to then unknown - declaration of the independance of instruction and school from different social fields. In detail, this is described in the 'Litauische und Königsberger Schulpläne' of 1809 which I would like to interprete as a first conceptualization of that new type of learning in school: learning activity. Just because of the relation to general education and the 'independance of instruction' the conceptualization of this new phenomenon is gaining a conceptual distinctiveness and clearness that cannot be found to the same extent with other solutions, for example that of Pestalozzi (12).
The only purpose of instruction is 'general education of mankind' and is not practical and useful special training (13).
The selection of contents and methods of general education therefore no longer can be justified by the demands of social qualifications but by a level that for Humboldt represents scientific knowledge on the most general level of generalization and theorizing. For him, this is philosophy.

In a practical and highly productive way, the contents of instruction are restricted to those sciences having developed methods. 'Instruction in school is divided into a linguistic, a historic and a mathematical one' (1809, 170) The only purpose of instruction can be ensured methodically only by the 'unity and continuity of instruction as it is', for Humboldt, 'the first and most important principle' (1809, 190). Content, method and how to deal with the pu-

pils have to be 'developed in an undisturbed connection' (1809, 168) which produces its own specificity and quality out of its own and is not directly determined by single fields of a practice apart from school.
Thus, there has been marked a frame in which the didactical problem of mediation is articulated consistently and unambigously, probably the most decicive prerequisite which enables a primary conception of learning activity.
For Humboldt, the object part in the problem of mediation includes a scientific knowledge on the highest level of theorizing and generalization instead of immediately useful knowledge - on the whole a form of knowledge that forms a sharp contrast to practical knowledge but also to the everyday life of the subject. On the subject part in this process of mediation there is the individuum as a subject of its own knowledge. It is concerned to a subjective relation of the individual to the whole of knowledge, and it is not concerned to skills which are determined by those fields of practice apart from school. It is just this extreme substantial contrast in the contents of these two positions that makes evident the problem of their mediation in all its distinctiveness. Instead of directly adopting useful objects and practical knowledge identical to worked-out results, the process of acquisition itself comes forward, but not as a process of movement in general. In this connection, Humboldt talks of a 'twofold occupation of learning'. Learning first had to be directed to a scientific knowledge as 'subject-matter which all own doing always has to follow' but an orientation on learning how to learn was - at the same time - of the very same importance.
This togetherness is no abstract postulate, it also need not be forced in any way and it need not either be aroused by specific motivations, for Humboldt, it results from the specific objectiveness of this learning, from the scientific character of knowledge. It ensures that 'the young person is busy in a twofold way: first, he is busy with learning as such and secondly with learning how to learn' (1809, 170). Only when busy in this twofold way the pure reproduction of learning material is replaced by a self-active construction of this material as subjective constituing.
Today, we would call the specific quality of this process in terms like 'reflexivity' and 'productivity'. Reflectivity as complete insight into the object to acquire, as well as into the process of acquisition itself is for Humboldt a principle to differentiate general education from special training.
Reflectivity as awareness opposite to the own learning is not a result of empathy nor does it result from an abstract self-activity. For Humboldt, reflectivity is determined objectively; its unfolding depends on a specific potential of scientific knowledge. In 1982, Davydov defined this in his conception of learning activity as follows: 'As it is known, each kind of theoretical thinking and awareness demands that the person does not only make inquiries about the contents of knowledge but also about its structure. In philosophy,

this is called the 'reflection' on the own processes of cognition' (14).
The orientation on the forms of knowledge is also an indispensable prerequisite for the productiveness of learning. Concerning this point, I think it is a correct interpretation to say that Humboldt for the first time stresses the separation of sign and denotation in all its didactic importance: to analyze 'the form of language itself', 'not to skip over at once to the level of denotation', 'to overcome the difficulties the sign sets up in all its main forms', 'to treat the signs of our ideas as real objects' - all this enables a flexibility of the learning individuum against the object to acquire. Signs and systems of signs are regarded at this point as the decisive means to transform the contents of instruction in internal cognitive representations, that is, as means enabling the productivity of learning as a changing of things into ideas, of ideas into concepts. 'The intellectual-mechanic forces' (1804, 170), Humboldt on this occasion talks about on a level of instruction in school, definitely are cognitive operations at and with signs. Therefore, the objects do not remain external to the learner himself. Only signs allow those substantial connection of knowledge and learning by which they becomes means of learning activity, means of a transformation of objects into the own knowledge, that is into the knowledge available for this subject.

Instead of a summary, I'd like to point at some problems and questions on a quite general level.
The development of a general educational system in the early 19th century is a historical and social process that is lasting up to our days and is not at all completed yet. The 'relative autonomy' of this educational system with regard to other social fields, above all to science and material production, is both, prerequisite and consequence of complex social-historic changes of knowledge and its social functions. To a large extent, this educational system has not yet been investigated as an active, changing factor in these processes (15).
With regard to the educational system as such, its 'relative autonomy' and its independency can be seen as essential requirements and pre-conditions for the fact that the relations between knowledge and learning activity develop their own quality and dynamics. It's only in the framework of this autonomy and independency that - in all its sharpness - the problem now arises that subject- and object-part of learning are to be mediated.
By what and how can it be ensured that the contents do not remain external to the learning process itself?
Wilhelm von Humboldt thinks a learning process as an active development of the contents to be a solution to this problem. This process is characterized as learning activity by reflectivity and productiveness and only develops this quality if and when dependant on its own object, the scientific knowledge on the highest level of generalization.

For Humboldt, this solution has a practical dimension for instruction and an explicitly social-political and institutional-organizational one. We can take similar - though in detail quite different starting points in the early 19th century as attempts to comprehend conceptually a new type of learning in school.
A social history of learning activity should investigate how these promises actually have been realized, impeded, held down and developed further, but at the time being, there is a lack of the most important basical methodological requirements.

Nevertheless, I briefly want to examine the question which place a historic perspective way on the whole has for further systematic investigation of learning activity. In my opinion, this perspective draws our attention to the following problematic situations.
Learning activity is a historic phenomenon. As a result of a complicated mediated process , it has been developed out of the necessity to acquire theoretic contents and forms of the societal knowledge and competences. Thus learning activity is by no means only a certain way or method of learning in school, it is a 'component of human essentials and therefore has to be adopted and cultivated on one's own' (16). School and instruction represent a socially organized and institutionalized framework of requirements which can be contradictory to itself. On the one hand, this result from the independency of this framework, especially of its relative separation and isolation of other social fields. On the other hand, this results from its being determined by the context of the society and its development altogether.
Within this framework, knowledge gets school-knowledge and learners get pupils. How and to which extent now does the contradictoriness of this frame determine the development of learning activity? This question can be differentiated, though quite unsystematically yet: Which significance can we ascribe to the single kinds of knowledge about subjective worlds ('Lebenswelten'), every-day-life, scientific knowledge in both, its contradictions and its correlations with regard to learning activity?
In which way does learning activity as an individual development of subject- as well as of object-part of learning, work together with instruction as social-communicative process? The features of learning activity have become clear up to now only with regard to scientific knowledge as their object.
How do these features change; which new components of learning activity could be derived of the specific potentials of subject-matters as music, arts and physical education and so on?

These hints to problematic fields are indicated to illustrate that the present division of labour between the historic educational sciences, psychology and didactics does not meet the problem of learning activity.
The historical science of education investigates school and instruction either from a point of view of the history of that institution

or from a point of view of political sciences dealing with the relation of dominance and society.
Psychology is regarded to be qualified for the description and investigation of learning processes and thereby largely disregards the contents. These, however, are the central topic for didactics, the aspects of their development being neglected.
On the whole, this deficit points out the necessity to develop 'learning activity' as an 'interdisciplinary topic of investigation' as 'interdisciplinary category'. To do so, a methodological level has to be found urgently, so that the different disciplines as the historic science of education, didactics and psychology, basing on this level, can on the one hand refer to the same real facts and on the other hand can relate to each other at the same time.

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RULES, REPRESENTATIONS AND IMAGES: DEVELOPMENTAL AND CULTURAL INFLUENCES*

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The following material was part of a presentation made at the international Symposium: Education For Cognitive Development, Utrecht, The Netherlands. It utilizes data which relate to three concerns that have been emphasized by Activity psychologists. The first set of data is concerned with children's generated rules, and distinctions among different kinds of rules. Van Parreren (in this volume) placed the concept of rules within Activity psychology. This data complements his presentation and at a later point, reference will be made to his comments. The second set of data focuses on what Vygotskij (1978) has called 'mediated remembering' (p.45), and the exploration of 'the sign-using activity of children' (p.46), related to those aspects that are invented by children and those that are passed down by adults. Finally, the third set of data is sligtly more problematic from an Activity psychology perspective and focuses on the cultural distinction between children's usage of imagery, and the development progression of imagery.
Before describing the data, two points need clarification. First, the data are based on children's responses to various arithmetic problems. The content area of mathematics is used because it carries with it a certain precision concerning the object of understanding. The implications, however, are more generalized in reference to the concepts explored. Secondly, while the issues explored are rooted within a theoretical perspective, the role of theory is to help structure the data and evaluate the various findings concerning the data.

Rules

The first study is related to the work of Wolters (1983) who asked the question, 'What kind of strategies are effective for helping children in learning basic facts?' (p.63). It was suggested that the use of the commutativity principle offered a strategy for

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a shortcut to solutions for problems involving addition, and that firstgrade children varied in their use of the principle when solving addition problems. The use of this principle assumes that the children understand a regularity: In defining addition, elements of N, $n' + n^2 = n^2 + n'$. A useful strategy for children would be the ability to reflect on commutative regularities, because by doing so the need for memorization of the addition facts is greatly reduced. Rules are defined by regularity, and the laws and regularities of arithmetic are a type of rule.
Van Parreren (1984) described rules of mathematics as rules concerned with proofs, distinct from social rules, and rules of self regulation. While mathematical regularities are not subject to consensus as are social and psychological regularities, it is not known whether children's actions take into account these types of distinctions. It is possible that children's reflections about social rules form the template or model for the way they reflect upon mathematical rules. If this is the case, it would be interesting to understand how a regulation such as the commutative principle is understood by children. The first section will attempt to explore this issue.

Thirty kindergarten and thirty first grade children were interviewed concerning their solution of a problem illustrating the commutative principle (see Table 1). After the children solved a simple addition problem they were asked the following series of questions:

How did you know what numbers to place here?
What does a rule mean? What is a rule?
Can you tell me a rule that you know?
Can you tell me a rule for numbers or arithmetic?

In order to elicit comments to those questions children were presented with a number of illustrations of the commutative principle and asked to solve the simple addition problems. All the problems summed to nine, or under, so as not to make the task of addition difficult. Table 1 illustrates the problems presented to the children.

Table 1

Problems illustrating the commutative principle

If	4 + 2 = 6,	then	2 + 4 = 6;
If	3 + 2 = 5,	then	2 + 3 = 5;
If	6 + 3 = 9,	then	3 + 6 = 9;
If	5 + 2 = 7,	then	...

The interviewer and the child read the problems together attempting, in this fashion, to have the child act systematically and consciously when asked to continue by placing the addition problem showing the commutative property of 5 + 2 = 7 in the place as 2 + 5 = 7.

Children's responses to the questions concerning rules were recorded and appear below.

Question (1) How did you know what numbers to put here?

Aswers from kindergarten children:

- I looked at that. (5+2=7)
- 'Cause I knew.
- Because I wanted to; because I like 5(after writing the number 5 in the space provided).
- I just remembered.
- I looked at the numbers and thought about what it would look like if it was backwards.
- 'Cause I just thinked (sic) it; I thought it would go like that.
- Well I just put a seven because I thought it in my mind.
- Because, if that way is the right way, the this way can go the same way.
- It's easy you get the first number to be the second and this number to be the same.
- It says the opposite.

Answers from first grade children:

- Because there is a five and the two changed over there - the five where the two and the two where the five.
- It doesn't matter if it is a different order and, if, it's 5+2, then it could be 2+5=7.
- Because on all the other ones it is just the opposite.
- They're opposite.
- I just changed the number around; they equal the same; it's just the numbers are changed around. You can do one way and you can do another one and it will still add the same number sometimes.

The answers of the children demonstrate their ability to reflect upon their solution to the problem. It is interesting to observe that kindergarten children would often use words such as, 'I thinked', 'I knew', 'I remembered,' and 'I looked'. Their responses suggest that many kindergarten children look for regularities in their own thoughts rather than regularities in the external environment; however, the first-grade children responded in ways that clearly show a shift in the content of reflection, from statements about their own thoughts, to regularities about the external referents. This is typified by comments such as, 'because on all the other ones it is just the opposite'.
While the kindergarten children made references to their own thinking the first grade children appeared to be searching for a generalization about the content.

The second and third questions were presented together:

2) What does a rule mean? What is a rule?
3) Can you tell me a rule?

Answers from kindergarten children:

2) Not sure.
3) Like your not allowed to run in the room.
2) Well, there (are) things like you can't do.
3) Like my rules I can't go across the street.
2) Something that you can't do.
3) Climb trees.
2) A rule is like you do something bad, like don't do something.
3) Don't fight.

Answers from first grade:

2) Like, you can't go against the rules, otherwise their is a penalty.
3) Like, some bad man went out and stole something from a house; he went to jail.
2) It's something you have to keep on doing for a long time.
3) If you get into trouble, you have to stay in and that's a rule.
2) It is something you shouldn't disobey because it is for a reason.
3) Well like, if your mother says don't cross the street, you shouldn't.
2) It's like whatever the rule is, you just follow it.
3) Kinda like you're king because you follow it; well, ah, it's you follow it if the person tells you the rule of a good person if you follow it; will then, if you live in a little town and keep telling everyone they will be like a king.
2) A rule is like, let's see, a rule is, let's see, it's something, it's like important, and it's an important word, because a rule is something that tells you to do something and it's a word.
3) A rule is like someone is telling you, like I said, "Put the books in the shelf, and don't let your room be messy," that's a rule.

The overall characteristic of the children's responses, in both classes, indicates that rules are basically understood as an obligation to refrain from a particular action or activity and, to a lesser degree, as a permission to perform a certain action or activity. When children talk about rules, they tend to relate them to social rules rather than rules of proof or rules of self-regulation In this regard, the responses would support the idea presented in Activity psychology that learning takes place within a social context. Rules as Wolters (1983) has shown can also empower children

and allow them to gain control of their learning. The data from the limited number of children in this study suggests that children tend not to regard rules as strategies that empower, but rather as negative and often restrictive social controls.

The fourth question asked:
Can you tell me a rule for numbers or arithmetic?
Answers from kindergarten children: (selective examples)

- You can't make them (numbers).
- Not at my house.
- The numbers can't be too big or too small.
- Count them and don't play around.
- No backwards numbers.
- No cheating.

Answers from first grade-children: (selected examples)

- It's hard you have to start on the right side in math; you always do that.
- Math? Like if your subtracting, you can; you have to use the higher numbers, because if you don't it might turn out to be different then it would be; you're supposed to always start with the higher number and in adding you can use either one.
- You can't make 'em backwards because ik would take up to much time to erase em. Cause in our class we have 20 minutes for math time, a 9 backwards is a P.
- Raise your hand, one of our rules of politeness. You can't skip numbers.

Most of the children simply stated that they did not think that there were any rules in arithmetic. Most thought it was a 'funny' question, or said, 'I don't know'.
Children's responses can be taken to mean that, at least in reference to arithmetic, kindergarten and first grade children are responding to mathematics with actions that are not regarded as rules. As Kalmykova (1982) stated, 'Forced to act in undefined conditions, one does not know which data are relevant and what kind of relations exist between them'. Rules of arithmetic provide one important way to help define conditions and relationships, and can contribute to reflective thought. When rules are introduced for use in this manner, there needs to be a correspondance between a childs ability to take advantage of rules and the instructional introduction of rules. An observation in reference to the size of the numbers used is relevant here. When large numbers are used children begin to focus on various tallying and counting procedures and thereby have a difficult time focusing on the questions concerning rules. From the difference in responses when small versus large numbers are used it is clear that if the goal of instruction is for children to understand the utility of rules and to use rules, it would be best to start with small numbers that are already firmly within the grasp of those children.

Representations (second data set - mediated remembering)

Before presenting the data in this section, it is important to clarify the meaning of 'representation' as used here. Scholnick (1983) discusses various meanings and positions concerning representations. Paraphrasing Furth, he points out that representations serve two functions: First they 're-present or re-introduce objects, persons, events, and ideas that are not presently in consciousness' (p.43), and secondly, a substitute is called to mind that stands for the object, person or event. Within this second function a series of questions my be raised and to some extent are by Scholnick. Piaget & Inhelder (1973) recognized this same issue when they postulated the distinction between the signifier and the signified, or the representations (signifiers such as signs, symbols, or gestures and imitations) and the object (person or event signified). The critical issues the understanding of the relationship between the two. Is it that the representations are copies of what is represented and meaning is derived from the copies, or do representations 're-flect the mental resources of the perciever - the biases and structures of his mental representational apparatus from which he constructs his structural descriptions'? (Olson and Bailystok, 1983, p.20). Scholnick's (1983) argument, concerning whether the environment determines representations (e.g. Rosch and Nelson) or whether representations are constructed as a result of developmental unfolding (e.g. Piaget), perhaps forces a dichotomy that in reality does not exist. While Scholnick forces the dichotomy, in Piaget's case the distinction is not clear. Meaning is thought to be a function of interaction between development and environmental influences with one not being reduced to the other.

Perhaps a more fruitful place to explore the argument is in the work of Vygotskij. Viewing one form of representation as the use of a sign (one thing standing for something else), it is possible to postulate following Vygotskij, '...This means that sign-using activity in children is neither simply invented nor passed down by adults; rather it arises from something that is originally not a sign operation and becomes one, only after a series of qualitative transformations. Each of these transformations provides the conditions for the next stage and is itself conditioned by the preceding one; thus transformations are like stages of a single process, and are historical in nature' (p.46). He goes on to say, '...observations show that between the initial level (elementary) behavior and the higher levels (mediated forms of behavior) many transitional psychological systems occur. In the history of behavior these transitional systems lie between the biologically given and the culturally acquired' (p.46).

The transformation of sign-using activity is much like that of language. External communicative speech as well as 'egocentric' speech, turn inward to become the basis of inner speech; 'the transformation of an interpersonal process into an intrapersonal one' (p.56) is seen as the result of a long series of developmental events.

Further, in their writing, Davis, Young & McLoughlin (1982) state that understanding is sometimes closely related to the ability to construct a suitable mental representation. They observe, with a sense of wonder, that this has been a neglected area of research. Similarly, Hughes (1983) concluded that children do not seem to realize that arithmetic symbols can represent quantities of objects and operations for real problems (p.217).

The second data set attempts to address some of these issues. 'Representation' will be defined as the use of written notations by children to stand for an actual configuration of modular blocks (Scholnick, 1983). In Piaget's (1973) terms, notations are the signifiers and the configuration of blocks is the signified. Within Vygotskij's (1978) construct, the notations are mediated signs, while they are written; they also are internalized and in this fashion can be thought of as an intrapersonal process.
The data builds on previous work by Zimmer (1983, 1984), and in order to present the current research it is necessary to explain earlier work. In the previous study children were given one-unit blocks, four-unit blocks, and eight-unit blocks. They were given instruction concerning the relationship between the single unit, 4 unit, and 8 unit blocks. When children were able to demonstrate that they knew the relationships, they were given enough blocks to be able to put them together so that they totaled eight in four different ways (one 8-block, eight 1-blocks, two 4-blocks, and one 4-and four 1-blocks), and summed to 20 in three different ways.
After the child had constructed first the 8-sums, and then the 20-sums, they were given a sheet of paper and pencil. The interviewer asked the child to use words, symbols, numbers or anything that would help him/her to remember, and record which blocks were used to make each of the combinations. Each child was told that the interviewer would return in a month with the blocks and the written notes. At that time, he/she would be asked to reconstruct the sums of 8 and 20, in the same way, by looking at what was written on the paper.
One hundred and twenty children were shown the blocks, asked to represent the additive combinations, and one month later directed to reconstruct their combinations using their own written representations. Theoretically, it is assumed that the 'form of representations may be dictated by the knower who brings to bear past experiences, and abstractions derived from reflecting on past experience, to form an enriched and personal interpretation of the data' (Scholnick, 1983, p.43).
Children's representations were judged on the basis of whether their mediations allowed them to remember the combinations from a month earlier, thereby enabling them to reconstruct the same combinations of blocks (See Zimmer (1984) for a detailed description of this study.)
It was then possible to place all of the children's responses on a continuum of efficiency, ranging from those mediational representations which did not lead to remembering the original additive combinations, to those that lead to a complete reconstruction of the original combinations.

In all, five levels were identified, each with a number of sub-levels:

Table 2

Levels of Written Representations.

Level	Sub-level
1)	a) Arbitrary symbols
	b) Drawings
2)	a) Cardinal number only
	b) Tally sequence
	c) Number sequence
	d) Cardinal number and sequence
3)	a) Graphic
	b) Cardinal and graphic
	c) Unrelated computations or numbers
	d) Total blocks used
4)	a) Correspondence between block value and number
	b) Non-conventional notation systems
5)	a) Conventional notation systems
	b) Use of number words and elaborated language
	c) Combinations of 5a, 5b, and 3a

Level 1 representations were not efficient for the purpose of mediating the reconstructions of the orginal combinations. These representations were characterized by marks displaced spatially, alphabetical characters, or an arbitrary number. In none of the cases, however, did they lead to a single reconstruction.

Level 2 representations were only a slight improvement on the previous level. These responses were characterized by tallies (e.g. ////////;-------- etc.) or number sequences (e.g. 1 2 3 4 5 6 7 8; 1 2 1 2 1 2 1 2 etc.) to represent 8 and 20. Still others at this level simply used the cardinal number 8 or 20.

Level 3 was the most frequently used category. While children were requested not to draw, still many did so. The drawings, however, were not efficient for reconstructing the combinations. Children also used the number of total blocks in the combinations (e.g. one 4-block & four 1-blocks would be represented by 5). Still others would use computations (e.g., 7+1=8), and while the computations were correct they were unrelated to the combinations of blocks.

Level 4 was not a frequently used category by this first group of children; but, as will be shown later, have often been used with a cross-cultural sample. Responses at this level were characterized by a correspondence between the value of the block and a number (e.g., two 4-blocks represented as, 4 4; one eight-block represented as, 8; one four-block and four one-blocks represented as 4 1 1 1 1), and non-conventional notation systems. The latter in some cases using algerbraic form, but with an important referent

left out and personal symbols used.
Level 5 was the most efficient with the mediational representations leading to almost perfect remembering and reconstruction of the original combinations. These efficient systems were basically of two kinds. One was a conventional notation system (e.g., two 4's represented as 4+4=8; one 8 represented as 8+0=8 or 4 and four 1's as 4+1+1+1+1=8).
The second system utilizing number words (e.g., two 8's and one 4 as 'one medeam (sic) with two big ones' or, in another case, two 8's and four 1's as, '2 toller skewers (sic) 4 little skewers (sic).
The level of efficiency of these children was significantly correlated with age. Younger children used lower levels of efficiency and older children tended to use higher levels of efficiency.

In terms of their mediational value, the lower levels are qualitatively different from higher levels. At lower levels there appears to be less influence form sociocultural factors, whereas the higher levels can be thought of as mediations that are cultural forms of behavior. It might also be assumed, following Vygotskij, that these culturally rooted behaviors become internalized and function as an intrapersonal process. If these higher levels are socioculturally transmitted, one would expect that adult populations would function at higher levels; further more, different adult communities would use different forms of representations.
In order to explore this question, three different adult groups were shown the same task and asked to represent the various additive combinations. One group was made up of parents from the same population as were the children; a second group was mathematic teachers, and a third, English teachers. None of the adult groups had responses that fit levels 1, 2, & 3. The math teachers, almost exclusively, used numerical or algebraic notation systems; the English teachers, with few exceptions, used elaborated language to describe the configuration of the blocks; and the parent group's distribution of responses was most like that of the children at levels 4 & 5.
The data would support Vygotskij's notion that signs used in mediational remembering go through a series of transitions and at the higher levels ('mediated forms of behavior') are transmitted culturally.
To further explore this notion, a cross cultural sample, a cross sectional sample and a longitudinal sample of children were given a task similar to the one described above (Zimmer and Cheng). It was reasoned that, for all samples, the younger children would have more responses at lower levels and fewer responses at higher levels, with the reverse true for the older children. In addition, at the higher levels, it was thought that there would be a cross-cultural difference in the types of efficient responses which might further suggest that the socio-cultural signs used for intrapersonal processes (mediated forms of behavior) are different cultures.
Table 4 and 5 present the data from kindergarten, first and second

grade for children from Taiwan and the United States. Table 4 shows the progression of levels of representations for the Taiwan sample. At the kindergarten level most responses are coded 1 and 2 with only three responses coded at level 5. Whereas, there were no second grade children's responses coded at levels 1 and 2, and 38 of the possible 50 responses were coded at levels 4 and 5.

Table 4

Taiwan 1983, Kindergarten

Coding

Problem		0	1	2	3	4	5
8	1			2	4	3	1
2-4	2			2	4	3	1
1-4+4-1	3			2	5	1	2
16	4			1	6	2	1
16	5			1	6	2	1

Taiwan 1984, First Grade

Coding

Problem		0	1	2	3	4	5
8	1			5	6	12	5
2-4	2			7	5	10	8
1-4+4-1	3			12	9	3	6
16	4			7	7	7	9
16	5			9	9	6	6

Taiwan 1984, Second Grade

Coding

Problem		0	1	2	3	4	5
8	1				4	1	5
2-4	2				1	1	8
1-4+4-1	3				2	1	7
16	4				2	1	7
16	5				3	1	6

Table 5 presents data from the U.S. sample showing both a portion of the longitudinal sample and the cross-sectional sample. As with the Taiwan sample at the lower grades, children's responses are primarily coded at lower levels of efficiency, and higher grades at higher levels of efficiency.

Table 5

U.S. 1983, Kindergarten (Longitudinal)

		Coding					
Problem		0	1	2	3	4	5
8	1		3	8	8	1	1
2-4	2		3	7	10	1	0
1-4+4-1	3		3	6	13		0
20	4	6	1	7	4	1	2
20	5	6	2	5	7	1	0

U.S. 1984 First Grade (Longitudinal)

		Coding					
Problem		0	1	2	3	4	5
8	1	2		17	1	8	
2-4	2	2		10	2	14	
1-4+4-1	3	2	2	10		14	
16	4	1	3	2	10	1	11
16	5		2	2	2	12	10

U.S. 1984 Second Grade (Cross Sectional)

		Coding					
Problem		0	1	2	3	4	5
8	1			1	5		4
2-4	2			1	4		5
1-4+4-1	3			1	4		5
16	4			1	3		6
16	5			2	2		4

Tables 4 and 5 show a number of interesting comparisons. As has been already mentioned, there is a clear developmental trend in both groups, with a movement from lower to higher levels of efficiency, from the kindergarten to the second grade. Another comparison is the use of categories 3 and 4. The U.S. sample, especially at the first grade level has a high distribution of responses in Category three, whereas the Taiwan sample has a high distribution of responses in Category four. Category three contains computational representations unrelated to the problem presented, and cardinal number values that correspond to the exact value of the blocks. It might be concluded that U.S. children are instructed at an early age to use operators (+, -, and =) but are unable to use them as mediators when solving the task. On the other hand the

Taiwanese children at the kindergarten and first grade levels infrequently use operators, but rather utilize a direct correspondance between their representations and the blocks represented.

Another task was presented to the first grade U.S. and Taiwan sample to further explore the use of operators. The children were given two simple problems. The first problem concerned the repre sentation of subtraction. Children were shown six cubes. The interviewers demonstrated, without mentioning a specific number, the following problem: 'We start with this many (6), and take away this many (2), and we have (pointing) this many left.' The second problem concerned the representation of addition. Children were shown (5) cubes placed on a piece of paper and (3) cubes placed on a second piece of paper and a third piece of paper with no cubes. The interviewer demonstrated the following problem: 'We start with this many here (5), and this many here (3). How many would we have here (pointing to the empty paper), if we put these (5) and these (3) altogether?' In each case children were asked: 'What can you write on a piece of paper to show what I have done with the cubes? How were the blocks separated (put together)?'
There was a marked distinction between the U.S. and Taiwan first grade sample in their use of operators. There were 26 U.S. children and 30 Taiwanese children. For the subtraction problem, four U.S. first grade did not use operators (+, -, =) and 22 did; whereas, 19 Taiwanese first graders did not use operators and 11 did. Similarly, for the addition problem only one U.S. first grader represented the problem without operators and 25 used operators. The addition results for the Taiwan sample were identical to their results for subtraction, 19 children used no operators and 11 used operators. The Taiwanese children would simply use the number values (e.g. 6, 2, 4, for the subtraction and 5, 3, 8, for the addition); whereas, the U.S. sample would use the operators (+, -, =), often times incorrectly. These results are also supportive of the idea that instruction in the first grade in Taiwan and the U.S. focuses on different type of mediating processes. In Taiwan, the instruction may emphasize correspondance without the use of more abstracted symbols such at mathematical operators.
Research (Lyons, 1984; Stigler, Lee, Lucker & Stevenson, 1982) has shown that the mathematical achievement of Taiwanese children is superior to that of U.S. children. Perhaps one explanation is that the mediated processes that Taiwanese children are taught, more closely parallels their development; or, in Vygotskij's terms, are within the children's proximal zone of development. Whereas, in the U.S. instruction at the early grades is not within the proximal zone and so internalization of mediated forms of behavior is less frequent. Consequently, a disparity in performance can be observed between Taiwanese and U.S. children.

Imagery

The final study addresses the use of imagery, especially as it re-

lates to reflective thought in mathematics and logic. Imagery can be thought of as a mediating process and, in this sense, can be considered as having a relationship to reflective thought. Zak (1983) stated, 'Mediated behavior is an indispensable condition for successfully performed activities...'(p.43). It would follow that imagery would be one possible function that would facilitate mediated behavior, in addition to language as described by Vygotskij. While Activity psychologist recognize the importance of processes over performance, Kalmykova (1982) stated, 'The fundamental components of cognitive development are (1) everyday experiences (2) available knowledge and (3) the properties of thinking which determine one's educability (the ability to aquire knowledge)' (p.74). Alternate ways to conceptualize development are possible. Williams (1983) and Zenhausern (1978), for example, base competency of learning on whether a particular cognitive style, related to cerebral dominance, has developed sufficiently to respond to environmental demands, particularly right/left hemisphere dominance (visual or logical). Inhelder and Piaget, and Piaget and Inhelder (1969 and 1971), have recognized that the image and logical operations are eventually integrated, but that the image becomes subordinate to operational dynamics such as logic. While the role of the environment is considered important, it is only so, to the degree to which it forces thought to construct solutions to problems posed by the environment. For Activity psychologist, development is concerned more with the experiences and adult influences upon children in the process of learning, than with the descriptions of internal functions or with constructive thought.

However, it must be emphasized that most modern day psychologies recognize the importance of experience, brain functions and the organization of thought on development and learning. It is more a question of how to think about the problems and the direction of influence rather than exclusion.

The questions asked are complex and beyond the scope of a single study but, the topic was addressed using cross-cultural, cross-sectional and longitudinal samples to collect data. Three imagery tasks (Zimmer, 1983) were given to kindergarten, first and second grade children from the U.S. and Taiwan. The tasks 'rotation of beads', 'bending pipe cleaner' and 'turning squares', all required the child to reproduce by coloring or selection what they imagined the presented objects would look like after they were displaced in various ways. The children were not shown the actual displacements but asked to imagine them, after various demonstrations which were designed to clarify what was expected without showing the transformation itself. Each child's responses were coded and given a total score. Possible scores ranged from 0-12. Table 6 presents the number of children, the sum and the mean for each group.

Table 6

Mental Imagery[1]

Sample	Number	Sum	Mean
[2]Kindergarten U.S. 1983	22	128	5.81
Kindergarten U.S. 1984	28	170	6.07
Kindergarten Taiwan	10	82	8.20
[2]First Grade U.S. 1983	28	173	6.18
First Grade Taiwan	30	266	8.86
Second Grade U.S.	19	171	9.00
Second Grade Taiwan	10	107	10.7

[1]Rotation of beads 0-5; Pipe cleaner 0-3; Squares 0-4.
[2]Longitudinal sample with six additional children in the second grade.

What this limited data shows is that there is a consistent increase both in the scores of the U.S. children and Taiwanese children. The means for the U.S. at the kindergarten level were 5.81 and 6.07, and increased to 9.00 at the second grade. The Taiwanese kindergarten mean was 8.20 and increased to 10.7 at the second grade. With this sample the date demonstrates a developmental progression. When the U.S. sample and Taiwanese sample are compared there is a consistent difference between the two; the Taiwanese means are higher at every grade level.

There are at least two possible theoretical explanations. One, following Vygotskij, is that the Taiwanese social-cultural influences can be considered to have caused the difference; and two, that following the arguments of proponents of left/right hemisphere thought, at least at this age, the right brain functioning of Taiwanese children is more precocious then the U.S. sample. The former explanations would need to be verified by a detailed comparative account of social-cultural influences upon imagery in both cultures. If such an examination was not supportive of Vygotsky's position the alternative might be plausible.

In terms of imagery as a mediated behavior, the same mathematical solutions are possible by either algebraic or geometric solutions. One requiring logical and the other graphic systems of thought. If we consider the data presented, as well as the University of Michigan study, an explanation for the distinction between U.S. and Taiwanese children might be found in the more prevalent use of imagery by the Taiwanese children. In turn, as with the geometrican, the image itself might be used as a form of mediated beha-

vior, more intuitive and less formal. Perhaps with children the competency to anticipate spatial transformations and displacements is an indication that the object of a psychological operation is the 'activity aimed at mastering oneself' (Vygotskij, 1978, p.55). If this is so, then the advanced use of imagery by the Taiwanese children might also indicate internally oriented behavior. This is not meant to imply, that at the same time, behavior is not externally oriented. Rather as Vygotskij has indicated it is both an internal and an external activity.

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II. EDUCATION IN THE THIRD WORLD

EDUCATION IN THE THIRD WORLD AND THE THEORY OF STRUCTURAL COGNITIVE MODIFIABILITY*

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The topic 'The Third World in its need for education' must be considered in a very broad way. As a matter of fact from the point of view of our need to adapt ourselves to certain discontinuities in the culture, we also are a 'Third World'.
Today's disruptive development presents us with the need to create in ourselves higher levels of modifiability, or flexibility in order to cope with and to adapt to new situations. Moreover the Third World, which is becoming the focus of education in this area, more than ever presents us with a real problem in a variety of ways: first their need to, and even their desire to adapt to dominant cultures in terms of their technology. A variety of parameters confronts them with some difficult tasks. The first one of them being the question: 'Who is adaptable?' If you just take the manifest level of functioning of many of those great masses, you may question to what extent and at which age and at which stage of their development they can achieve the kinds of cognitive processes necessary in order to adapt. First of all, there is the problem of assesment. We know this problem exists in many of the countries of the Third World in which people are assessed in a static way by the present psychometric approaches. These approaches reflect a very low level of functioning as compared to what is required in order to achieve higher mental processes. As a result the danger exists that the outcome of the traditional psychometric approaches will obstruct their way to change and to develop. Therefore, when we approach the problem of the education of the Third World we first have to set the stage for the concept of modifiability.

Modifiability

This concept consists of three elements:
1. a goal: These people have to change. Irrespective of whether we consider it to be adequate for them to adapt to our technology - in terms of value judgements - it is an inevitable fact that

*) The original lecture by Reuven Feuerstein has been recorded on tape. This text has been prepared and put into written language by A.P.J. Goud and E.M.J. Goud.

these people have to change. Considering it to be self-evident that they have to adapt to the new technologies and to the new modalities of thinking and all it entails, we have to set goals: the goal of modifiability being - the first and foremost important goal for their educational proces.

2. A second element of modifiability is assessment. We have to use modifiability as a criterion for the assessment of the cognitive processes of these individuals and their capacities to adapt/learn/acquire and not to use the manifest level of functioning such as it is assessed by static measures which are being used by present day psychometrics. These measures actually tend to categorize or label an individual on the basis of what he has acquired up till now rather than on what he could become in the future, if and when he will have the proper intervention.
3. Thirdly, modifiability has to become the major feature of intervention. Any intervention has to stimulate those elements in the individual, which will make him modifiable.

Barriers for change

So, here is a goal, a view on assessment, and a kind of intervention all guided by the concept of modifiability.
What I will try to present to you today has been derived from the theory of 'Structural Cognitive Modifiability'. This theory postulates the capacities of human beings to become involved in processes of structural change, irrespective of three conditions considered to create barriers for change. The three elements we usually consider to be barriers are ones of an etiological nature. The Genetic Hereditary Conception of Intelligence does not leave room for change or for modifiability of the individual. Even other types of etiology such as genetic disorders, chromosomal conditions, constitutional elements are considered to be barriers for change, since they create fixed and immutable conditions of cognitive as well as motivational and emotional elements. Within the framework of the theory of 'Structural Cognitive Modifiability' we believe, a scientisfic belief if you want, that human beings are modifiable irrespective of the determinants of their conditions. Whether there is some genetic, hereditary element or not does not mean that the individual's condition will be immutable. It can be overcome or as a journalist, writing about my work with Down-syndrome children has put it: 'Les chromosomes n'ont pas le dernier mot'. The chromosomes do not have the last word, to say.
Irrespective of a second element, which is often considered as producing immutable conditions, the concept of 'Critical Periods' in development, we do not believe that Critical Periods present insurmountable barriers. We may speak about 'Optimal Periods', but optimal periods in development may present themselves throughout the life-span. Life-span psychology points that out very clearly. However, considering the severity of the condition, many people would still say: 'Yes, we agree with the concept of optimal periods, but

this child's level of functioning is too low. You won't be able to do something about this'. Well, we have empirical data and we have a theoretical stance, which points out that you can indeed change individuals, even if their level of functioning is extremely low. I would like to define my term of modifiability more precisely. What do I mean by modifiability? Well, the concept of modifiability has to be differentiated from change. Change is produced by development and development may be a very fixed set of stages, whose course is well set beforehand and therefore very predictable. I would refer to modifiability, however, as the departure at a given period in the course of development from the predicted one, and which may result in levels of functioning, which had not been predicted by the antecedent level of developmental conditions for the individual. It is in this sense that we refer to what has made this deviation appear in the life of the individual. There may be a number of elements, an intervention, some anecdotal evidence, well known to exist, but they eventually have to be made possible, even predictable by some kind of intervention, which will cause the individual to develop in a structural way, modified in a structural way, which will then guarantee not only that something has happened to him but that, what has happened to him will have a lasting effect. Remember that my definition of structural cognitive modifiability relates to three elements: the first one is that structure has always to do with a relationship between the part and the whole. This means that if development takes place in the part, it will affect the totality of the system. A second element of the structure, as I defined it in the constructivist way, is the fact that the structure is always transforming itself as well as staying constant at the same time.
Finally, a third characteristic of a structural change is that once initiated, it is self-perpetuating. Once started, it will continue to promote itself throughout the life of the individual and it is also self-regulating according to the need-systems, which are being produced in the individual. It is in this sense, that we speak about modifiability of the individual, irrespective of those conditions, which I previously described.

Cultural differences

Let us come to the concept of 'Cultural Differences' and examine, what are the necessary tools for their conditions. First, I like to define my term 'Cultural Difference'. I will define it by means of opposing it to the concept of 'Cultural Deprivation'. Cultural Difference is the distance between the culture of a group - culture in the broadest sense of the word - and the culture to which members of the previously mentioned group have to adapt. I use this term in a way, which will permit us to consider ourselves as culturally different, if for one reason or another we would be thrown into a culture, to which we would have to adapt. A cultural different individual is an individual, who has been affected by, who

has been exposed to a certain culture. It is my contention, that no matter how different this culture happens to be from the one the individual has to adapt to, due to the very fact that there has been exposure to, that a learning process has taken place in the individual in order to become 'cultured' by some group, he has established within himself those learning sets, those modalities of interacting with the environment, those modalities of becoming modified through his own culture, which will enable him to benefit from exposure to a new culture, and eventually will permit him to adapt himself with a more or less greater degree of easiness. There may be technical problems, there may be technology. There may be certain types of thinking, modalities of expressing. Certainly they exist, and they may somehow delay the adaptation of the individual, but it is more a matter of subject, of content learning, which the culturally different individual will have to undergo.
I can tell you now that I am dealing with a group of people, who came to Israel during the last three or four years. These people are literally backward by four or five hundred years. Backward, please forgive me using this term. I am referring to the Falasha-people from Ethiopia. People, whose living conditions are roughly similar to our living-conditions in the twelfth century with respect to certain modalities of interacting with the environment, the types of technology they are using as well as the level of literacy. They have been exposed to a culture, a very valuable one, but also one of a kind, that has been transmitted in an intimate way, preliterally, because these people do not have a high rate of literacy. However, I have never seen people to adapt so quickly, learn so quickly a new language, a new technology, modalities of orientation with respect to time and space as these people do. I have been following this group for the last three or four years. I have been working with groups of children from fourteen years onwards as well as with groups of adults. Their modifiability can be characterized as extremely efficient, rapid.
Despite the fact that they have problems - they stand out with their color, they look dark as compared to the Israeli group of occidental origin which poses a serious problem for them - they show a tremendous amount of modifiability. Earlier in history we had a similar problem with the Yemenite-people, who also came to Israel as a very different group as compared to our occidental people. That means that if you speak about a culturally different group, the very term 'different' means that such a group has been exposed to a culture, to learning processes of both formal and informal manner and that cultural institutions, agencies concerned with socializing, transmitting culture and so on, have been effective and have affected the learning capacities. The Yeminite-people were capable of this no matter what content it had been exposed to, and irrespective of the degree to which its culture differed from the one they had to adapt to in Israel.

Now, the 'culturally deprived group', and forgive me, this term was

not very well accepted the last thirty or fourty years, because it represented a kind of culture-centered approach. Usually a culturally deprived group was described as a group, whose culture deprives the group. We are using this term in a very different way. For us a culturally deprived group is a group, who became deprived of its own culture. A group, in which the cultural patrimonium has no longer been transmitted to the next generation due to processes as social disorganization, cultural disorganization, internal as well as external migration or other kinds of conditions, clashing with the dominant culture, which all together cause the cultural core to dissolve totally. On top of this these processes affect the social agencies within the group itself and what is even more important they affect the core-group, the first socializing cultural transmitters, i.e. the family, who stops mediating to the child.

Mediated Learning Experience

Here I have to introduce a very important element of the theory of structural cognitive modifiability: the concept of 'Mediated Learning Experience'. Many times you have been exposed to the term 'mediation' as referring to intrapsychic processes e.g. when language mediates to us certain modalities of operations.
When I refer to mediated learning experiences, I have in mind one of the two modalities of learning, of becoming modified. The first way of being modified is through direct exposure to stimuli: organisms are changed through direct exposure to stimuli; a fact which is reflected in the various learning models, either in the S-R approach or in the Piagetian S-O-R approach. Basically these approaches reflect types of learning, which have to do with direct exposure to stimuli. As the organism is exposed to the S, and reacts and so on, we agree with Vygotskij that this conceptualisation represents only one of the two modalities of interaction, which will affect and modify the cognitive processes of the individual. We certainly are affected by being exposed to stimuli, and by responding to them, but this is not really describing the whole story of human development. One needs an additional modality in order to understand more precisely the two following elements:

1. The development of higher mental processes, which can not be explained by sheer exposure to stimuli, or as a mere epiphenomenon of our exposure to stimuli.
2. The differences in the modifiability of individuals and their capacities to become affected, to enlarge their schemata by assimilating new stimuli.

These elements require a more adequate explanation than the one, which states that learning solely takes place as a result of direct exposure to stimuli.
Therefore, we have suggested a second modality of interaction, which adequately explains development: the 'H'. Note please that I am not speaking of a 'M', a mediator, but that I am referring to a 'H', a human being in order to avoid a possible transformation of

the 'M' into a 'C', a computer. I think that a mediator has to be human. It cannot be substituted by some other neutral type of thing. The 'H', which stands between the source of stimuli and the environment as well as between the organism and its response, mediates to the organism the world on a given level of the interaction with the reality. There are other levels of interaction with the reality, in which the stimuli and the responses flow directly to and from the organism. We consider this 'H', this mediational experience as crucial, and as creating in the organism those prerequisites of learning, which will make him able to benefit from, and make proper use of stimuli to which he will become exposed. Unless this 'H' is there, these direct stimuli may affect very little in the individual. This is true in the animal world. Mediational experience, which exists in this world too, occurs rarely, however, because it is limited to some biological needs. These needs have to vary little in order to adapt and therefore the variability and the modifiability of the animal world is very limited, whereas human beings have to modify themselves constantly. Otherwise they cannot survive...

The reason for this flexibility has to be related to the quality of interaction - as represented by the 'H' - since lack of mediated learning experience, which may be the case for the culturally deprived or what we refer to as the 'cultural deprivation-syndrome', will result in one very important characteristic: lack of modifiability or limited modifiability. This state of affairs is typical for many of the children, which we tend to label as retarded performers. It is also typical for many of the groups, which were referred to as culturally deprived. How does this lack of modifiability manifest itself? Well, there are many people, who continously observe, percieve and experience the same thing over and over, and each time they are confronted with this stimulus it looks new to them. The amount of efficiency of their interaction with stimuli is not enhanced by previous exposures. We refer to this phenomenon as the Episodic Grasp of Reality. These people are hardly affected by their experience. You can take this as a structural definition of certain conditions of inefficient, inadequate cognitive functioning, including incapacity to use abstract thinking, which is a mental process of a higher order, that uses experiences and activities to formulate new modalities in more adequate, more economic, more productive and more creative ways. This abstract thinking modality is not just a self-evident result of our direct interacting with stimuli. We can use these stimuli a hundred times without creating a concept, that will allow us to combine a number of phenomena into one thing, to which we can relate economically.

The cuturally deprived individual is a human being, whose capacity to benefit from direct exposure to stimuli is very limited. This is the result of not having had mediated learning experience. This occurs on a group level, which I will not describe in too much detail. At the present I am working with Indian groups. People in the United States have made extensive use of my theory in order to

help the Indian People, who have become alienated from their own culture. This has reflected itself very badly in their capacity to learn and to adapt themselves to the american culture. Their revival has been accomplished by going back to mediational processes within their own culture, in order to create learning sets, learning capacities in their children. I have had a very interesting interaction with a group of Navahos and other tribes two years ago and they still use our models and our programs as a way to revive the transmissional processes in their culture.

Cognitive map

So if you describe cultural difference as a phenomenon, in which culture makes the difference, then we have to refer to those people as people, who can become modified, as people who have a more or less greater distance from the culture to which they have to adapt. Using a 'cognitive map' I try to diagnose the needs of such a group. What do we have to provide them with?
Things we will immediately observe are differences in terms of content. They have learned to think during the process of making a canoo, during the process of making arrows, in short during the processes of making very simple technological things. Even though they had to produce great ingenuity in doing these things, perhaps even greater than ours equipped as we are with the best instruments, the content is certainly different in those culturally different groups and we will have to equip them with new content. The modalities or language in which the mental act is expressed, another dimension of the 'cognitive map', will have to be changed too. We will have to give them modalities to communicate with us, with the culture to which they have to adapt.
However, when I come to the third element - the phases of cognitive functions required by the mental act - I will have to worry much less about equipping them with proper elements (e.g.) in the area of input. They have beautiful ways of perceiving things, of distinguishing things. They have beautiful ways of comparing things. I do not have to teach them how to compare. Only the content will have to be different. If I am asking a Bedouin: 'Tell me, how long will it take me to get to the sea?', he will say: 'Two and a half cigarettes'. Two and a half cigarettes, he does not really consider how long the cigarettes are, how quick one smokes. That is not of great importance. Notice the great inprecision in the concept of time; he has time enough, it does not matter to him how long it will take. If it takes another three cigarettes, it is all the same. But if you ask him: 'What animal went through the dessert?', he will give you the most exact answer: 'How many tons of hasjiesj have been loaded on the camel?' He will answer in such a manner, because he will distinguish in the characteristics of the traces how heavyly loaded the camel must have been. So in this case one can observe discrimination, a capacity to perceive, a capacity to take into consideration the number of sources of information: how

deep, how wide was the trace, and it must be said that they are wonderful tracers. Indeed, when were in Sinaï within a few years they mastered all the technology, which we learn in technical school, with hardly any difficulties. I have a doctoral dissertation on the modifiability of these Bedouines in which was stated that these people were not capable of thinking in an abstract fashion. We have used the learning potential assessment device (the LPAD), our methods to train abstract thinking and within no time their learning has become wonderful. They have been able to master after six, seven or eight hours of LPAD-group testing syllogistic thinking and syllogistic formulating. So, we did not need to introduce to them the problems of input and output too heavily except for the language. We had to teach them some operations, which were absent in their repertoire. We accomplished this by means of our 'Instrumental Enrichment Program'.
Presently, we have groups of Bedouines, and groups of Falasha people as well as Indians, who are exposed to syllogistic thinking and to logical thinking and we can state that they learn very quickly. We do not need to elaborate more on the prerequisites of thinking, because these have been formed as a result of their exposure to their original culture. We will have to make sure that they will start performing on a more complex level. However, another element, which may be very different is the level of efficiency in terms of rapidity, precision, complexity.

Cultural deprivation

Now, consider the culturally deprived individual. Imagine, for instance those really self displaced people, who are coming to a country with another culture than their own one. A lot of parents wil tell their children: 'Do not become like me' and 'I am not going to mediate myself, to project my culture in you. You are going to be disadvantaged if I do so. So please be like the dominant culture to which you are exposed'. This creates a disruption. Imagine the case where lack of mediated learning experience is due to some internal barriers of the individual, which do not enable him to benefit from mediated learning experiences as is for instance the case with autistic children. These children are good observers. Motorically speaking they can be good manipulators, but they are unable to accept that a mediator interposes between them and reality, and that a mediator tries to develop or substitute certain needs by others. These children do not accept that. Irrespective of what has made an individual culturally deprived by lack of mediated learning experiences - whether the external conditions did not offer mediation, or whether there were internal barriers, which did not allow for mediation - we are dealing here with an individual who need a substitute form of mediated learning experience. This kind of intervention will have to take into consideration the age, at which the intervention takes place, the condition of the individual - a mother, who has to mediate to a child, who is hyperactive, with a

high threshold of stimulation, will have to substitute normal modalities of mediation in order to make the child penetrable to her attempts at mediation.

Conclusions

So here you have a variety of conditions under which mediated learning experiences will have to become a substitute and then modifiability is something which can be produced in the individual. The substitute form of mediated learning experience is geared towards creating in the individual a higher level of modifiability. The concept of modifiability can be considered as the most relevant concept of the theory of structural cognitive modifiability. In today's world we regard human flexibility - the capacity to find within oneself the resources to change and the capacity to do without all preformed modalities of activity as well as preformed ways of thinking - as a necessary tool to cope with new realities. We do not accept them anymore and because of this we have to construct with our cognitive processes things, which previously were ready made for us. So, today we are in a condition in which we have to foster the modifiability of an individual as a way to preserve its homeostasis. A capacity to modify ourselves and respond to the dangers incurred to us by the enormous, rapid and disruptive changes, which occur in the world. Therefore, modifiability should be the slogan of education in general. This certainly illustrates itself forcefully in the need of culturally different individuals to adapt as well as in the need of culturally deprived individuals to adapt whether they are deprived, because the culture has not been transmitted to them, or whether they are deprived, because they are not able to accept mediation in the forms in which it was offered to them.
The second thing is assessment. No longer can we afford to assess people with static measures. Especially with respect to this issue, I was happy to find in the work of Vygotskij, a precursor of this approach, the idea that you do not have to use statistical artefacts in order to evaluate a concept of intelligence. In Vygotskij's lifetime defending this idea could cause one to become an outcast in the civilized psychometric world. You will probably remember that it was said that if intelligence where to exist, it should be amenable to measurement. Others stated that if intelligence could not be measured, the concept would be worthless. I permit myself to parafrase it by saying: 'Measuring the inexistent does not necessarily prove its existence'. When I started in 1950 to examine children from all parts of the world, I put aside not only statistical and psychometric measures, but also those tasks, which I measured in accordance with the Piagetian approaches, which I could not make of any use, because they were applied in a static way. 'Static' meaning: I observe, I elicit from you responses and on the basis of these responses I predict what you are going to be able to do within the next life or eventually even after-life. There is

some way to measure statistically and to predict how you will behave in the other world...
Well, I had to do away with the static measures, trading them for a more dynamic approach, in which I offered the individual the prerequisites he is missing after which I would assess what he is capable of doing with the things I provided him with. The mediational intervention, the mediational experience - I will not go into further detail - will be geared to structural change of the functioning of the individual. By means of this approach I will find out how modifiable he is and under what conditions he can become modified. I will also determine the meaning of the changes I produced in him, another very important element.
A third element is the creation of procedures and methods, which will allow modifiability to take place. The Instrumental Enrichment Program is a first attempt to capitalize on mediated learning experiences in order to produce in the individual a higher level of modifiability. But since my time is over now, I will suggest that we discuss this program during our discussion.
Thank you...

EDUCATION AND THE THIRD WORLD: A CRITICAL DISCUSSION AND SOME EXPERIMENTAL DATA*)

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Before I start my lecture I would like to state that it is going to deviate somewhat from the one I had in mind. In view of Professor Feuerstein's speech, as well as the lectures that were given earlier I thought it would be a good idea to change my speech a little and to draw up a list with general points that deserve some more attention. To me these points serve the purpose of making a comparison between the ideas of Professor Feuerstein and my own thoughts concerning various concepts. Having read the excellent work of Professor Feuerstein I have often wondered whether my own ideas differ from his thoughts in a substantial manner or whether the observed differences merely reflect different terminologies. By contrasting approaches explicitly I hope that the following points will contribute to a fruitful discussion.

Mediation

First of all, there is the term 'mediated'. I believe that I think about 'mediation' somewhat differently than Professor Feuerstein does. In English, there is the notion of a 'direct' effect. I know that because of my direct experience. The opposite of 'direct' in English is the word 'indirect'. In English it is also quite common to use the word 'immediate' as a synonym for 'direct' and so you can speak about 'an immediate effect' of some cause. The opposite of 'immediate', of course, is 'mediated'. Somehow when we use the term 'mediated' the notion that the term 'mediated' is a synonym for 'indirect' is slow to come.
The conclusion that I draw from this word game is that Dr. Feuerstein and I have somewhat different notions of mediation. When he uses the term, he accompanies it with a diagram such as the following:

Environment---human beings---child

The diagram I use is taken from the formulation of Lev.Vygotskij, which has a great deal in common with the ideas of Engeström et al.

*) The original lecture by Michael Cole has been recorded on tape. This text has been prepared and put into written language by A.P.J. Goud, and edited by Michael Cole.

be a long way off!). There are always certain drawbacks of technology because all tools have only context-specific applicability. This principle applies particularly to the technology to which the population of the Third World has to adapt.
I worry greatly that too much 'progress' along our current path will have the long term consequence that those creatures who inherit the earth will be cockroaches, creatures immune to radiation. So, dominant notions with respect to economic development and with respect to technological adaptation make me extremely nervous. And I would like to try to find some way out of the bind that we find ourselves in, such that our Soviet colleagues could not join us here today.

Representing education as a mediating process

With those provisional definitions in mind let us try to think some more about education, cognitive development, and the Third World. In figure 3 we have created a Vygotkian-type diagram of mediation in which I have put the individual, what the other day was called the problematic domain of social reality (or what Friere (1970) would call 'the environment turned back on men'), and the system of signs or the system of shared understandings and the tools with which those understandings are regulated, or culture.

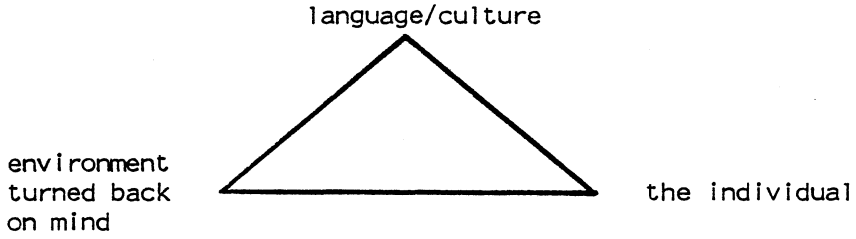

Figure 3

In the next diagram (Figure 4), education represent the transmission of that whole system over time. The intended goal of the system of education, broadly considered, is that individuals in a later generation will be able to face the environment that they encounter in a way which will allow them to continue living at least as well as their parents.

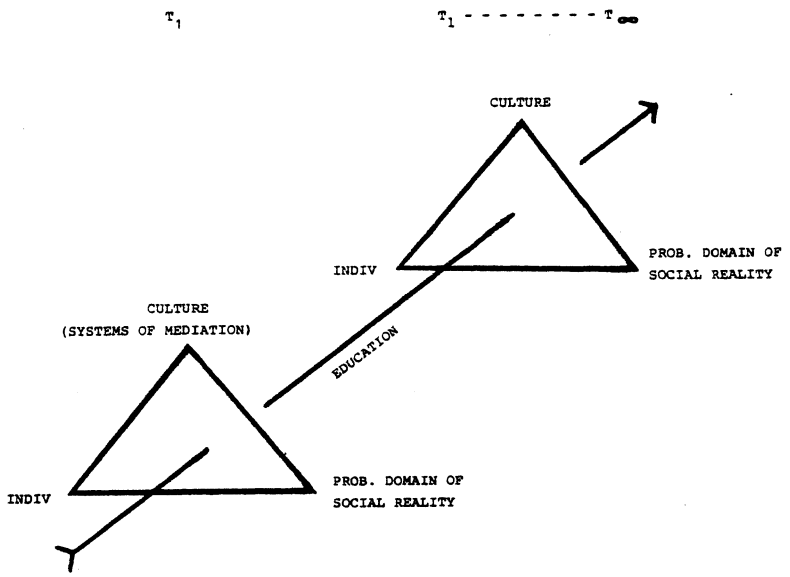

Figure 4

As Professor Feuerstein stated we currently have to deal with a more frequent situation which can be characterized by the fact that the form of mediation of parents to children is such that these parents do not want their children to continue on their path. The reason for this situation is that many parents view their way of life as a dead end. Therefore, they want to help their children to a world which is different, and one that they do not understand very much. People use the term 'adaptation' with respect to this problem. They will say, 'My kids have to learn how to set along, to adapt themselves to the future'. Although I understand what they mean by this idea of education-as-adaptation, but I also think that this 'adaptation' poses some problems for us.

Two broad systems of education compared

What I would like to do now is to contrast two systems of education. One is the system of education that I learned about when I visited Liberia. It is a system of education which has been traditional for many generations in the south western part of Africa. The second is a system of education which I will call European of European-American, the kind of education that Bernd Fichtner (in this volume) refers to as typical of the modern era.

Bush School

First of all, the form of education that one encounters with the Kpelle, the group I worked with in Liberia, is interesting, because unlike a number of other non-technological groups but (like us) they actually have an institutionalized period of time in which

children are removed from the village, go to separate place for a number of years, and then return to their village. During these years the children are said to have been in 'Bush School'. They learn to master and take responsibility for a wide range of cultural activities during those years. These practices provide an interesting parallel in one way between the educational system of this tribal group and the forms of education that one would encounter in Holland today. In both educational 'systems' there is an early period of time - six to seven years - during which the children are raised within the family unit. Then, there is a period of time starting at seven or eight years of age, in which children are removed from home for long periods of time. During this time there are relatively few adults socializing or as we say 'educating', children. And then the children come back to the community and they enter a sort of third phase of what I would call education 'on the job'. This aspect of education has not been mentioned here at all. I find this interesting, because everybody knows that our college students, as well as high school students, come out of school unable to do adult work. Therefore, our businesses, our armed forces, and our adult institutions complain about the work of the school and say that they have to give more education to the children coming out of school. In fact, there is good evidence that this form of schooling will gain power in coming years so there is a homology between the two educational systems, Kpelle and Euro-American, consisting of the three phases of education. One of these phases is separated from the community, while the other two are embedded in the community, but at two different levels. At the highest level one can observe specialization of a variety of kinds. Among the Kpelle that specialization is bone setting, weaving, in short, special activities which are not common to all members of the group. While they are being educated in the separated institution among Kpelle, as among European children, are being taught basic skills.

In both cultural groups one can distinquish some activities set aside from everyday life (what I would like to talk about as a theoretical context of dialogue between teacher an learner). In this respect they are alike. But if you look at both content and structure - the 'morphology' of activity of the children when they are in Bush School - you notice that it is virtually indistinguishable from the morphology of activity in their everyday lives. What do they do in Bush School? They go off and create a small village. They grow rice, they build houses, they have discussions. Now the major difference between activity when a child is in school and activity when a child is at home for a Kpelle child is the answer to the question 'who has responsibility for conducting the activity'?
At home when Kpelle people build a house the kids are carry mud, they help their dads strip the sticks, they do a variety of things as <u>apprentices to adults</u>, but do not have much responsibility for

the outcome. When they go to Bush School, there are very few adults there. The adults are present to help the children to master those activities so they can take responsibility for doing them, and to teach them the lore of the tribe (or that set of common ideological signs which they have to produce when they go back home). This knowledge will become their mark as Kpelle adults. That is, special knowledge, which makes 'us' us, and 'them' them. It has to be taught, in Liberia it is taught orally in the form of stories, in the form of incantations and songs, which the children need to learn.
What you learn in Bush School is a lot like what you learn at home. There is a very striking feature about these sorts of skills. That is that everybody learns them. It is out of the question that somebody fails to learn what it takes to make a rice farm or how to make a house. There is division of labor: women know a lot more about the various seeds in planting than men do, men know more about hunting than women do. So it is not the case that there is no division of labor, but rather that there is no failure in Bush School. Nor is selection a prominent feature of Bush School. The selection takes place either through hereditary positions within the villages, differences in power, political power from other sources, or through special skills learning that children do after they come home.

European education

Now, that is really different from what happens when my children go to school! First of all, when my children go to school, literacy is the crucial medium of interaction. It dominates the structure of discourse. At home and in the community, reading leads to actions on other objects and people. In school, literacy activities are put at the service of other literacy activities. At home (most of the time) or at work you read in order to do. (I will put entertainment aside, because I am not quite sure what entertainment does.) So, the 'morphology' of schooling is different than the morphology of action in most everyday (non-school) activities.
Secondly, the acquisition of literacy in America means the acquisition of an abstraction that can not be explicitly communicated. I think that is extremely important, i.e., the alphabet is a representation of language that cannot be communicated explicitly between children, nor between a teacher and an adult. Nor can we explicitly communicate what it means to comprehend the main idea of a paragraph. There is no declarative theory of comprehension, nor is there a declarative theory of the relationship between a phoneme and the alphabet itself.
That claim may sound strange, but let me give you an example: Take the word 'caterpillar'. What is the smallest unit of language that can, so to speak, be directly communicated between people? It is syllable. And the way you can demonstrate for yourself it is a syllable is to try to pronounce something less than a syllable. It

could go something like this:
caterpillar.....ca-ter-pil-lar.....ca--ter--pil--lar.....ca---ter---pil---lar and I could go on slower and slower until you are all asleep. But I can not say the following and have you know what I mean: It is impossible to 'say a phoneme'. People can pronounce something like a consonant-vowel pair, but the letters of the alphabet that we talk about with children cannot be pronounced in isolation. They are the names of the letters of the alphabet. They are not the things themselves. The alphabet is the medium for the children to discover how to use it, to make meaning with. There are some children who climb way up and master that abstraction. But for a lot of kids that discovery process fails or is difficult and that failure has a lot of difficult downstream consequences. They are so locked into rendering the text orally that they do not comprehend what it is that they are reading.*

A third special feature of modern Euro-American education is that the content of instruction introduces children to a vast array of valuable information not easily referable to the content of activity anywhere else in their lives. If you do not believe me, just try to explain to children why it is functional to learn algebra. In fact I can ask most of you what you have used algebra for recently, and if it has not been for teaching a kind of algebra, I will bet that you have not used it. Most of what algebra is for in the lives of children and adults is to help you to the next part of the curriculum and so on.
Fourth, the goal structure of school interaction requires people to carry out operations, whose organizing motives are obscure.
Fifth, the focus of instruction is on basic skills understood as a set of operartions that will be components of many life contexts outside of school, i.e., those wherever print, and numeracy skills might be useful.
Finally, explicit evaluation and comparison of performance are prominent features organizing the discourse of modern schools. Children fail there.

*) This point can be connected back to something that I think is important in the triangular diagram of Figure 1-2 and the approach to understanding education that I am advocating. I am referring to the idea of Luria (and Van Parreren) which is not so much that human beings always think about the world indirectly, but that the world is given to us twice. The basic cognitive process consists of resolving the information that is directly given with what it is that is given a mediated way. The basic intellectual operation is that of alienation and recombination. We triangulate on the world. We do not know it just directly (Griffin, Cole, Diaz & King, 1985).

With these abstractions, and with these forms of institutionalizations, modern education produces a separation between the activities of education and the activities of everyday life which creates the well known problem of 'transfer'. Having very nicely separated things out and having created very specialized discourse for conveying how it is that certain operations and actions are carried out (but in activity settings that do not adequately relate to everyday life settings) we create the problem of transfer. Even when we are very successful in school we can create problems. When students come out of school, a great deal of what they have learned remains in the classroom and is not connected with the context of everyday life.

Age or schooling?

What are the consequences of the two different educational systems? I will show you some data which will produce a couple of paradoxes. Before I do so, however, let me first inform you that these data were not taken from Liberia, but from the people of the Yucatan in Mexico where I did some work on consequences of education (Sharp, Cole & Lave, 1979). In the Yucatan one encounters a lot of different levels of education in a relatively homogeneous population due to both the location where government built roads and the policy of the Mexican government of making education possible for as many people as they could over a number of years. These conditions were not present in Liberia. Therefore, we performed some of our research on the cognitive consequences of formal education in Mexico. One set of studies focused on memory. We used photographs as stimuli, because people had been exposed to photographs and had no difficulty finding out these pictures were about. These pictures were of things like a pot, a tortilla, a bull, a coconut, a dog and so on. We would show these pictures to people and afterwards we would give a recall test.
If I did this kind of free recall experiment with you, you would probably remember 10 to 15 words out of 20 after having gone through the first trial. As a psychologist or someone familiar with psychology, however, you would soon draw the conclusion that you would not be able to remember all the items on the list and you would begin to notice that all the items could be categorized into a few categories. You would recluster all the items according to these categories and you would be able to recall all of the 20 items.
If you compare children who have been to the seventh grade with uneducated adults over five trials during which they were given the opportunity to learn these pictures, you can observe that the seventh graders in these Mexican villages not only mastered the list quickly, but also come to use the categories as a mediating device for memory rapidly. Furthermore, it can be observed that the adults do not make use of these categories. This is not an untypical finding; many times we have done repeated free recall experiments with non literate people and they do not show any improvement

over trials.

A second kind of comparison involved a syllogistic reasoning task, the kind Professor Feuerstein was referring to previously. My own exposure to this kind of thing came from Alexander Luria. The experimenter says: 'Women from Mexico City are pretty. My girl friend is from Mexico City. Is she pretty?'
The answer to this question may seem obvious to us, but not to other people. Two response patterns stand out in the data. Some people solve such problems as if they were empirical problems about the real world. Others assume that they are hypothetical questions to be reasoned about on their own terms. Following Scribner (1977) I will call the first pattern 'empirical' and the second 'theoretical'. Consider the following data: first graders respond theoretically in 50 percent of all the cases. Basically, if they respond theoretically, they respond correctly. If they respond empirically, there is 50/50 chance that they will respond correctly depending upon the empirical truth or falsity of the question. With respect to grade levels you can draw a nice function. High school educated students do not make a single mistake with respect to the syllogistic reasoning task. Adults who have only been to the fourth grade respond just like kids who have been to the fourth grade. Adults who have not been to school at all respond basically like little children. Empirically speaking these data represent clear evidence that 'primitives think like children' or maybe this should be stated as that 'uneducated people think like little children'.

You might object that this experiment is somewhat artificial. Well, my third set of data are taken from an experiment in which both artificial and real materials were used. As artificial materials we used triangles, squares and so on, on a card that was either blue or white. Furthermore, the materials could be described as either small or large. The experimental task consisted of a division of the materials into two categories such that the figures in each category are alike in some way and different from the ones in the other category. So, a subject might take the triangles and put them into one category and put the squares into another category. The experimenter would say: 'Okay, that is one way to do it; do it another way'. Educated people do this task as fast as their fingers can move. No problem at all. There are three ways to do it and you might even subdivide the categories into subcategories.
As real material for the Yucatan people we used corn. We asked the people what sort of corn they grew and they came up with three categories. Corn is either red or yellow. Some of the kernels are big, others are small. Some kernels are twins, whereas others are singles. We asked them to perform the same categorization task as the one mentioned earlier for geometric figures. The observed pattern is similar to the pattern for the syllogisms. Thus, as the number of years in school increase, the likelihood of correct performance increases too. Furthermore, it can be observed that this

relationship is independent of age. This seems to be clear evidence that certain skills - intellectual development - are promoted by schooling.
However, there is still the problem of separation in other words, the question of transfer: to what extent do these kinds of psychological tasks measure something about increased thinking ability in general and to what extent do they simply index activities that somehow map on to the structure of school?

The following set of data presents an interesting contrast case to think about because schooling exerts no effect, but age does. Take an item like a tortilla. Take as possible contrasting elements a candle, an orange and a match. In this case it is obvious that the orange and the tortilla go together. Both objects are round and both can be categorized as food. Now we ask that a tortilla be classified with a yellow button, an orange and a coffee cup. A tortilla generally has a yellowish color. So the yellow button matches the tortilla with respect to its shape as well as its color. The orange and the tortilla are both food. And there is the coffee cup which has a round shape. You might even say that you could drink coffee when you are having tortillas. So there are a lot of possible conflicts in there. The experimenter says: 'I want you to take the tortilla and I want you to state which of three other things it goes together with'.
In this experiment correct responses seem to be related to age and not to years in education. In all cases, the subject could obtain the correct answers by multiple routes, related to everyday knowledge, and they did so. Conflicting bases for a response cause confusion regardless of age or education.

Considering these data as well as other sets of data, which I will not mention here, you can derive following generalization: If the structure of the task and the correct answer roughly match the morphology of what it is that people do in everyday life, then you will find various task performances increasing as a function of age. However, if the logic underlying the experiment has to do with the kind of abstraction underlying the technology of schooling, then performance increases as a function of schooling.
What could this possible mean with respect to cognitive development in general?

The morphology of activity and the structure of the lexicon

The institution of formal schooling, the abstraction that is called 'writing', and the scientific which it supports, all coincide with a special morphology of action that has its reflection in the structure of the lexicon. Concerning the development of word meaning, the following can be said on the bias of Luria's book, Language and consciousness.
Take the word 'dog'. For a small child a dog maybe something terri-

ble, if he has been bitten by one for instance. A dog may be something quite pleasant, if the child has grown up with a dog or is accustomed to play with it. Thus, the word 'dog' has an affective sense, and for a small child the affective sense is the essence of word meaning. During the next stage the word 'dog' evokes the memory of a concrete experience: a dog being fed; a dog guarding the home; a dog keeping thieves away; a dog carrying things; a dog fighting with cats, etc. In other words 'dog' begins to give rise to a whole of concrete images and situations. For a child who is studying science, and even more so for a college student a dog is an animal that is included in an entire hierarchy of mutually subordinate concepts (Luria, 1981, p. xx).

The structure of word meaning takes on an entirely different character between these stages. At the third stage the word enters into a system of hierarchically connected and mutually subordinated categories. It acquires, as linguists say, a paradigmatic character. So, here you have as your criterion of development something that sounds very much like what Van Parreren was talking about: development as differentiation and the creation of hierarchies of structure. Notice that each of these so called 'stages' must be present all of the time in language-mediated interaction. You can not have 'dog' without dogs doing something. You can not have cats without cats doing something.

The underside of education

If you look at the structure of discourse that is organized around writing and around the scientific enterprise in the United States, one can observe that it has a kind of vertical (paradigmatic) structure. This sort of paradigmatic structure is highly emphasized and is underlying many curricula. It is the dimension of language suited to the abstractions of physical science. However, if you look at the Kpelle education one can observe that the morphology of action that has to do with schooling is very much like the morphology of everyday life. It is organized around the 'syntagmatic' or horizontal pole of meaning ('stage 2' in the diagram).

Now let's address the great problem of the Third World with respect to education. When you go into a Kpelle village, you are asking people to master a set of abstractions around a set of practices having to do with science that are systematically unrelated to what they are doing in the village. When you introduce Euro-American education, you introduce a system in which education creates alienation from the real culture. In Kpelleland, if you have a sixth grade education and you have learned to read and write, you no longer have to work in your village and you no longer have to go out and work on the farm.
What are you going to do? Well you can go to the capital city. And what can you do there? You can be unemployed there. Why can you be

unemployed there? There are two reasons for this. First of all, there is little work that involves either reading or writing in most Third World countries. Secondly, if there is work for you, the education you received is likely to be inadequate for the demands of the job.
So, if you now look at the larger context, you find the following sorts of sad things happening. Around the towns where the Kpelle children go to school the infant mortality rate is higher than it is in remote villages where there are no schools. Why would it be that an education that makes you cognitively more developed would increase the infant mortality rate? Isn't it supposed to go the other way around? But wait a second. When you were in the theoretical context school it was not just theoretical. It transmitted a set of values about what it means to be modern and among the things it means to be modern it that you really do not breast-feed your children. So you will probably give your children a bottle of milk, if you are modern. The water is very dangerous, it is full of parasites. So, using bottled milk is a very dangerous thing to do. But what if you run out of bottled milk? You would not want people to know that you are too poor to have bottled milk so you would probably feed you child out of a bottle anyway. If you take the rice and the water from rice when you have washed it and put it in the milk bottle it looks just like milk. And you kill babies, because that water is impure. A whole set of contradictions arises, because we have a set of abstractions which are characteristic of our glorious technology. They are alien to much of humanity. How are those people supposed to adapt/survive, let alone 'make progress'?

Summary remarks

There is a sense in which education produces cognitive development. You can prepare children for a future, but you have to worry a lot about the larger socio-economic context and I think we all have to worry a lot about the future. Because of the country in which he lives, Professor Feuerstein is able to work with people for whom cognitive development is an important and generally accepted idea. He can count on full participation of all people, regardless of the area of the world they come from they are all Jews. In my country, it is the case that we destroyed the Native Americans who were alienated from their culture. After we had conquered them, we told them to master our set of abstractions in order to adapt to us. That sequence produces an extremely difficult intrapersonal bind for a Native American.
For a person living in Liberia what are we promising, when we promise modern education? I do not believe that we will make them generally smarter. I believe we are teaching them a set of abstractions of limited, though often great, utility in human life. But for them, what education mostly menas is that one person from their village can get into the government to protect them. In the mean—

time everybody knows that modern education comes at the cost of a very high level of social disintegration and an actual increase of what is already a high infant mortality rate.
This is the underside of education for cognitive development and although I admire the work of Professor Feuerstein, I think there are a set of dillemas having to do with human development that his work does not fully address (my own work fails to address others). The first task is to avoid confusing mastery of advanced technology with virtue, or with a secure human future. It may well be that our glory, our ability to alienate ourselves in order to analyze the world, will simply destroy us. Secondly, what we have to try to figure out is a way to balance the activity of everyday life and the activity that we call 'schooling'. And remember that we do not know the future. Remember too that human as well as other biological evolution does not occur simply by adaptation. There is an emergent process in evolution that is a part of human activity which we better keep in mind. Otherwise, we will simply create a system for subordinating other people 'for their own good' which I do not think will be doing any of us much good in the long run.

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BILINGUALISM AND EDUCATION FOR COGNITIVE DEVELOPMENT: THE CASE OF MOZAMBIQUE.

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This paper consists of two parts. In the first part I will briefly shetch the recent development and actual situation of education in Mozambique, with special reference to the linguistic aspects. In the second part I will summarize the outlines and main assumptions of a research project concerning the language problems faced by Mozambican schoolchildren, in which I have been involved for the last few years and which is still in progress.(1)

I. LANGUAGE AND EDUCATIONAL POLICY

Historical background

When in 1962 Eduardo Mondlane succeeded in bringing together three nationalist movements of Mozambican refugees that operated in the neighbouring countries of the then Portuguese colony of Mozambique and the Front for the Liberation of Mozambique (Frelimo) was founded, English was during some time used alongside Portuguese as the new movement's vehicle of communication. Terms like 'chairman' and 'branch', for instance, were automatically adopted from Tanzanian and other sister organizations.

At Frelimo's First Congress, however, held in Tanzania in September 1962, the language question was resolved in favor of Portuguese. The language of the colonizers became not only the official language of the liberation movement, used in all its meetings and documents, but also, later on, the language taught in Frelimo's schools and literacy courses throughout the so-called Liberated Areas ('Zonas Libertadas').
National unity and anti-tribalism have always ranked high on Frelimo's program and the Front's members came from all parts of the country, representing all major Mozambican languages. In these circumstances only the language of the colonial power could guarantee the efficient and non-conflictuous communication between Mozambicans from all regions, tribes and races, as well as with the outside world.
In fact, little has been changed in this respect since the early

years of the armed struggle, also not after 1975 when Mozambique became politically independent and Frelimo the leading force of the new Peoples' Republic. The basic option in favor of Portuguese has been re-affirmed at several occasions, although one is always careful to stress the importance of the national languages (2).
In the educational field the most recent major event has been the approval of the outlines of the National System of Education (SNE) in December 1981 and the beginning of its implementation in 1983. Linguistically the SNE is fully Portuguese-based, both in regular schooling as in adult education, without any place or function whatsoever for the Mozambican languages. The most one can say is that the situation of bilingualism in education is recognized as such and that an attempt is being made to introduce teaching methods that take into account the fact that Portuguese is a second language for the large majority of Mozambicans, children and adults alike.

Language situation

The language situation of Mozambique is, in itself, not very particular nor complex in relation to many other African countries. Depending on how language and dialect boundaries are defined, one comes to some 20 to 25 different languages, all belonging to the group of Bantu languages, so genetically related (which, by the way does not mean they are mutually comprehensible). A few languages function to some extent as a lingua franca, such as, for instance, Tsonga in the South and Nyanja in some parts of the North. According to the Study Group of Mozambican Languages of the Eduardo Mondlane University it would be possible, with some effort towards unification and standardization, to reduce the number of languages that are necessary to cover the whole country to 7 or 8: Tsonga, Shona, Sena, Nyanja, Yao, Makua, Makonde and eventually Swahili (which is hardly spoken as a first language). Of these, only Makua, a rather 'big' language spoken by some 4 to 5 million people, is exclusively Mozambican; all the other are used as well in neighbouring countries, in some cases even with official status (like Shona in Zimbabwe and Nyanja in Malawi, there called Chisewa).
In Mozambique, none of the national languages have any official status, neither at a national nor at a regional level, but Radio Mozambique does use a dozen of them in its regional broadcasts. At a local and very restricted level, some languages are used in experimental projects, all in the field of information, like local radio production in Communal Villages ('Aldeias Comunais') and bilingual Peoples' Journals ('Jornais do Povo').
The knowledge of Portuguese is rather limited and, naturally, mainly confined to the cities; according to a rough estimate, some 10% to 20% of the population has mastered it to a varying degree, which goes from understanding a few words to full-fledged native competence.

Literacy

As far as education is concerned, there is a growing awareness that the exclusive use of Portuguese as medium of instruction has its drawbacks, but as far as I can see no fundamental policy changes may be expected in the near future. Portuguese, eventually with some Mozambican pecularities (taken over from African languages or caused by the fact that it is mainly spoken as a second language) will remain the official language and the language of national unity and the SNE is seen as one of the major agents of its dissemination.
The only field where some new orientation might be expected is literacy and adult education, where the situation is in fact rather embarrassing. Mozambique is one of the very few countries that carry out literacy campaigns in a second language not even spoken by the target population. Consequently, 'literacy' has become practically to mean 'learning Portuguese', and neither political goals nor the more strictly technical ones (reading, writing and arithmetics) can play the role they deserve in the process.
More than with respect to regular schooling, one is starting to question the feasibility of this all-Portuguese approach, especially for the rural areas, in spite of its clear political justification in terms of the fostering of national unity. What is, after all, for the average farmer, the sense of struggling to learn a new language which hardly has any use in his or her daily life?
The meager results of the campaigns and the serious problems to motivate people to take part in literacy courses at all, after the dying away of the initial enthusiasm of the post-independence years, have certainly contributed to this critical re-appraisal of the whole process. No substantial changes have taken place yet, however, apart from some very small-scale initiatives, such as an experimental 2-month pre-literacy course in Tsonga and a tentative proposal for bilingual/transitional literacy courses. In the meantime, literacy work and adult education continue as a rather schoolish and very centralized process, completely oriented towards Portuguese and to the norms and values that go with it.

Primary School

Back to regular schooling. Before entering into some aspects of my own research on the bilingualism of Mozambican schoolchildren, I will make a few general comments on the educational situation in Mozambique since Independence and on the National System of Education (SNE). When in 1974 the coup d'état of the military made an end to half a century of fascism in Portugal and new perspectives were opened up for the independence of its colonies, education became one of the new popular demands and a real run towards the school started. In Mozambique, for instance, in a few years time, the number of children registered in primary school increased more

than three times, from less than ½ million to more than 1½ million, while the number of qualified teachers only diminished and hardly any possibilities existed to aument or improve existing infrastructures. This massive quest for education had a series of consequences which are felt up to the present day: of the more than 20.000 primary school teachers more than half does not have more than 4 years of schooling itself, without any didactical or pedagogical preparation whatsoever, and classes of 70 pupils or over are still rather common, especially in the lower grades, despite efforts to control entrance figures.

I believe most people working in the planning and development of education in Mozambique will share the conviction that curriculum modifications (goals, contents, methods, maybe even language of instruction) are not, in the present circumstances, the deciding factor in improving educational output. Its eventual positive influence will crucially depend on the gradual elimination of the kind of material limitations metioned above, which are of course nothing else than aspects of the country's colonial past and actual state of extreme economic underdevelopment.

In its essentials, the actual primary school curriculum is the same as the old colonial one, stripped of its most extreme characteristics. But in 1983 the implementation of the SNE has started with the introduction of the new first grade. The SNE contains a 7-year basic school - meant to become the period of compulsary education in the future -, followed by 5 years of secondary and pre-university education or by technical or commercial courses.

One aspect of the SNE that I will note only in passing is the apparently non-terminal nature of its primary school curriculum; in its goals and contents it seems rather a preparation for further schooling than for any kind of activity, professional or otherwise, outside school. Even official statistics, however, show that the majority of primary school leavers will not be able to continue its studies, for a long time to come. The problem is of course, like many other evils of education in Mozambique, rather well-known from other African countries. In Mozambique, the principles of polytechnical education and of the link between education and production and of the self-relience of the schools are theoretically advocated but their full practical realization is still far away. I will not pursue this point here any further, however.

In Mozambique various forms of pre-school education do exist (creches, Kindergarten and pre-primary grade) and the pre-primary grade is even surprisingly widespread, for instance in Communal Villages.

The SNE does not have any place for this stage, however, reportedly for purely economic reasons (it is too expensive), since policy-makers are well aware of its importance and of the growing interest that other countries put in it. The recently introduced new first grade integrates in part the existing pre-primary program, for instance with respect to oral learning of Portuguese before starting

to read and write, but the entrance age has been set at 7 years, while the pre-primary now begins at 5 years.

As has been said above, there is no doubt that the low level of school achievement in Mozambique can be drawn back to a number of causal factors, the most important of which are of material nature and can only be superceded gradually in accordance with the socio-economic development of the country. But apart from these material factors, another type of school barrier might very well exist, one that is more closely linked to the situation of bilingualism created by the educational language policy and that has to do with the clash between, on the one hand, the daily communicative and cognitive experiences and the norms, values and expectations that the children bring to school from their home environment and, on the other hand, the demands that the school has to make in order to promote the child's development and to guarantee success in the educational system.

II. RESEARCH IN PROGRESS

Backgrounds

For the last two years I have been involved in the preparation and realization of a research project at the National Institute for the Development of Education (INDE) in Maputo, which was set up as a first attempt to tackle the above mentioned issues in a systematic and objective way. The rest of this paper will be devoted to the presentation of the main aspects of this work, which is still in progress.

At the outset I must say that our project does not question the political decision to continue with Portuguese as the only medium of instruction in the schools. Rather it took up the challenge to analyse its pedagogical implications and to develop strategies of educational intervention that would maximally exploit its potentialities and diminish its negative effects on school achievement. The question then is how to reconcile in one curriculum two equally important, but potentially conflicting objectives of the first years of schooling (without mentioning other ones that certainly do exist), viz. teaching the new language and stimulate cognitive growth.

One of the starting points of the project, which carries the title 'Bilingualism, Cognitive Development and Pre-School Experience of Mozambican Children', was, somewhat paradoxically, that the main problem of education in Mozambique, as far as language is concerned does not lie in the fact of bilingualism itself (although admittedly the task of learning a completely new and different language on entering school is not an easy one, given the poor conditions pre-

vailing in Mozambican schools). Rather the assumption was that the main barrier has to be sought in the transition from a certain use of language that is typical of daily life outside school to a cognitively different and more demanding use that is typical of Western type formal education with its emphasis on literacy and objective analysis.
If this would be true, it becomes relevant to get to know as much as possible about the nature of the child's cognitive-linguistic experience and to compare it with scholastic demands. And that is precisely what our project set out to achieve.

Our interpretation of the relationship between language, bilingualism and scholastic achievement leans heavily on several research traditions in the fields of sociolinguistics, bilingual studies and educational psychology and which might be of interest to the main theme of this Symposium. To the work of James Cummins and Tove Skutnabb-Kangas (3) we owe the insight that an adequate development of second-language skills, especially in the cognitive domain, crucially depends on the level and kind of proficiency already attained by the child in her mother-tongue. To obtain positive educational results, the bilingual child has to reach certain minimum or 'threshold' levels of language competence; if she fails to do so in her mother-tongue, she runs the risk of becoming 'semilingual', i.e. apparently fluent in two languages, but cognitively deficient in both.
Other authors, e.g. Wallace Lambert (4), already made a distinction between so-called 'additive' forms of bilingualism, in which the learning of a second language represents a useful contribution to the child's linguistic and cognitive repertoire, and forms of 'subtractive' bilingualism, in which the learning of a second language practically implies 'saying goodbye' to the mother-tongue, in many cases with rather disastrous outcomes for cognitive development.
But what do we have to look for in the child's pre-school linguistic experience that could be of relevance to school achievement and so to curriculum development? In other words: what kind of cognitive linguistic skills are necessary to succeed in formal education and how are they acquired, resp. learned? Cummins already suggests that the threshold level of bilingual development involves more than mere linguistic competence in the Chomskyan sense of knowledge of the structure of language (pronunciation, vocabulary, sentence formation and meaning) and includes the competent use of language as an instrument of thought and analysis. For a fuller understanding of the nature and origin of this cognitively competent use of language we turned to the 'cultural-historical school' in Soviet psychology, founded by Vygotskij (5), to the 'socio-cognitive' approach to language and learning as exemplified in the work of Bruner and others (6), and to Basil Bernstein's work on 'socio-semantic codes' (7).
We might summarize the position we extracted form this reading in the following four points:

1. Higher psychological processes such as language and thinking (and verbal thought) have a social origin, i.e. they develop through a process of interiorization of the everyday communicative interactions of the child with his social environment (especially with adults), which, in their turn, are determined by the material conditions of life;
2. What matters for cognitive development is not so much the possession of language per se (a universal phenomenon), but rather the degree of elaboration of its use (a socially and culturally differentiated phenomenon);
3. The most important aspect in this elaboration is 'decontextualization' (or 'disembedding'): i.e. the degree to which the verbal message is freed from the particulars of the immediate contexts of action and reference by a process of verbal explicitation and objectification; in general we might say that a more decontextualized encoding of meaning withdraws the words from everyday actions and experiences and allows its interpretation without support from a particular context of origin (including presupposed shared knowledge of the participants);
4. Formal schooling and literacy are the most influential factors in the transition from context-dependent speech and thought to modes of speaking and thinking that are more decontextualized or disembedded; just 'living through' daily experiences is apparently not enough to establish this transition, which involves distancing from and reflecting upon these experiences; despite the essential role of schooling, home environment clearly makes a difference in that certain homes do provide a better preparation than others.

More concretely, we started from the following assumptions with regard to the language problems encountered by rural Mozambican children that enter primary school:
Educational succes or failure depends to a large extent on the level of cognitive or analytic competence the child manages to achieve in Portuguese, since that is the exclusive language of instruction from the first grade on and thus the only guarantee for the child's transition to more disembedded forms of cognitive functioning required by formal schooling. The child comes to school already with certain skills and competences (linguistic, communicative, cognitive), acquired in and through its mother-tongue. At the present moment the school is not equipped to take advantage of this mother-tongue experience and consequently treats the child as a linguistic and cognitive blank. The child's mother-tongue competence, however, is the basis for the construction of its competence in Portuguese, especially as far as its cognitive aspects are concerned (which are the least specific for each language and thus most easily transferable).
As far as the child's home and social environment do not provide the necessary conditions for the kind of cognitive-linguistic development demanded by formal education, the school has to make a

special effort not only to teach the new language, but also and at the same time to promote decontextualization skills. In order to enable the school to fulfill this task, one must know the peculiarities of the child's cognitive-linguistic skills and experiences at the beginning of its school career.

Data collection and analysis

To analyse the use of the mother-tongue by rural Mozambican children, data were collected in two Communal Villages, one in the southern part of the country (A.C. 'Eduardo Mondlane', Marracuene District, some 40 kms. from the capital Maputo) and one in the northern part (A.C. 'Milamba', Chiúre District, some 2.000 kms. away). The samples were arbitrarily constituted and consisted of 20 children each, with an average age of almost 7 years.
Each child was observed during a whole day and recorded by means of a radio-microphone for $4\frac{1}{2}$ hours, spread out over the day in order to obtain recordings of as many different situations as possible. Every care was taken to ensure the naturalness of the data. All together more than 180 hours of natural conversations were recorded on tape, in two languages, viz. Tsonga and Makua. The recordings were then transcribed and divided into utterances and episodes, and the transcriptions were accompanied by notes on the situational context (place, activity, participants, etc.) and by a translation into Portuguese, in order to be more easily interpretable and analysable. A first and rather superficial check of the recordings led to the conclusion that the degree of naturalness achieved is reasonable: an estimated 50% of the conversations seem to be completely free, both in form and in content, from the influence of the observation.

Apart from these natural observations, so-called 'experimental situations' were set up, in order to examine decontextualization skills in a more direct way (8). The tests consisted of a number of direct questions (like: What do you usually do during the day?, How to prepare a certain dish or drink?, How to build a hut?, How to play a certain game?, etc.) and some communication games (including cartoon-story telling and the verbal discrimination of pictures). All these situations were also recorded on tape, but transcription and translation of this part of the data have not been concluded yet.

The only type of analysis completed so far consists in the tentative classification of the spontaneous utterances of 20 children (LI = Tsonga) according to a functional grid adapted from the work of Joan Tough (9). This classification scheme, with functions like Describing, Explaining, Comparing, Self-Regulating, Imagining, to name just a few, was designed in order to get to know what children say or how they say it, but rather what they do in saying it or what do they use their language for. More than 15.000 utterances

have been classified in this way and those ones have been identified whose main function is to analyse 'the world' and reflect upon experience, rather than to establish or regulate social relationships.

The main part of the analysis and interpretation of the data still has to be done. It crucially depends on a satisfactory operationalization of the concept of 'decontextualization', to be applied both to the spontaneous speech data and to the data from experimental situations. Other aspects of the material worth studying include the more interactional side of the conversations, in particular the contributions of adults and older siblings in the joint construction of more complex and disembedded meanings (10). In this respect we might note the occurrence of some cases of a kind of 'instructional dialogue' between children and parents or grandparents.

The second part of the fieldwork, which involves the observation and tape-recording of verbal interactions in the classroom, is currently carried out, but the normal course of work is severely hampered by the precarious security situation of the country, which makes it virtually impossible to visit Communal Villages.

As will be clear from this brief overview, we are still far away from making practical contributions to the qualitative improvement of primary education in Mozambique. I hope, however, that I have succeeded in giving an idea of recent developments in Mozambican education and of the ways in which our research project eventually might contribute to the removal of some of the obstacles that make that bilingualism and education for cognitive development are still in conflict.

Notes

1. I would like to thank my colleagues at the INDE for their help, especially Mariella Baldo, Clotilde Waddington and Zaida Gulli.
2. As, for instance, at the First National Seminar on the Teaching of Portuguese, held in Maputo in October, 1979.
3. See e.g. Cummins (1976 and 1979) and Skutnabb-Kangas (1976).
4. See e.g. Lambert (1977).
5. See Vygotskij (1962) or, for a clear introduction, Wertsch (in press).
6. See e.g. Bruner (1975), Olson (1977), and Scribner (1977).
7. Collected in Bernstein (1971).
8. The idea to combine a more anthropological type of data collection (observation) with a more psychological one (experimentation) was taken from the work of Michael Cole; see e.g. Cole et al. (1971) and Scribner & Cole (1981).
9. Tough (1977, p. 68-69).
10. Cf. Well's criticism of Tough: Wells (1977).

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PROBLEMS AND POSSIBILITIES OF PRESCHOOL EDUCATION IN GUINÉ-BISSAU*

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1. Introduction

Guiné-Bissau is a former Portugese colony on the west coast of Africa with less than one million inhabitants. After a long struggle for liberation it claimed its independence in 1973.
As one of the poorest countries in the world it faces a lot of economic problems. The population comprises about 20 different tribes. As a result, there are more than 10 different languages, the Creole being the most widespread one. 21% of the children die before they reach the age of one year and 30 to 40% do so before they are five years of age. Since the 'coup d'etat' in 1980 its original socialist aspirations have been reformulated.

General aspects

Nearly half of the population attends the present school system. The primary school consists of two parts: an elementary primary school (grades one to four) and a complementary primary school (grades five to six). According to the law all children are expected to visit the elementary primary school. However, only 85% of the children actually do so. 15% of these children go on to visit secondary school which also consists of two parts: a general part (grades seven to nine) and a complementary part (grades ten to eleven).
The latter part is also called pre University or polytechnical education. When it comes to attending university, students have to go to countries like Portugal, Cuba and the Soviet Union, since there are no universities in Guiné-Bissau.
The State practically controls the whole educational system. Only some private schools as well as the coramic or islam schools are not under control of the Government. The average number of pupils for one teacher is less than 30. Only 7% of the primary school teachers passess a professional certificate, whereas 53% of them have a fourth grade certificate.
12% of the total budget is spent on education and the biggest part of this budget is financed through foreign aid - about 4 million U.S. dollars annually.

*) The original paper by W. Verbunt has been edited by A.P.J. Goud.

Output

While the population has increased by 2% in the course of the last five years, the total number of school attending people has gone down by 1,6% annually.
An analysis of schooloutput shows that on the average:
- 7 pupils out of a hundred complete primary school education in 4 years;
- 13 pupils out of a hundred complete primary school education in more than 4 years;
- 50% of the pupils get to second grade;
  33% of them get to third grade, and 25% of them make it to the fourth grade;
- 2 pupils out of a 1000 graduate from secondary school after 11 years;
- 15 pupils out of a 1000 need more than eleven years to complete secondary school.

In short, there is a high dropout rate. At the most 20% of the children will obtain a certificate of the fourth grade. This is another way of stating that 80% of all children can be thought of as dropouts. The fact that only 35% of the children get to third grade means that 65% of the population will remain illiterate.
Thus, the principal output of the schoolsystem as measured for the last five years is: dropout 80%; illiteracy 65%.
The poor results of primary education in Guiné-Bissau are often ascribed to the following factors:
- the lack of qualified teachers
- the lack of didactic material
- the lack of equipment
- the insufficient network of schools
- the insufficiency of the budget for education
- the lack of means of transport
- the lack of preschool education.

Preschool education

The ministery of education charged me with the task of analysing the influence of preschool education on the development of primary schoolchildren, because officials considered the lack of preschool education to be one of the causes of the bad schoolresults in the first classes of the primary school.
Preschool already existed in a few schools in the capital Bissau, and the government's intention was to enlarge it for the entire country to give all the children equal chances for development.
In order to find out what exactly was the problem in primary school I started to observe the situation in the first grades taking into account the family circumstances of pupils and teachers.
What struck me was the following:
- Children start visiting school very abruptly. Normally they enter school at the age of seven, but in the interior parts of Guiné-

Bissau it is not uncommon to start attending school at the age of eight, nine, or even, ten years. As soon as they are in school they begin with reading, writing and arithmetic without having had any basic knowledge or training. Thus, it is not surprising to observe that children are having problems with tasks like controlling a pencil with their hands. In contrast to our children they have not had the opportunity to practise these things before entering school. Neither have they become familiar with either books or pictures. As a result they do not realize for instance, that the picture of a little banana corresponds to the one they can see hanging on a tree.

- I noticed that the children are not able to conduct either a dialogue or a discussion with adults. It does not exist at school. That is easy to understand when you know about the situation at home. Usually people live in an extended family with a socalled 'vertical' structure related to age. This means that little children are not allowed to give their opinion to older members. They only have to obey, they can say 'yes', but 'no' is not permitted.
  Teachers (tend to) repeat this pattern in school. They do not stimulate the discussion, and the children do not ask anything, they only absorb and repeat stuff, that is offered by the teacher.
- It is also evident that children hardly play at home, because they are to participate in household work. They have to take care of the baby, they are to bring food to the people who are working on the fields, they have to go out with the cattle etc.
  Due to this way of life, children do not have enough time and opportunity both to play and to develop the kind of creativity initiative, and curiosity that we consider to be necessary for cognitive development.
- Language poses a problem for many children. The official school language is Portugese, but there are at least ten other languages. The most widely used language is Creole. It is spoken by 44% of the population. Although teachers are supposed to use the Portugese language, most of them have not mastered the portugese language very well. Many people, including me, think that it would be a better idea to introduce Creole as the main language. These people also advocate the use of the other native languages in school during the first years in school. But there is a lot of resistance against this proposal. Some members of the government fear that in this way the portugese language will disappear.
- In primary school children tend to stick to learning by heart. They only repeat whatever it is the teacher is saying, and they copy what he is writing. With regard to reading I have often observed the following scene. Children seem to be reading, indicating this by means of their fingers. However, a lot of children had the wrong page in front of them. Others did not even have a book. All children were reading in the same way - in chorus. Teachers use this method for all subjects. I have heard children counting from one to a hundred in this way. Holding up four

fingers in front of a pupil's face, however, would not lead to a correct answer on part of the pupil. So, pupils learn by heart in a very rigid fashion.

Having noticed all these problems in primary school, I could easily imagine that preschool education could be very useful in order to solve at least a part of these problems.
As I already told you before, there were two infant schools for children in the capital Bissau at that time. These infant schools are attended by children of public servants. These schools are rather well equipped. With the help of six teachers I established five preschool classes in the popular quarters of Bissau. These classes were meant for children, who were either five or six years of age. The infant teachers were assisted by socalled 'auxitiares' mainly women with neither qualifications nor training.
While I was completing my analysis of preschool education the Department of Education suddenly decided to start with preschool classes in the interior parts of Guiné-Bissau without consulting our preschool unit, and ignoring important characteristics of each of the nine different regions of the country. All these regions immediately started with experimental preschool classes.
And then chaos began. There were no teachers for the pupils in the interior parts of Guiné-Bissau. As a result, primary school teachers without any training or experience had to be employed. Since there were no accommodations available, the children had to be taught in primary school classrooms whenever they happened to be empty for one period of the day. This produced a lot of confusion. At times, children were taught under a mango tree. The lessons consisted of primary school activities, which had to be carried out without any material. Confronted with this unexpected development my superior - she is an infant teacher - and I did our best to turn this into a success:
- We prepared a course for preschool teachers, the socalled 'monitors';
- We made plans for both supervision and stock taking of the regions in order to create infrastructures etc.;
- We tried to raise funds for all our activities.

In the end we did not succeed in raising funds, because the government of Guiné-Bissau refused to put preschool education on its list of priorities.
Collaboration with other departments within the ministry of Education turned out to be minimal. The department of primary education regarded preschool education as some kind of daycare and failed to realize that it had a learning and developmental function.
In Bissau many primary school teachers made complaints with regard to the pupils. They considered pupils to be undisciplined, too free, too impulsive etc. The teachers could not view these aspects of behaviour as positive. This kind of behaviour does not fit in with their schooling system, which is very rigid and based on learning by heart.

My conclusion is that, at present preschool education has only succeeded in the capital Bissau. This is not surprising, because the Europe-oriented population lives and prevails in Bissau. Besides, most of the infant teachers who have had their training in Europe, happen to work there. But in the interior parts it was a complete failure.

Analysis of education

We had to look for other ways to solve the problem.
In collaboration with an Unesco expert we tried to make a thorough analysis of the educational system in general. In the end our experience led us to the conclusion that the poor schoolresults in Guiné-Bissau could not be explained by the official reasons:
- the lack of qualified teachers and didactic material
- the lack of equipment
- the insufficient network of schools, and the insufficient budget
- the lack of means of transport and the lack of preschool education.

We observed that during the last five years there had been an increase in:
- the proportion of qualified teachers;
- the available number of manuals;
- the number of schools;
- the budget of education and even the number of preschools.

On the other hand we observed that the results of the school system had deteriorated annually.
Apparently, the poor school results could not be explained by means of the supposed causes. Consequently, we had to analyse the situation in a larger context.
After studying the sociocultural and economic aspects of the country we came to the following conclusions:
- The school is hardly adapted to the needs of the country. It is a colonial inheritance made for the benefit of Europe. It had been created to make assimilated people, who were able to attend secondary and superior studies in Portugal. This has not changed over the years. The school does not take into account the values of 95% of the population, who either adhere to an animistic religion or stick to the Islam. In contrast the school only suits the needs of the Europe-oriented population. Futhermore, through programs, holidays, feasts, methods, construction of schools, and administrations the school progressively alienates itself from the majority of the population who gets to be more attached to its own culture. This situation is very difficult for the teachers, who face the claims of the Europe-oriented administration on the one hand and the needs of the population of Guiné-Bissau on the other.

As far as the economic situation of Guiné-Bissau is concerned its most important sources for economic development are agriculture,

fishery, timber, and mining.
Actual productivity measures of these industries fall far below their potential outputs. The school does not stimulate the development of the economy, nor does it serve to ameliorate the living conditions in the villages as well as the popular quarters in the cities.
This situation has to change. The school has to start making a contribution to the economical situation. In order to do so, there is a need for a solid educational policy that includes the establishment of study programs, the construction of schools and necessary equipment, adequate description of teacher qualifications and course materials.
This policy should be in accordance with the sociocultural reality of the country and its existing value systems. Otherwise, any educational policy will fail right from the start. Some ethnical groups for instance, tend to keep boys and girls seperated from each other during the years of primary school. Because of the fact that primary school does not seperate both sexes, it has happened that parents have kept their children from going to school. Educational policy should take this into account.
I also think that educational policy should build on the local way of raising children. It is not uncommon for instance, for older children to teach the younger children. Education could make use of this custom.

At present, I think it would be better to delay the implementation of preschool education. I think it would be wiser to continue with a thorough analysis of the educational system. In the course of doing so, one could also look for ways of integrating preschool activities into the first grade of the primary school, since the latter grade is a part of a well established structure. Furthermore, one should attempt to make more use of local instead of European material.

Foreign experts

With respect to 'foreign experts on education' I would like to make the following comments.
Foreign experts should come to Guiné-Bissau without a fixed teaching model in mind. Unfortunately, many experts from either Cuba, Portugal, East Germany the Soviet Union or Western Europe happen to make this mistake. They come to an underdeveloped country with a fixed teaching model, which they will attempt to work out behind their desks.
After a period of time they will leave and their successors will take over starting a similar cycle. I think it would be more useful if foreign experts could abstain from using their models. Instead, they should come to an underdeveloped country with an attitude of openmindedness which will render them capable of analyzing local situations adequately as well as building their educational schemes

on local needs and existing ways of raising children.
Based on a thorough analysis of local conditions, they might eventually find themselves contributing to the construction of a general model for education in Third World which will fit with the needs of an underdeveloped country in an adequate fashion. With this goal in mind ethnological knowledge me be of vital importance with respect to the preparation of foreign experts for work in Third World countries.

III. MOTIVATION

MOTIVATION AND ACTIVITY IN EARLY SCHOOL AGE

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1
I shall deal with the motivational development in the early school age and discuss the following questions: What happens to the pupil's way of working and to his attitude to the school work in the early school age? What are the changes in the development process? And what determines these changes?
In order to illuminate these questions an account of some preliminary results of an investigation will be given (see also Thyssen, 1984).
The investigation is founded on the theory of activity; furthermore it is based on works by Davydov, Markova (especially on motivation), and Ajdarova (especially on teaching of mother-tongue).

Particularly the following aspects of the developmental process will be treated:

1. The development of learning activity;
2. The question of pupils as subjects for the activities in the classroom;
3. The development of voluntary control of psychic processes.

These three sides are, however, closely interrelated. This will become apparent from the following account.

2
The investigation had the following character:
A schoolclass was observed from the first to the third year in school in the subject Danish. The children's way of working was organized on basis of a theory concerning the nature of the conditions for the development of motivation. In the last term of grade 2 the content of the school subject was changed in such a way that investigation and analysis acquired a more dominant position in the pupil's activities in order to promote a further development of the motivation.
Only part of the lessons in Danish language has been observed. In the lessons concerned the pupils' activities consisted mainly of working with small problems in the Danish language.
Just now the children have finished grade 3, and according to the plan the investigation will stop now and the data will be submitted to a detailed analysis. The pupils, however, may be observed for

some time, but in that case not as closely as in the previous period. It was mentioned that the children's way of working was organized on basis of a theory concerning the nature of the conditions for the development of motivation. Important in this respect is the so-called group leader arrangement, which was introduced at the beginning of grade 1. The basis of this arrangement was an organization of the pupils into groups of four or five. Then one pupil in each group was given the task of watching the work in the group and leading it in the direction of the carrying out of the learning activities, that is solving the given problems. This pupil had to do his ordinary work at the same time. The pupils in the group alternately had the function of group leader. In this way disturbances, noise, and the changing attractiveness of the work may have been made apparent to the pupils, and activities against these phenomena carried out. In this way the inner processes related to carrying out school work in its entirety were given an outer form.
Another important point was an arrangement which brought about a segregation of goal and result in the work of each single pupil, and for the pupil himself or herself. This took place as follows: Before starting the work with the problems and tasks the teacher asked the children how many problems they thought they might be able to solve. Each child put down the number on a special form. Just before the end of the lesson the children were asked to stop their work and enter on the samen form what they had actually achieved, that is the number of tasks done.
In this way the children were enable to reflect on the goal they formulated and the actual result of their work with the subject.
A third important point was an attempt to change the content of the subject in such a way that it became possible for the pupils to learn thgough investigation and analysis. This change in content of the subject was carried out only towards the end of grade 2. Such a change that really resulted in that investigation and analysis became main activities was very difficult to organize, and it cannot be said to be fully achieved.
The change in content was based upon the work of Ajdarova. Thus the teaching was concentrated on the inner structure of nouns and verbs as well as on the sentence. The teaching was still mainly arranged so that the pupils worked with problems, but the problems now had another function. Before they functioned mainly as training whereas now they became a framework for an activity through which a learning process took place. In this part of the teaching models played an important role. In the analysis of a word, for instance, the pupil leans on and is supported by a model for the structure of the word.
This change in the content of the teaching was not planned from the start of the investigation. Therefore it toop place rather late. The reason why this change was carried through was that it seemed possible to foresee that a very positive attitude to the work which the pupils had developed might disappear again, because the tasks

the pupils were occupied with only to a limited extent demanded thinking.
In the second half of grade 3 a new arrangement was introduced. Once a week in a certain lesson it was discussed and then agreed on what was to take place in the lessons in the coming week. In advance a superior plan was agreed on which meant that for instance instruction in grammar was to be given each Wednesday. But the further content and the further activities in each lesson were discussed weekly. The topics for this discussion were: Shall we pass on to something new? How will you do the things, that is which methods shall we use in the learning process, and so on.

This was a brief description of the special background for this group of pupils, that is of the conditions which distinguish them from other pupils in the Danish school.
Now some results from the investigation will be described.

3
First I shall describe the development of learning activity.
In the pupils' early time in school the work with the problems took place as follows: The work with the problems and communication between the pupils were interwoven. Furthermore, the pupils worked without concentration. The pupils' efforts were definitely aimed at the tasks, but in the described peculiar and unconcentrated manner. That work and communication are interwoven in this way appears from the fact that the pupils were talking about the problems What the names of the letters were. They told each other how the work was progressing, the number of problems they had solved, and so on. Now and then they said the letters out loud or they said the sounds out loud in order to analyse the words in the problems. Further ordinary noise was heard. A pupil knocked on the table with a ruler, another was whistling, and so on.
Only a short time after the introduction of the group leader arrangement the activity in the class room changed.
First came a transitional period. This period was characterized by the group leader intervening against the other pupils in the group, and these pupils doing as the group leader told them. Furthermore, it was characterized by the conversation between the pupils now taking place at a lower level. The pupils were now speaking with low voices or whispering. Furthermore, the pupils were speaking (or more correct whispering) much less than before. The talking and whispering that could be heard had partly the problems as content and had to do with how many problems you had solved and with the way of solving them, and were partly a support in the analysis of the problems. So you heard the children spelling and whispering the sounds of the words with which they were working.
So the pupils directed their efforts to the tasks. But the work proceeded with a relatively low, but within the period rising concentration. And furthermore, some communication took place between

the children as well as disturbances as for instance humming and whistling.
About one and a half months after the introduction of the group leader arrangement the pupils' activity during the lessons concerned was changed substantially. Only a low whispering was heard which might be supposed to be a support in the solving of the problems. And furthermore: the teacher could now leave the room without any noticeable effect on the children's way of working. When this happened a few of the pupils looked up shortly, but immediately continued with their tasks.
So now a problem solving activity was segregated from a more comprehensive activity. Within this activity the pupils solved small problems in the subject Danish. They solved these problems with great concentration. This change in the children's activity took place towards the end of the first half year in grade 1.
In connection with the change in content which was introduced in the second half of grade 2 the pupils' problem solving activities got the character of investigation and analysis. The pupils now, for instance, analysed words as to their parts and the sense of these parts. They analysed short sentences as to what the different words tell us. And so on.
But it seems to be so that pupils are now really thinking when they are solving problems - they do not just reproduce knowledge. It was, however, a difficult process to organize and control.
In the period up till now the pupils had displayed interest mainly in the learning process and in the content. Markova has emphasized that an important feature in the development of learning activity is a change to interest in methods. Furthermore, interest in methods is a phase in the formation of the motive for self-education which is the cardinal point of a developed learning activity.
Beginning interest in methods has been observed in connection with planning of what has to take place in the coming week.
In connection with the questions raised about the work in the coming week the pupils reflected on how to do the things, they put forward proposals as to how you might do, how the problems should be (more difficult than last week, for instance), what the teacher should do, and so on. When I say beginning interest it is because it was a certain small group of children who were especially active in putting forward proposals about methods.

4
The second question which I shall deal with concerns the pupil as subject for the activities in the class.
In the early period at school it is mainly the teacher who is the subject for those activities in the class, which concern learning. The teacher points out the goals for the pupils' acts. And the pupil's activity is appropriate only when really makes these goals his own, that is carries out acts corresponding with these goals.
When the group leader arrangement was introduced the teacher point-

ed out goals for the group as a whole, for the collective, and the collective was given the task to govern the activity.
The goal was to solve the given problems in a calm and concentrated manner. In the following period the pupils first directed and controlled their own activities through the collective. The group leaders kept an eye on the other pupils: Said they had to start working, if they were doing other things; said they must stop talking, and so on.
After a transitional period where the pupils governed their own work through the group leader arrangement they themselves became subject for their own work. That, for example, appears to be the case in that the teacher could leave the class room without the pupils reacting. Some of the pupils looked up for a moment when he left the class room, but at once returned to their work and then went on working with the same concentration as before even though the teacher was not present. This took place in grade 1 in December. The same thing happened later, so it was not an isolated occurrence.
Another change took place in the middle of grade 2.
But first I must explain that after the summer holidays (in the second school year) it became possible in the investigation to use two weekly lessons with a break in between. In the first lesson the teacher explained the problems to the children, after which the children started working on them. At the end of the lesson the teacher stopped the work and the children had their break. After this they came back to the classroom and the teacher asked them to carry on with their work.
The change in question consisted in that the children after the break on their own initiative went into the classroom, took out their papers and started working before the teacher came. When the teacher and the participators in the investigation came into the classroom the pupils were already sitting at the tables working quietly and with concentration on the problems.
That the pupils of their own initiative started their work when the teacher was not in the classroom was observed again and again and cannot, therefore, be seen as an accidental occurrence.
This change in the pupils' activities means that yet another displacement as to who is the subject for the activities in the classroom had taken place. The role of the teacher was diminished, the role of the pupils had grown.
In the middle of grade 3 the pupils expressed some criticism against the teaching. They found that the teaching contained too much grammer and too little of other things. The criticism was reasonable. This reaction from the pupils shows that a further displacement as to who is the subject of the activities had taken place.
The criticism from the children was treated in the following manner: First there was a discussion with the pupils about what in fact had to take place in the Danish lesson (reading, writing, grammar, and so on). Thereafter a permanent plan was made together with the pupils for what had to take place in the weekly lessons: grammar

Wednesday, reading Thursday, and so on. Finally an arrangement was introduced whereafter a lesson every Monday was set aside for planning in more detail what was to take place within the individual lessons in the coming week.
The crucial questions in this planning were the following: How did things go last week (for instance with the problems in grammar)? Can we go on to something new, or shall we look at similar questions next week? How shall we do it (that is which methods shall we use)? These questions were discussed between the teacher and the class. In this discussion appeared reflections on what you already knew, reflections on whether you might begin to work with something new, and reflections on how you should do the things, that is the methods.
So yet another displacement as to the subject-question had taken place. The pupils' significance for what went on in the classroom had grown. The pupils were to a still larger extent subjects for the activities in the classroom. Still more extensive questions were drawn into the activity of the individual pupil.

5
Finally I shall deal with the third problem I mentioned in the beginning: The question of the voluntary control of psychic processes. This developmental process is characterized by the circumstance that it becomes possible for pupils to govern inner psychic processes connected with the work with the problems. That is, it becomes possible for the pupils to work with concentration on the school work.
It was possible to follow this developmental process, and the group leader arrangement seemed to play an important role in it.
In order to look closer at this process I shall turn to the children's earliest period in school and once more look at what happened in this period.
Before the group leader arrangement was introduced the pupils' work was interwoven with communication between the children. The children talked with each other while they worked. I have described this earlier.
Shortly after the group leader arrangement was introduced two things happened at nearly the same time. Firstly, there was now less communication between the pupils and more work with the problems. If communication took place the group leader reacted. Secondly, and this is most important in this connection, the individual child reacted against its own acts. That this was the case appeared from the fact that children didn't only communicate less, but they also communicated in another way. Instead of speaking with normal loudness they whispered. That is the pupils didn't react against themselves by interrupting their own acts alone, but also by changing them.
Therefore it is possible to conclude that the transitional phase was characterized by the pupils acting against their own acts.

The group leader arrangement was a model, realized in the collective for attentive work with problems. Furthermore, the arrangement functioned as control of whether the pupils worked attentively.
After the described transitional period the pupils worked attentively and with concentration on their problems.
That the transition took place in this way gives rise to conclusions about the psychic basis for concentrated and attentive work. A special psychic system seems to be necessary. Further it seems possible to forward a hypothesis about the structure and development of this system.
The system has come into being through collective activity and through individual activity. In the collective a model is created for the individual activity, and in the collective the individual activity is controlled. Those acts that are the main components of the psychic system are realized between the members of the collective - so the group leaders react against the group members and these do as the group leaders say.
Furthermore: The main components of the inner psychic system are acts which seem to be changed into operations. That acts are the main components appears from the genesis of the system where a phase is characterized by the pupil acting against his own acts, that is where ordinary speech is changed to whispering.
The function of the system is to inhibit disturbing activity and further activity which is in accordance with the present task.
So when we speak of the structure of motivation we must include such sub-systems. If such a sub-system is not developed in the psyche of the child, the child will not be able to govern its own activity in accordance with the present task even if appropriate motives are present in the child. It will be diverted by disturbances originating from the surroundings or from itself, that is from interior processes in itself.

6

Finally I shall say a few things about the development of personality.
First I shall point to a seemingly paradoxical phenomenon. A pupil may enter the classroom at the beginning of the lesson and say: "Bah! Are we now going to have problems again"! After a little while he is deeply absorbed in the problems. And after the break by his own initiative he enters the classroom, takes out his papers and starts working. Exclamations like the one cited appeared for the first time in grade 2. Not all the pupils said such things, but part of them did. What is the meaning of them? What may they tell us about the pupils?
The exclamations are in contradiction to the pupils' real relations to the problems. That appears from the fact that the pupil immediately after the utterance was deeply absorbed in the problems. Should a deeper understanding of them then be based on a hypothesis that the pupil himself does not have insight into this relation?

There seems more reason to believe that they are caused by that the pupils are beginning to orientate themselves in norms and attitudes concerning pupil activity. In other words, it's likely that they shall be seen as an expression of the pupil seeing himself as standing together with other pupils opposite the teacher, and not opposite the teacher as a single individual. Seen this way the pupil's exclamation does not necessarily tell much about how the pupil evaluate the coming activities. The exclamation tells us something mainly about how he percieves himself in the present social situation. In order to understand himself in this situation he experiments with the norms and attitudes that are communicated in the school.
Accordingly it is possible to interpret the exclamation as a sign that independence towards the teacher is developing in the group of pupils, and that the pupils are orienting themselves in norms independently, that is indepentendly of the teacher. This peculiar activity also manifests itself in other ways, for instance in an at times teasing attitude to the teacher.
In the actual case the norms and attitudes are in contradiction to the school work. If these norms and attitudes become effective a problematic situation, psychologically and educationally, prevails.
I shall point to one more thing which may be related to this question. The mutual relations between the pupils seem at the same period to be changing. A certain intimacy is seen between some of the pupils. Above all between some of the girls. So they call each other by pet names. Furthermore, they have developed clear preferences as to whom they want to sit together with in the classroom.
It is likely that there is an inner connection between the phenomena I have pointed to here: Orientation in the pupil role and the changed relation between the pupils. And the earlier discussed displacement as to whether the subject for the activity in the classroom seems to be a related phenomenon.
As a whole these phenomena seem to indicate beginning changes in personality.
According to Davydov, Elkonin and Markova personality development in the early school age takes place through learning activity as the dominating activity. The main new qualities of personality are the development of a theoretical understanding of the reality. That is undoubtedly correct. But what I have pointed to above indicates that something else also happens, something that is important: The pupil himself or herself plays a growing role in the activities he or she is drawn into.
It is likely that we have to do with a pre-stage to the next phase in the psychic development. According to the theory of periods in the psychic development* in this next phase communication is the dominating activity, and the content in the developmental process is exactly orientation in roles and norms in society, relations between people, etc.

*) See Davydov, et al. (1978) and Elkonin (1972).

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A broader definition of internal vs. external motives is given by Maehr (1983, p. 194). This dimension is included in his goal categories:

Intrinsic Goals		Extrinsic Goals	
Task	Ego	Social solidarity	Extrinsic reward
Venture/Novelty	Did better than others	Pleased others	Got paid
Understood something	Showed more intelligence	Made other people happy	Increased allowance privileges

Goal categories have the function of creating personal meaning for behaviour.
The attribution theory of learning motivation underlines the function of motives as the originators of personal meaning. The attribution mechanism creates the 'cognitive motives proper'. Thus the most important learning motives result in cognitions connected with the explanation of the causes of the achieved results. Subjective interpretation of observed events form the substance of motives.
Theoretical elaboration of the need of achievement theory has produced different recommendations for the problem how to create and sustain the right learning motivation. McClelland (1965) developed a special training program to increase the need for achievement level. The program was based on the stimulation of achievement phantasies. It included descriptions of the characteristics of high need of achievement persons, simulation games and discussions, scoring of phantasy materials concerning achievement. By organization of social influence, monitoring of thoughts and social modeling of appropriate behaviors an attempt was made to change the need to achieve and corresponding concrete behaviours of the subjects.
A similar attempt with the achievement motivation training is made in the frame of self- or personal-efficacy concept by Bandura (1977). In his therapeutic intervention the methods of modeling critical situations and providing proximal goals a greater sense of self-efficacy are created. This should lead to a sense of intrinsic interest in the activity.
In spite of the intentions to create and sustain an intrinsic learning motivation in the form of task-goal orientation concrete methods of intervention are limited to the classification of pupils into different motivational types and adaptation of teaching to this division. Rohwer et al. (1980) presents a good example of this: 'Success, praise, and even failure, then affect success-seeking students in positive ways, but such outcomes only further diminish the self esteem of failure-avoiding students. The problem, therefore, is how to adapt your teaching to both these kinds of students' (p. 230).

The paradox of intrinsic, task-goal oriented motivation in the frame of need achievement theory and its attribution corrections is that the methods of creating intrinsic learning motives are extrinsic. Maehr's (1983) list of means for creating intrinsic learning motives demonstrates this clearly: (1) External evaluation should be minimized, (2) choice and freedom of movement must be fostered, (3) social competition must be minimized and (4) the elite may need ego goal conditions.
This short review of the need of achievement approach to learning motivation reveals the shortcomings of theoretical and methodological elaboration of the cognitive learning motivation concept. Learning motivation is not an integrated, organic part of the general cognitive learning theory. The goal of developing instructional intervention strategy reveals the necessity of integration between cognitive and motivational components. Resnick (1983) defines the goal: 'It now seems absolutely certain that our task is to develop a theory of intervention that places the learner's active mental construction at the very heart of the instructional exchange' (p. 30).

The construction of a theory of intervention presupposes a solution for the following methodological problems of integrating motivational factors with the learning concept:
(1) The problem of need in learning. Is the need to achieve the only relevant need in the learning context? According to the achievement motivation theory the need to achieve is the only relevant social need. The concept of need refers to any goal-directed, human activity. The meaning of the concept is limited to the fact that man has goals. Does any specific need of learning exist? What is the relation between specific needs and general social needs?
(2) The substance of learning motivation. According to attribution theory the contents of motivation consists of a person's subjective interpretations in a specific achievement situation. The subjective causal explanations (ability, effort, task difficulty, luck) of the achieved result are the substance of motivation. If learning motivation is limited to subjective interpretations ex post facto, there is no room for intervention. The idea of intervention means that the meaning of learning is at least partly created and elaborated within the learning process as a joint social enterprize. The intervention strategy cannot wait for results and their subjective interpretations. It is necessary to reveal this mechanism between subjective and social meaning in order to construct a strategy of instructional intervention. In other words the substance of learning motivation is social and societal, not subjective.
(3) The development of learning motivation. A theory of intervention implicity presupposes a theory of development. Intervention does not have any purpose if it does not aim at developmental changes. The problem of development is hardly dealt with in achievement motivation theory. There are only preliminary remarks on differences in the need to achieve in different age-groups and between

boys and girls.
A developmental perspective to motivation presupposes an analysis of the role of learning in psychological development. It is possible to suppose that the developmental impact of learning presupposes a specific type of learning motivation (e.g. interest in the methods of acquiring knowledge, interest in the developmental processes). The need of achievement approach is based on general goal-orientation and does not specify a developmental perspective or specific learning motives which are presupposed by instructional intervention.
(4) The method of instructional intervention. The need of achievement approach to motivation relies on the methods of measuring social motives. At the first stage a general goal-orientation (achievement phantasies in TAT-test), and later a person's attribution (which factors explain the achievement of the result) comprise the research interest of this approach. From the point of view of instructional intervention the measurement problem is secondary. Many important factors of the intervention strategy lie outside the scope of the measurement approach. E.g. the attribution hypothesis is possible on the following conditions:
(1) there is an effective need of achievement as a trigger of motivated behaviour (in order to explain motivated cognitions a need to achieve has to be present) and (2) there are other necessary achievement conditions (goals, social factors etc.) There seems to be a clear discrepancy between the achievement motivation (attribution) theory and the instructional intervention strategy. The achievement motivation theory cannot implement instructional intervention.
The theory of instructional intervention presupposes apparently a new methodological approach based on a social unit of activity. Individual interpretations (attributions) do not represent the essence of motivation.

2. The problem of need in learning motivation

The concept of need is the last link in the explanation of human goal-directed action in the achievement motivation approach. As a matter of fact the whole theory of achievement motivation relies on the soundness of the need concept, because the need explains why a person is engaged in a particular goal-directed action.
The use of the need concept implicates usually a specific mechanism of induction of a goal-directed action. The action of an organism is launched by the increase of the need tension accompanied by the delivery and use of energy. Another feature of this launching mechanism in this approach has been: the higher the tension of the need, the more intensive the induction of action.
The basic problem of the achievement need explanation arises from the adoption of a physiological homeostatic need mechanism. As the concept of need was first used in connection with organismic needs, the homeostatic need model was carried over to the analysis of psychological processes. In spite of the fact that already on the

level of physiological regulation of psychic activity non-homeostatic forms are dominant, the dynamics of motivation is explained by the use of the homeostatic model. Such characteristics of human activity as probabilistic prediction, modeling of future events and non-stereotypic attainment of goals presuppose the non-homeostatic model of dynamics (Bernstein, 1962).
In spite of these facts the concept of need in most theories of motivation follows the homeostastic model. The substance of a need is defined negatively, as absence of something. Thus a need is an individual state of mind which is eliminated by the positive object of the need and negative state of mind is transformed into the positive one. If a need is defined as a subjective state of mind, it is impossible to explain the energy function of the need and its role as a trigger of human activity.
Nikolov (1984) has described the vicious circle of explanation in the following manner: 'A curious theoretical situation arises: a need is defined as the origin of the activity of a subject or an organism and in this sense an explanation of the activity: at the same time the need itself as a specific active state should be explained by another origin of activity outside it. This situation is a result of understanding a need as specific actual state of the subject or organism' (p. 69).
A need defined as a specific actual state of the subject is in correspondence with the homeostatic model of motivation. When the balance is achieved or the need is not actual at the moment, it disappears. This is a logical consequence of defining the essence of need in terms of need tension. The only possibility to break the vicious circle is to suppose that need satisfaction does not eliminate the need. In this case need satisfaction, the absence of need tension is a specific manifestation of a need.
Does the homeostatic need model have relevance in the analysis of learning motivation? In learning situations there are no specific deprivation states which could explain 'the need for learning'. Some attempts to postulate psychological process needs explaining learning process exist (e.g. Deci, 1975). But the model of deprivation fits poorly to the psychological contents of the learning process: the essence of learning is societal, not organismic as suggested by the deprivation model.
It seems plausible to look for the sources of motivation in psychological processes such as learning inside the human activity itself. The need cannot be an external 'motor' intrinsically preceding the activity itself. In this sense the motive of learning may be understood as 'a functionally determined specific organ of activity' (Judin, 1977).
The fuctional approach gives quite another scope for the definition of the need of learning as compared to social. extrinsic needs of learning which are usually defined in the form of 'in order to'. E.g. Heckhausen (1963) names the following specific needs of school learning: avoidance of punishment acceptance, competence, identification with the teacher etc.

These needs are extrinsic motives of school learning. It seems necessary to define the intrinsic needs and motives of learning which reflect the substance of the object of learning. This is not possible without the definition of the societal essence of learning. In terms of psychological description it is necessary to characterize the developmental perspective of the need of learning.
The solution of the problem of need presupposes characterization of human learning as an activity. In other words only learning activity may have specific needs. This is connected with the fact that learning has a decisive role in the human psychic development. Animals have two types of experience: (1) experience which is based on genetic unconditioned reflexes, (2) individual experience which is based on conditioned reflexes. Human beings have a specific societal-historical experience which is acquired through a specific type of learning (Leont'ev, 1957).
A.N. Leont'ev (1957) has emphasized a new function which learning has in human development: consciousness is produced through learning. Human consciousness results in a new relation to reality. Changes in an individual's relation to reality are the main criteria of psychic development in the frame of the cultural-historical school. The key-concept, which opens up the possibility for changing individual's relation to reality, is the leading activity type. Learning activity is one of these.
According to this conception learning has a different function in the psychic development of an individual. In the broadest sense learning in a general mechanism of acquiring the human species-specific, societal-historic experience. The learning process takes place in life situations where it is necessary to change human actions. Learning has, however, quite a specific function in the ontogenesis as a specific human activity. Learning activity is characterized by its relation to developmental changes and structura features. Play as an activity (in its most developed form: role-play) opens new possibilities for the child to cope with the environment.
A specific developmental task of learning activity is to form a theoretical relation*) (developmental perspective) to reality (Davydov, 1972; Davydov et al., 1981).
A new relation to reality as the specific need and result of learning activity may be concretized with the help of the following changes: (1) the child starts to discern societal parameters in the learning object, (2) the child's relation to his own activity changes (self-regulation of learning process), and (3) the child forms a prerequisite for the next two (Markova, 1977). A specific characteristic of learning activity is that the process of acquiring knowledge becomes the goal of learning.

*) The concept 'theoretical' is not used in this connection in its usual meaning: abstract, conceptual or discursive. It refers to a specific type of analysis: analysis of a developing system in order to find its genetic basis and its transformations into specific traits and phenomena.

According to the activity theory, the need for learning activity originates from the contradictions between limited contents of knowledge and psychic formations of imagination and symbolic function. The development of imagination and symbolic function reveals the necessity of theoretical knowledge and skills. This contradiction of play activity forms the prerequisite for the need of learning activity. Further development of the need presupposes teaching and learning which develop the basis of theoretical thinking (Davydov et al., 1980).

The functional approach to the problem of need in learning leads to the following conclusions:

(1) There is a specific need of learning whose substance consists of a theoretical relation to reality.
(2) The specific need of learning is limited to learning activity. Learning may take place under different need-constellations. If the specific need of learning is absent, developmental impact and the activity structure differ from that of learning activity.
(3) The specific need of learning originates from the basic contradiction of play activity in the child. The essence of this contradiction is social.
(4) The specific need of learning has a clear developmental perspective: play-activity brings it about and the basic contradiction of learning activity prepares the transition to the next type of leading activity.
(5) The funtional need-concept reveals the necessity and possibility of the instructional intervention. The potential of the specific need of learning results in the spontaneous intervention of adults. Further development of the need depends on the active planned intervention strategy by the adults. (Learning activity does not develop spontaneously.) Planned instructional intervention transforms the need of learning into specific motives and goals of learning activity.

3. The development of learning motivation through instructional intervention

Different theoretical approaches to motivation produce different interventional strategies. As demonstrated in the first part of this article in the frame of the need for the achievement approach and attribution theory, there have been attempts to influence motivation by stimulating achievement phantasies, and presenting proximal goals or models of a performance.
In spite of the expressed hope to develop an instructional intervention strategy attribution theory has resulted in classifications of different motivation types of pupils. Educational consequences of the classification are limited to adapting instructional methods to the existing motivational types, or giving recommendations concerning external motivational factors (e.g. Maehr, 1983).

The attribution theoretical framework directs intervention interestingly towards external methods of creating meaning for learning in spite of the possibilities to facilitate learning by using the methods of 'epistemic or conceptual conflict'. The attirubtion theory of achievement focuses on the subjective experience and seems to forget the potential of contents in learning motivation. This can be demonstrated by comparing the instructional intervention based on the concept of epistemic conflict by Berlyne (1960). He discerns six types of conceptual conflicts (doubt, perplexity, contradiction, conceptual incongruity, confusion and irrelevance).
Instructional intervention based on the concept of epistemic conflict originates in quite a different set of practical recommendations for teaching the same subjects and themes compared to attribution theory.
'Contents-bound' motivation is created by 'didactic provocations' which may take the following concrete forms (Lind, 1975):
(1) presentation of an unexpected event;
(2) presentaiton of an anomaly which should be explained;
(3) presentation of suspicions concerning the potential of a given explanation;
(4) creation of suspicions concerning self-evident knowledge of the pupil;
(5) presentation of different parallel explanations of the same event;
(6) introduction of a theoretically valid explanation.

A more thorough and detailed intervention strategy creates a conceptual conflict by making every student first aware of his own preconceptions. Nussbaum and Novick (1982, p. 188) e.g. propose the following guidelines for instruction in science subjects:
1.(a) Create an 'exposing event' which requires students to invoke their preconceptions in order to interpret it.
(b) Encourage students to describe their preconceptions verbally and pictorially.
(c) Assist students in stating their ideas clearly and concisely, thereby making them aware of the elements in their own 'alternative framework' (preconceptions).
(d) Encourage confrontation in which students debate the pros and cons of their different preconceptions and increase their awareness and understanding of the differences between their own 'frameworks' and those of their classmates.
2. Create a 'discrepant event', one which creates conflict between exposed preconceptions and some observed phenomenon which they cannot explain.
3. Support students' search for a solution and encourage emerging accomodation. Encourage students to articulate and elaborate the desired conception when it is proposed.
The conceptual conflict approach is based on the conceptual change model of learning. This creates some limitations for the motivational potential of the said intervention strategy. In spite of the

fact that the conflict is presented to exist between the subjective preconceptions and the scientific explanation of the same phenomena, there is no trace of contradictions in the objective reality. The subjectivist standpoint is clearly demonstrated in the list of the conditions which a new conception has to satisfy to be integrated with the existing preconceptions: (1) a new conception has to be intelligible, (2) a new conception has to be initially plausible and (3) a new conception has to be fruitful (Hewson, 1984). This list is in accordance with the traditional model of school learning (Engeström et al., 1984). The conflict or contradiction is limited to the relation: subject's preconception - scientific explanation. This is a narrow perspective from the point of view of the development of learning motivation.

Intervention, which aims at the creation of specific learning motivation, should apply a broader societal unit of intervention. Essential requirements for the intervention method are the following (Engeström et al., 1984, p. 182-183):

- the experimentation takes as its point of depature the inner contradictions, the emerging or 'rebelling' new forms of learning and societal practice;
- the experimentation aims at the development of a new structure of activity and a new type of theoretical consciousness, eventually at the formation of collective subjects;
- the experimentation involves the alteration and restructuring of the societal practice (outside school) of the subjects;
- the structure of the learning activity, created and used in the teaching experiment, corresponds to the process of ascending from the abstract to the concrete as the general mode of theoretical consciouness and theoretically conscious activity.

Experiments aiming at the creation of specific learning motivation through restructuring learning activity have been carried out by A.K. Markova's research group. The hypothesis of experimental research claims that a specific motive of learning: interest in the methods of cognition, can be attained by developing learning activity proper (learning task, learning actions, evaluation and control). Interest in the methods of cognition represents the motivational aspect of the new type of theoretical consciousness which learning activity aims at (Markova, 1978).

At this preliminary stage the elaboration of the motivational aspect of instructional intervention has been concentrated on the impact of the mastery of learning activity on specific learning motives (interest in the methods of inquiring knowledge). A methodology of transforming teacher's goals into pupil's goals and learning tasks has been developed parallelly (Markova, 1982, 1983, 1984). These two methodological approaches should complete each other and form an integrated whole.
The intervention strategy for developing learning motivation through learning activity comprises of stages and instructional tasks:

I. Specific motivational stage: (1) The creation of a problem-centered learning situation, (2) the formulation of the basic learning tasks, (3) self-control and self-evaluation of the possibilities to carry out the activities necessary for the study of the theme. II. Operational-cognitive stage and III. Reflective-evaluation stage of learning.
The stages are carried out in the form of a system of learning tasks which aim at theoretical generalizations (Markova, 1984; Markova et al., 1983).

In spite of considerable progress in the development of methods for creating learning motivation, there are still problems in the methodology of instructional intervention aiming at learning motivation. The following list includes inly three basic problems:

(1) The collective subject of learning. Instructional intervention strategies are usually limited to individual subjects of learning. The societal essence of human learning seems to presuppose the formation of collective subjects (cf. Engeström et al., 1984; Hakkarainen, 1984). The strategies for constructing joint problem solving tasks do not meet the requirements of the formation of the collective subject of learning.
(2) The inclusion of the societal practice. The intervention strategies usually focus only on the school learning situation. Consequently learning motivation is isolated from other activity types and their motivation.
(3) The interrelations between subjective and objective contradictions. Motivational intervention is concentrated on the subjective meaning of learning. Motivational contradictions are created between subjective preconceptions and 'objective' explanations of the same phenomena. The contradictory nature of the development of phenomena in reality is not always reflected in motivational interventions. The systematic relating of objective and subjective contradictions is a challenge for improving the intervention strategy to learning motivation.

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IV. SCHOOL SUBJECTS

STUDENTS' COGNITIVE RESOURCES AND CLASSROOM TASKS

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Psychologists have yet to develop a description of school learning processes which does justice to the complex and subtle interplay between teachers and students in classrooms. Such an account would necessarily have to include detailed information on the cognitive recources available to students and the demands teachers place upon these recources. In a useful attempt at conceptualizing classroom events, Doyle (1979) and Posner (1981) have both discussed the idea of "classroom tasks". In their view, teachers provide students with a series of tasks and some recources for accomplishing them; however, students may, and often do, reformulate the tasks with reference to their own interests and values, using their cognitive recources in addition to selecting from among the recources offered by teachers.
The main body of this presentation will include a discussion of the character of "student recources".

The Constituents of Student Knowledge

One approach to the exploration of school knowledge is to try to discover the critical competencies that the student has to develop and use, in order to cope with the demands of school. For example, Mehan (1980) has proposed that in order to participate effectively in the classroom students need to synchronize two forms of knowledge, one covering academic content, the other interactional form. In other words, it is not enough to have mastered the content of a subject-matter, the student must also be sensitive to the classroom rules that govern the presentation of such knowledge.
In developing a conceptual framework to make sense out of school experience, students, it will be argued here, operate stimutaneously with three kinds of knowledge. The first type is academic knowledge, or grasp of substantive knowledge in subject matter domains An example (Osser, 1980) is the following: the teacher of 9 year olds provided them with initial definitions of three interrelated verbal concepts, local, national and international news, which referred simply to the location of the news-event. Given this in-

formation, the children were asked to cut and classify stories from newspapers. As part of the ensuing research, the children were asked to justify their classification of newsitems invented by the investigator. It was not uncommon for the children to provide evidence that they were not dependent on the teacher's simple categories and they had, in fact, moved beyond them. In the following excerpt the child offers the distinction (not previously proposed by the teacher) that a news-item may be classifiable as local or international, depending upon the location of the event and the reader:

I: Now let's say you had a French newspaper in a French village of 300 people and somebody had a brick fall on his head. What kind of news would that be? ...

Joshua: International.

I: You would call that international?

Joshua: Yes, because it didn't happen here, it didn't happen where you were. But if you were in that country ... in that village, it would be local.

The second type of knowledge is social-cognitive knowledge which includes the student's ability to both make meanings and intentions clear to others and in turn to discern their meanings and intentions.
As Erickson and Shultz (1981, p. 147) suggest:

> "The production of appropriate social behavior from moment to moment requires knowing what context one is in, and when contexts change, as well as knowing what behavior is considered appropriate in those contexts".

The following (Osser, 1982) is an example of the complex social-cognitive knowledge, in this instance knowledge of the teacher, available to one 9 year old boy:

I: Do you know how the teacher decides where you're going to sit?

David: Um, well people if that you haven't sat next to before, or that you aren't terrifically great friends with, or you've sat on the opposite side of the room from them. She might change you for that reason.

I: So what would her reason be for doing that?

David: So you'd get a different, so you'd get to know different people in the class.

The third kind, metacognitive knowledge, relates to the student's skill in self-monitoring, illustrated by the use of feedback and the resultant corrective procedures. One linguistic example is the phenomenon of the "retraced false start", where the speaker detects a speech "error" and corrects it by the substitution, deletion, or addition of new verbal materials (MacWhinney and Osser 1977). Other equally common examples are where the student might monitor task comprehension by asking such questions as, "What is this all about?" "Is it difficult?", "What is the next step?", and "Did I forget anything?".

A Clinical Assessment of Students' Metacognitive Knowledge

The following is an account of information generated by a study of a teacher and her students in a special class for children with substantial learning problems. One goal of the study was to analyze the role of different types of knowledge in children's mathematical performances. The following discussion will focus on metacognitive knowledge. The skills of metacognition in mathematical problem-solving include, for example, predicting, estimating and checking, that is they refer to the basic characteristics of thinking efficiently in learning situations (Flavell 1979, and Brown 1980). A second goal was to provide some information on the extent of the teacher's influence on students' performances. For example, the student might on some occasions operate with a "formulaic" strategy in school learning where some, or alle, of the material would be memorized with minimal understanding. On other occasions the student might adopt a "generative" strategy. This represents an attempt to comprehend the relations between the elements of a classroom task. The student using a formulaic strategy may be voluntarily taking up, or be forced into, a dependent learning role, so that the student simply acts as a reproducer of the teacher's ideas, values, and problem-solving stategies; whereas the student using the generative strategy is more likely to have an independent learning role, and thus be an autonomous producer, or co-producer of knowledge with the teacher.
Clinical interviews of both the teacher and her students were employed to discover the extent to which students take up work stategies as previously formulated by the teacher. In the following segment of an interview with the teacher, the focus is on the procedure of "checking" as an instance of monitoring work. The interviewer speaks first and then the teacher describes how the students are taught to check their work, and she comments on their fidelity in following her recommendations:

I: Do they check their work? Are they supposed to check their work?

Teacher: I have thaught most of them how to check their own

subtraction questions by adding the bottom number with the answer to get the top one. Basically it's just a visual check. "Six divided by two. I have six put into groups of twos. I'm not going to get three, or twenty eight groups. I'm not going to get eighteen and I'm not going to get twelve. It doesn't make sense. I have to get a smaller number". Just usually checking to make sure if it makes sense or not. "If mother had five cookies and she gave four away, how many has she left? She can't possibly have nine".

I: You were saying that they do this or they don't do this?

Teacher: They're encouraged to do it.

I: And to what extent do they try to do that?

Teacher: I don't think that many of them do it. They simply get their work done and hand it in and so on to something else. Get some free time or whatever have you. It's simply "let's get it done". There are some that try to get their work right but they won't check it to see if they have them right or have answered all the questions. This happens quite often. I'll call them back and say "You did not answer this question. You left that one out, you did not do this one, what was the lesson?". "Oh, I didn't see those". So they didn't go back to see if they had everything down. "Did I have seven questions to copy off the board? Did I copy seven down? Did I copy five down?".

I: So there's two kinds of checking that they are not always doing. One is just to see that you've completed the actual work, that you've put answers down or copied all the problems down that you were given. And the other is to see whether you've done the work properly, when you actually did it?

Teacher: Right. If you allow them they just don't do it. They think basically "I've gor to get my work done and handed in, let the teacher check it over. Then if I get the work corrected, all right! ...".

The teacher's assumptions seem to be that students typically:

(1) Do not check to see whether they have copied all of the work fron the blackboard, or whether they have answered every question.
(2) Know appropriate checking procedures which allow them to arrive at an estimate of the right answer, and thus can

make prograss toward it.
(3) Nevertheless the students typically leave it to het to check their work.

The following are samples from the interviews with two female students, Terry (8 years) and Carol (11 years):

I: Do you ever check your work?

Terry: No. I try to, but I just make the same math questions more worser, so I just leave them alone.

I: Oh, what do you mean that you make them worse?

Terry: Like if I hand'em in and I corrected them, right? Then she says "That one certainly isn't that". Say I handed that in and it was ten hundred, and she says "That wasn't it". I was wrong.

I: Do you think sometimes you have them right and then you change them when you check?

Terry: Well, I never check no more because I used to get them wrong. Now I sort of get them wrong the same way.

I: Do you ever check your work?

Carol: No I just look over it. Well when we're supposed to, like, um when Mrs W. was here we, we um did this kind of thing and she would put the answers up on the board and we would check them by ourselves and that's fun 'cause I like doing that.

I: Oh I see, you mean you would check to see if your answer was the same as hers?

Carol: They would show the real answer, the right answer, on the board, we did that last year and we passed over some. You take one person's work and you check over it to see if you got all your work right. You would take your own paper and check over.

Terry does not appear to share the values that the teacher attaches to checking, nor does she seem to understand the basic procedures for checking. She has apparently tried repeatedly to arrive at the "right" answer in the past without success; consequently she has given up on checking as a monitoring strategy.
Carol, on the other hand, agrees that there is some value in checking, but her definition of it is very different from the teacher's;

"checking" to Carol simply means comparing her answers to the teacher's "right" answer, or to other students' answers.
The teacher's view that the students have been taught and, therefore, must know how to check their math work is not validated by the evidence; however, the teacher's suggestion that her students expect her to check their work does receive some support. The teacher appears to underestimate the difficulties faced by her students when they are asked to check their math work. Successful checking (or monitoring) presupposes: (1) that the student is competent in basic mathematical operations, such that errors can be detected; and (2) that knowledge of correction procedures, including estimation and prediction, are available. THese competencies even when developed by "learning disabled" children are often inaccessible, as their diminished confidence in their stock of knowledge results in the adoption of the strategy of "playing is safe", exhibited in Terry's abandonment of her checking procedures, and Carol's delight in using others' presumably "right" answers. The two students seem to be operating, at least in the meth class, with a general formulaic strategy in learning.

Individual Differences and School Competence

Differences among pupils in academic performance can be understood by referring not only to variations in academic and social-cognitive knowledge as Mehan (1980) suggests, but by considering possible significant effects of differences in metacognitive knowledge. To return to the topic of the monitoring of comprehension, it is conceivable that students who closely monitor their understanding of a mathematical task may select a different and more appropriate problem-solving approach if and when it appears that they are not making progress. On the other hand, students who monitor their performances in a casual manner may miss the clues that indicate they are not on the track, so that faced with difficulties they cannot precisely define, they might be inclined to give up, as Terry did, rather than to persist the work.
It is conceivable that a student who typically employs a "close monitoring" strategy for a given set of school problems will be more likely to adopt the generative mode of learning and its associated student role of producer, or co-producer, of knowledge. The corresponding hypothesis is that a student who typically adheres to the "casual monitoring" strategy for a given set of school problems will adopt the formulaic mode of learning and with it the student role of reproducer of knowledge. THe performances of Terry and Carol seem to fit this latter characterization. However, it is likely that every student will follow a "close monitoring" strategy for some school problems and a "casual monitoring" strategy for others. If this is the case the student, if observed for a long enough time period, will likely vacillate from independence of the teacher to dependence on her as a function, among other things, of the subject-

matter being taught and the specific context of learning, including the quality of personal relationships in the classroom.
One clear suggestion from the results of part of the clinical assessment of Terry and Carol is that they coferred their own meaning on school experience which did not coincide with what had been proposed by the teacher. This conception of students as shapers and interpreters of experience receives general support from the psychological theory of human action espoused by Von Cranach (1982). Form such a theory it is possible to predict that students would inevitably develop alternative conceptions of "school mathematics", or any other part of the formal and informal curriculum, which would be quite distinct from the "authorized" versions. What the students "alternative conception or framework" may be is however problematic, in fact we are very far from having ad adequate account of students' interpretation of and cognitive recources applied to school work.

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TWO ASPECTS OF MATHEMATICAL LEARNING ACTIVITY IN PROPORTIONAL REASONING*

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The present paper tries to apply some basic components of a psychological theory of activity to a field of mathematics education that is known as the teaching of ratio and proportion. The crucial point in question is, how the theoretical statements about means and tools of activity can be applied to mathematics education in a productive way, where by mathematics learning is understood as a mediated activity. As Vygotskij (1962, p.55-62) put it: 'The main question about the process of concept-formation - or about any goal-directed activity - is the question of the means by which the operation is accomplished. ... All the higher functions are mediated processes, and signs are the basic means used to master and direct them. The mediating sign is incorporated in their structure as an indispensable, indeed the central, part of the total process'.
The teaching and didactics of mathematics have since their beginning conceptualized the means and media of learning activity as external objects, that could be used by the students and help them as concrete embodiments of abstract ideas: e.g. diagrams, graphs, cuisenaire rods etc. This paper tries to give a tentative answer to the question, how such means of learning activity organize the acquisition of mathematical knowledge and at the same time the application of this knowledge to problem situations and tasks. It can be said that there are two aspects of mediated learning activity: the interiorisation and exteriorisation of knowledge structures.
Means like schemata, diagrams, and the visualisation of certain procedures with the help of tables, arrangements, arrow-diagrams and so on stand between the science of mathematics on the one side and didactic tradition and experience on the other. Sometimes they have resemblance to the inventions of ingenious practitioners from the dawn of industrial revolution, sometimes they are visualisations used in mathematical science transformed for teaching purposes.

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This contribution will present some findings of an empirical study of visualisations that are used in ratio and proportion, especially in the teaching of percent.
Empirical work that has been done so far by Karplus and co-workers (see for instance Karplus & Karplus, 1972; Karplus, Pulos & Stage, 1981, 1983a, 1983b), by Hart (1981), Suarez (1977), and Noelting (1980) has produced beneath other important results growing interest in the question how visualisations of mathematical facts influence the solution of proportion tasks. There is no simple or clear cut answer to the question, whether visualisations promote the acquisition of mathematical knowledge: sometimes they do, sometimes they block or hamper the acquisition process (see Otte, 1983; Jahnke, 1984). The empirical study of school reality and the problem solving or task-oriented behavior of students does obviously not by itself structure the knowledge continuum in this domain. Therefore a theoretical structure appears to be necessary that gives a description of the interaction between tools and means of human (learning) activity and its process quality.

Learning system and its environment

I will start with an outline of the situation that can be found when a learning system interacts in certain ways with a variety of other aggregated systems, that can be called 'learning environment' or 'learning ecology'. Between these two systems there exist different forms of interrelation and exchange: fusion, symbiosis, communication, and interaction according to the degree of autonomy that the respective system maintains (see Jantsch, 1979, following Maturana).
Looking at the means of activity we find them organizing the exchange and communication between the learning system and its environment. They are powered by the engine of living activity. The processes running between the learning system and its environment can be described from the point of view of interiorisation vs. exteriorisation.
The psychological significance of interiorisation for the acquisition process has been substantiated many times since Vygotskij analyzed the interiorisation of speech. The aspect of exteriorisation is a key for a better understanding of the evolution of tools, as shown by Leroi-Gurhan (1980). Piaget introduced the concepts of assimilation vs. accomodation to describe the process-structure of activity. He regards means of activity, however, primarily as cognitive and internal and not as material means of the tool-type (see critique of Piaget by Damerow, 1980; Raeithel, 1983; Brockmeier, 1983). Analyzing the role of material means for the interiorisation vs. exteriorisation of structures between systems we find a reversal of direction of process-structures, compared to the relation of assimilation vs. accomodation analyzed by Piaget. Piaget conceptualized the process of assimilation as a development starting from a state of spontaneity that is gradually transformed through the

different stages into a maximum of order, expressed in the concept of the INRC-group seen as the summit of intellectual development. In contrast to that view means of activity can be said to give rise to a multitude of possible cognitive representations, while only exteriorisation implies a certain ordered sequence of operations during the application.

Exteriorisation as a mediated relation between structures can be said to be structurally determined or algorithmic: the learning system exports a sequence of processes fixed by the tools or means to the outside of its system boundaries. The machine is the incorporation of crystallized internal processes driven to a maximum. Volpert (1984) has directed attention to the fact, that the system boundaries between man and machine do not coincide with the surface of our skin, that the interface between the two systems lies inside the human body. It can be said that rigidity and reproducibility are the outstanding characteristics of the exteriorisation of structures by the learning system.
Interiorisation as a mediated process is more oriented towards the surprise or news value of an imported structure. The tools and means of interiorisation organize the process quality of the exchange between the systems. Flexibility and creativity are the outstanding characteristics of interiorisation, that can best be expressed in the ambiguity of pictures and visual symbols.
Interiorisation and exteriorisation are complementary processes. E. von Weizsäcker has in his theory of pragmatic communication analyzed the interaction between systems from the point of view of initiality vs. confirmation. Jantsch (1979) has applied these concepts to a general system theory of evolution. Using their ideas it can be said, that interiorisation continously transforms initiality into confirmation, whereas exteriorisation is dominated by confirmation. The interaction between the systems comes close to a balance, if confirmation or exteriorisation prevails. The interaction is far from balance, if initiality is transformed into confirmation during interiorisation. This is an other interesting difference to Piaget's theory where equilibration is the core concept for the explanation of learning and development. It is one of the great discoveries of Vygotskij that interaction between a learning system and other systems cannot be seen as a relation close to balance. Between everyday concepts on the one side and scientific concepts on the other a permanent tension is the propelling force of development. The 'zone of proximal development' is an interaction far from balance, what seems to be only a different way to say, that psychological development and instruction in schools cannot be separated.

The application of these concepts to the situation of students in today's school gives the following picture. The system can only fulfill its central function, learning, if it is organizing the transformation of initiality into confirmation by itself securing

for the future the occurence of initiality, a state far from balance giving rise to learning. Learning in schools, teacher-student-interaction and the use of visualisations, however, always aim at maximal confirmation and a balanced relation between learning system and its environment. Teachers very often find those teaching efforts especially excellent that have succeeded to teach something new to the students without them becoming aware of the fact that it was something new. This reduction of new knowledge to old one is a common feature of school mathematics (cf. Brousseau, 1983), whereas the system can only learn, if existing knowledge is projected onto a 'zone of proximal development' (Vygotskij) that is based on the explanation of existing knowledge with the help of new one.
Coming back to visualisation we can give a tentative summary: according to whether the analysis predominantly adheres to the exteriorisation or interiorisation of structures visualisations are viewed either as 'machines' or as 'symbols'.

The notion of the process-structure of learning activity is different depending on an interiorisation or exteriorisation point of view. Two models can be distinguished:

- the emphasis on exteriorisation leads to a model of learning activity that gives a hierarchic-sequential picture of the organization of action, where lower levels of action are completely controlled by higher levels. The idea of an algorithmic nature of activity processes prevails and the concept of 'the one best way' elaborated by Taylor for the organization of industrial work lies very close to it. The models of teaching that are based on a hierarchic-sequential model of the process-structure focus on the solution of tasks and on task analysis (cf. Resnick & Ford, 1982). The reproductive characteristics of process-structures are heavily stressed.
- The emphasis on interiorisation leads to a model of hierarchical organization of the process-structure of activity, that is not directed towards the vertical control executed by higher levels on lower ones. Instead it stresses the self-organization of interacting living systems having a relationship of co-evolution. The models of teaching that reflect this view aim at meaning and understanding of a mathematical fact, that result if a variety of interrelations can be established between this fact and intended applications. In this view the productive and creative characteristics are heavily stressed.

The following table tries to summarize the statements presented so far:

Table 1

	interiorisation	exteriorisation
process structure of activity	hierarchy of living systems	hierarchic-sequential control
models of teaching	meaning and understanding: productive/creative	solution of tasks: reproductive
evaluation	multiple presentation	right/wrong
visualisation as tool and means	'symbol'	'machine'

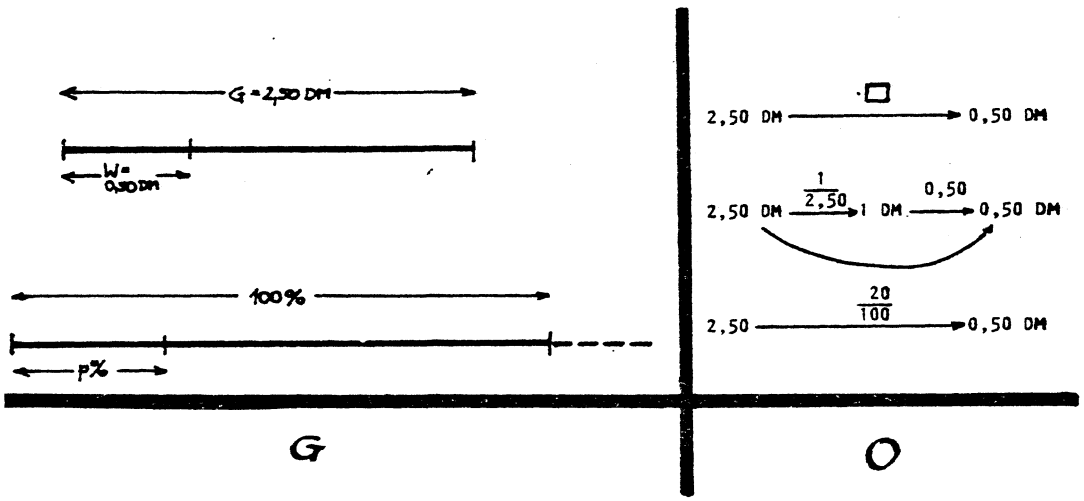
Empirical study

The empirical study reported here used percent word problems form lower secondary level (grade 7 and 8). Visualisations of the 'symbol'- and 'machine'-type were selected from a number of different visualisations. In two different test-versions these visualisations were used as introductory tasks to a test consisting of six percent word problems. A third test-version C (control) received no introductory task. The two test-versions are described below.
The introductory task read as follows:

'Thomas holds a weekly allowance of DM 2.50. Regularly he saves DM 0.50. His friend Peter tells him: 'I save 25% of my allowance'. Who saves the greater amount of money in percent?'

Test-version G received the following visualisation (G = base, W = percentage, and p = rate):

Table 2



The two test-versions G and O represent two different approaches to the use of visualisations in the teaching of mathematics. Approach G considers them more as 'symbols' and emphasizes the geometrical nature of visualisations, whereas approach O bases the effect of visualisation on the concept of the 'operator'. Unequivocally directed arrows are established between magnitudes using operator-arrows, thus trying to build up a sequence of operative steps. The operator-approach and with it the operator-diagram is the conception that has received the widest dissemination in the teaching of ratio and proportion in the secondary school in West-Germany. The test was administered to 600 students of grades 8 and 9 from different types of schools. The students were 13 to 17 years of age. It was recorded which textbook was used by the teachers when they introduced percent. In the mathematics curriculum percent is usually at fist taught in grade 7 and repeated in grade 8 in a more shortened version as 'application of percent'. Grade 8 and 9 were choosen to give to the test problems a definite reproductive character.

Table 3

	Task					
	1	2	3	4	5	6
no answer	1.3	9.4	9.4	7.9	21.7	20.5
wrong	8.9	14.3	53.8	21.1	34.0	42.3
right	89.7	76.3	36.9	71.1	44.3	37.2

Empirical findings

Table 3 shows the total results for the six test problems divided into 'no answer', 'wrong', 'right'. It may give a first impression how task-difficulty was distributed. In task 1 the students were asked to find the percentage, in task 2 to find the rate (the same type of problem as in the introductory task). Task 3 turned out to be the most difficult problem: it was asked, to calculate the reduction rate, given the old price and the reduced price of a dress. Nearly two thirds of the students didn't realize, that they had to subtract the obtained rate of 68% from 100% in order to get the reduction rate. Task 4 required to compute the base value given percentage and rate. Task 5 asked for an increased and task 6 for a decreased base value.
The results show that there is an obvious difference between tasks 1, 2, and 4 on the one side and task 3, 5 and 6 on the other. With tasks 3, 5 and 6 the greater difficulty results from the fact that they require more than the application of the simple routine: match

type of problem and procedure at hand. A two-step operation is required: match type of problem and problem situation given in the verbal description of the word problem, and second select corresponding procedure. The order of the steps may, however, be reversed.

Table 4 shows the results for the different test-group in percent of 'right' answers. This kind of presenting data may be somehow unfamiliar, so that some words of explanation seem appropriate. I have tried to find a way of presenting data that allows a quick orientation and avoids the overload reaction produced by large tables of accumulated numbers. This more 'geometrical' or 'visual' approach is used in modern exploratory data analysis. The visualisation approach used here was inspired by the exploratory data analysis of Bertin (1981). It tries to visualize relations between classes of data by arranging rows and columns of a display in such a way that a gradient of increasing or decreasing intensity results. The area of the single boxes represent 100%. In table 4 the rate of 'right' answers in percent is decreasing from left to right, or in other words: the task difficulty is increasing. The tasks are arranged according to their respective difficulty. Task difficulty increases, too, from top to bottom of the table. One advantage of this kind of data presentation is that 'outliers' are easy to spot. 'Outliers' are results that are not in accordance with the gradient created by the other results. Table 4 shows no striking differences between testversion C, G and O. A Chi-Square-Test showed significant differences only for task 1. In the overall picture, introductory task O seemed to produce slightly better results, and introductory task G seemed to slightly reduce right answers when compared to the control group. It is, however, interesting that the results of task 3 in test-version C are not in accordance with the gradient, but slightly better. It can be said that the results show that the operator-approach produces better results with reproductive tasks. The general results produced with this approach were, however, rather poor with tasks 3, 5 and 6. The geometrical-approach seems to confuse students and was of less help for a reproductive orientation.

An analysis of the answers showed that the students used ten different task approaches, characterized by different forms of visualisation and procedures. Basically this were four different approaches: (1) simple calculation, (2) operator diagrams, (3) percent equation/formula, (4) rule of three. Simple calculation with just writing down the results prevailed, very often with the help of hand held calculators. Table 5 shows the results of the different task approaches in percent of right answers. The 'equation' approach produced the best answers, followed by the 'rule of three' and 'calculation-approach'. The 'operator'-approach turned out to produce the poorest results. That means that the better results of test version O can now be specified: they can't be explained by a superiority of the operator-approach, but must be seen as a result of employing other

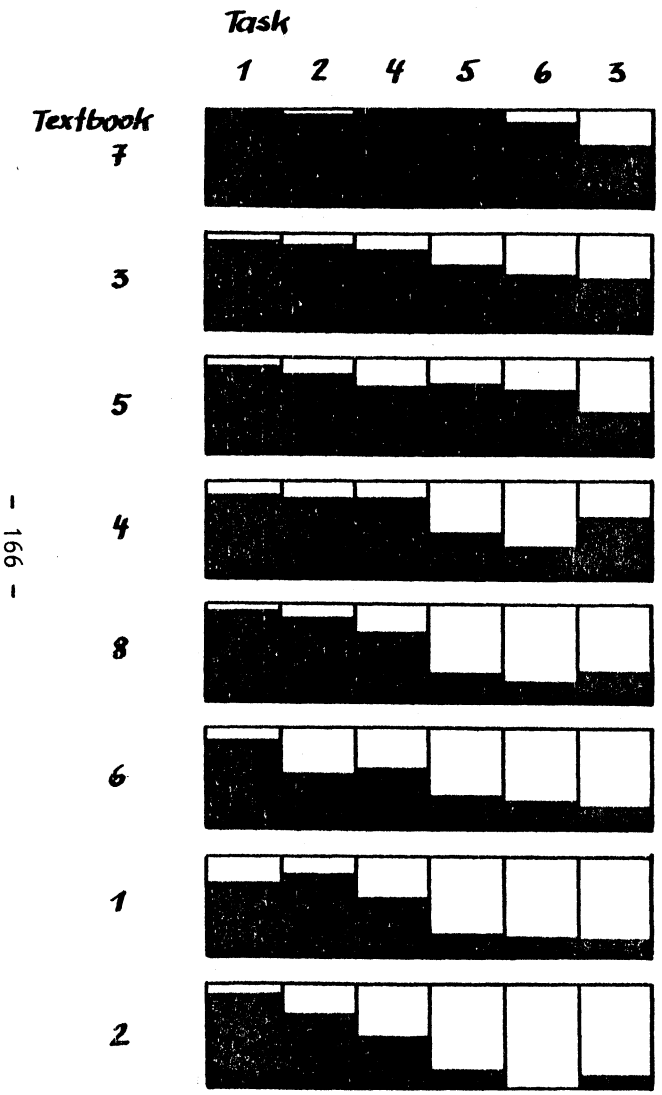


Table 6

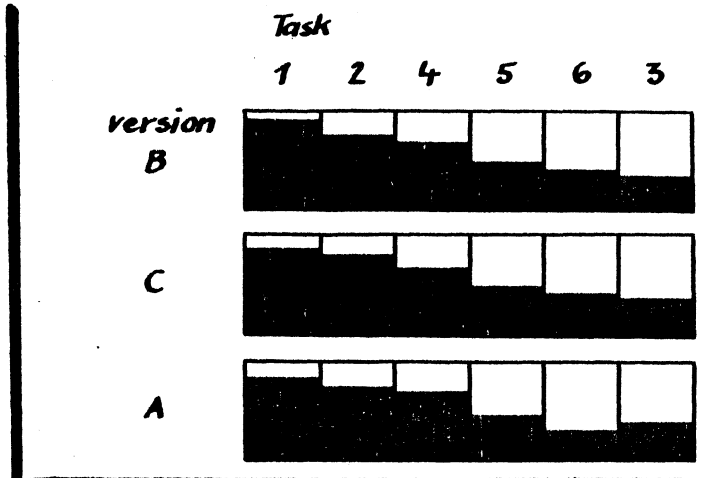


Table 4

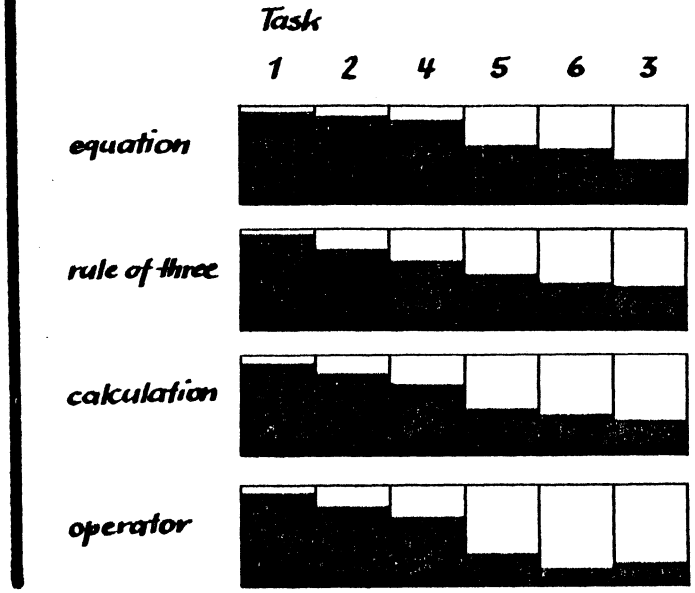


Table 5

task approaches, too.

The students in the sample were taught according to eight different text-books, each employing operator-diagrams. But the differences between the textbooks were deeper than this similarity at the surface. The differences could be noticed at three levels: (1) How the concepts of percent were introduced, (2) if different task approaches were confronted and compared, (3) the extent to which pictorial and graphical visualisations were used.
Table 6 shows the results in percent of right answers for the different textbooks. Beginning at the bottom of the table, we find textbooks 2, 1 and 6 producing the poorest results. These were the textbooks introducing the concept of percent with the help of the operator-diagram, textbook 2 and 6 being the only ones in the sample that taught explicitly procedures and visual arrangements for the pocket calculator. Textbooks 2, 1 and 6 can be said to follow a conception of percent teaching that is completely algorithmic. Going to the top of table 6 we find textbook 7, that introduces percent with the help of the rule of three, followed by an explicit and continuous comparison of three different approaches: 1. rule of three, 2. operator diagram, 3. percent equation. Textbooks 3, 5 and 8, introduced percent with geometrical diagrams like the one in text-version G. Textbook 4 introduced percent with the operator-diagram plus the percent equation, followed by an explicit comparison of three different approaches.
Without going into further detail the results show, that the comparison of different procedures and the introduction of percent with geometrical diagrams are obviously of grater help for the acquisition process than algorithmic approaches.
So textbooks and their use of means of representation seem to make a difference in the successful teaching of percent. But everyone knows that teachers make a difference, too (see Good, Biddle & Brophy, 1975). The effect of textbooks could be an effect of the use of special textbooks by the more effective teachers. But it seems to be true, that teachers follow textbooks especially in questions of visualisations and means, while more or less modifying other contents. Further theoretical and empirical analysis seems appropriate and desirable. The operator diagram so vastly used in the textbooks is possibly not so adequate as has been supposed. The reason may be that the visualisation in the operator diagram is heavily influenced by the machine-metaphor.

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TEACHING THEORETICAL THINKING IN ELEMENTARY SCHOOL: THE USE OF MODELS IN HISTORY/BIOLOGY*

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I. INTRODUCTION

In recent years, there has been an increasing interest in the role of models in learning and instruction. During one year, in cognitive psychology, both Gentner and Stevens (1983) and Johnson-Laird (1983) published a volume titled 'Mental Models'. In instructional research and didactics, works of McDonald-Ross (1979), Moxley (1983), Salzmann & Kohlberg (1983), Schaefer, Trommer & Wenk (1977) and Stachowiak (1980) may be mentioned.
This psychological and educational interest in models was preceded by a long and rich discussion on models in philosophy. The emphasis was on the role of models in scientific thinking and theory construction. Regrettably enough, the present psychological and pedagogical attemps often suffer from an inadequate philosophical and conceptual grounding. In the following, we shall enter the psychological and educational field by first considering some philosophical starting points.

Models in learning activity

Historically, the dominant form of the daily school learning is a very restricted kind of learning (see especially the impressive paper of Fichtner in this volume). We cannot here go into the historical antecedents and preconditions of the emergence of the qualitatively new kind of learning, most thoroughly analyzed by Davydov and his collaborators (cf. Davydov, Lompscher & Markova, 1982) and called by them 'learning activity'. It is here sufficient to note that the quality and structure of learning activity is essentially isomorphic with the quality and structure of genuine theoretical research. '(...) in linguistic analysis, children are

*) The research reported in this paper has been supported by the Research Council of Denmark and by the Academy of Finland.

taught to begin with a specific operation as a result of which related language forms are reproduced. Once these forms are there, the way students study and describe them is essentially similar to the work of the linguist (save, of course, for the variety and complexity of the task being tackled). (...) What a scientist does at his desk is of the same order as what anybody else does when he is engaged in like activities - if he is to achieve understanding. The difference is in degree, not in kind. The schoolboy learning physics is a physicist, and it is easier for him to learn physics behaving like a physicist than doing something else' (Aidarova, 1982, 113).

In learning activity, the text (or the 'subject matter' in general) functions as material for model construction and model concretization. Basically, however, the model is not taken from the textbook in a finished form but rather constructed with the help of analogy, play and fantasy (cf. figure 2 in the next section). '(...) first-graders tackle the initial task of modelling the subject of their research - communication episodes - while play-acting gives a concrete embodiment to the communication model' (Aidarova, 1982, 143). In learning activity, models are constructed and used in investigating the objects of the social life-world. Futhermore, the objects to be investigated are systems encompassing total activities (such as language, or measuring and counting), not separate actions and fragments of the life-world. In traditional school learning, texts (subject-matter) are an end in themselves. They become pseudo objects of the activity of 'school-going'. They are handled in a fragmentary manner (the 'daily text'), leading necessarily to a frozen, compartmentalized storage of knowledge (Engeström, 1981).

II. MODELS IN SCIENTIFIC INQUIRY

In the post-positivist philosophy of science, certain authors have developed a conception of theory construction where models play the central role (see especially Ruben & Wolter, 1969; Harré, 1970; Wartofsky, 1979; Bayertz, 1980). Common to these authors is the idea of science as a socio-historical activity or 'theoretical labor', not simply as a set of concepts, laws and principles. Science as 'general labor' is essentially production of models (Ruben, 1978, 19).
Theoretical activity starts with the constitution of its object. In other words, the object of inquiry is delineated with the help of available previous knowledge concerning the problem domain. This constitution of the object often takes place in a tacit fashion, without the researcher's conscious efforts, as an unreflected projection of the researcher's experiences and conventions. However, the object is never just there, without the constitutive actions of the researcher - an object with no name no figure is no scientifically meaningful object. Another term for this first step is problem identification. We may now sketch this step diagrammatically

as follows.

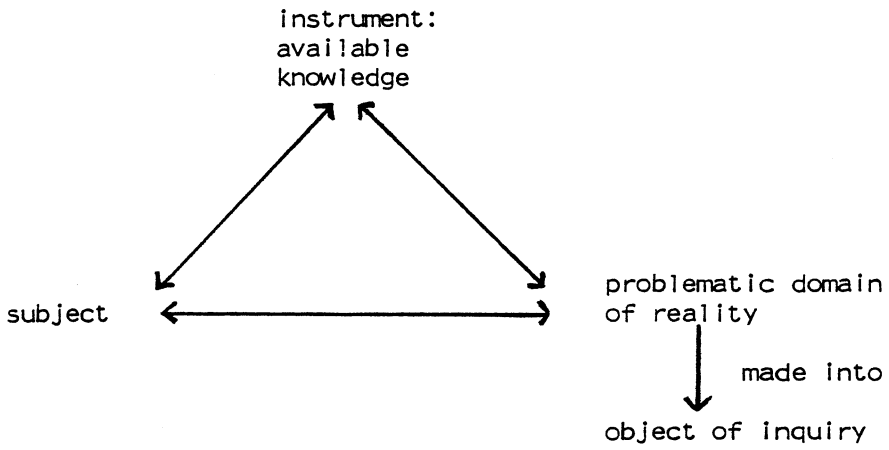


Figure 1. Object constitution or problem identification as the first step of theory construction.

Now this, often tacit or implicit, step does not discriminate between theory construction and any everyday problem solving situation. Theoretical activity differs from other activities in that it constructs a model of the object, attempting to uncover or make visible the hidden relations or regularities behind the observable behavior of the object. This model construction is achieved with the help of analogy. 'Thus, at the heart of a theory are various modelling relations which are types of analogy' (Harré, 1970, 35).
Analogy as an instrument is closely related to play and imagination. In both, the subject is making the 'rules of the game' or the hidden relations of the object transparent and visible through various forms of practical and mental experimentation. '(...) play marks a step forward in the evolution of communication - the crucial step in the discovery of map-territory relations. In primary processes, map and territory are equated; in secondary processes, they can be discriminated. In play, they are both equated and discriminated' (Bateson, 1972, 185).
This second step of theory construction is a step to the realm of 'secondary processes' in Bateson's terminology, i.e. a step to consciously externalized abstractions. This step may be depicted diagrammatically as follows.

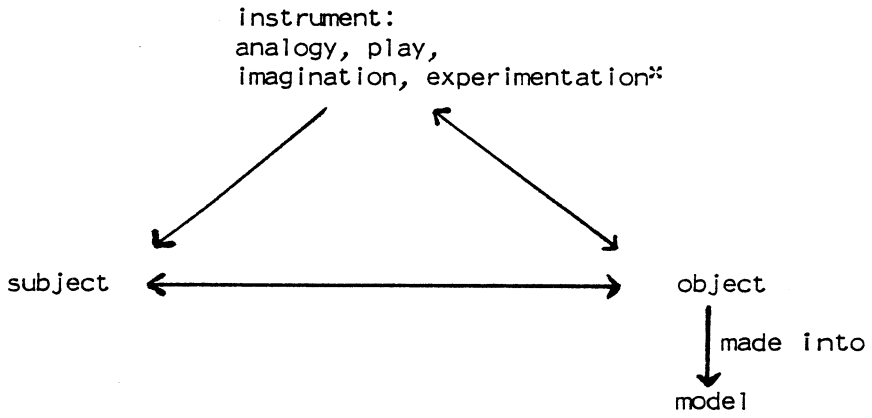


Figure 2. Model construction or initial abstraction as the second step of theory construction.

In this connection, Harré (1970, 13) points out an important difference between two types of models, iconic and sentential: '(...) scientific knowledge consists of knowledge of the structures of which the world consists, and knowledge of how these structures can change, that is of how they can behave. How they do behave depends upon which particular stimuli they suffer. So our knowledge of actual behaviour depends upon knowledge of actual initial conditions. Since this is particular, traditionally it is not considered to be part of scientific knowledge proper. Characteristically, structure is presented diagrammatically (by pictures and models), and the possibilities of change sententially, as conditional statements. By considering only conditional statements, and forgetting the structural 'picture' from which they have been abstracted, one gets the characteristic 'event' view of the world since it is just the successive states of things, but not the things themselves, that conditions describe.'
More generally we may say that theoretical models are attempts at uncovering the general, relatively constant relations (or structure) behind the external behavior of the object, while empirical models are aimed at describing and systematizing the external behavior, change, or also external qualities or properties, of the object. Therefore, theoretical models are iconic and systemic with reciprocal inner relations, while empirical models are typically sequential algorithms or just classificatory hierarchies and definitions (sentential).

*) In Harré's argumentation, this uppermost corner would read 'the source' (Harré, 1970, 37-40), referring to the material upon which the model is based. The object corner of our triangle would be called 'subject', referring to whatever the model represents. These differences are matters of arbitrary nomenclature, not of substantial disagreement.

The model is not yet a full-blown theory. The theoretical model may be considered as an instrument of developing and applying the theory at the same time. The model invites and provokes thought experiments and concretizations. '(...) model is not simply the entity we take as a model but rather the mode of action that such an entity itself represents. In this sense, models are embodiments of purpose and, at the same time, instruments for carrying out such purposes. (...) when we make a schematic model of some complex organism, or make a prototypical model of something we intend to produce - this in itself is an achievement. In a sense, it is a creation of something working toward the future, something which, at the point of making the model or contemplating it, has not yet been achieved' (Wartofsky, 1979, 142).
In this 'working toward the future' the subject applies the model in practice and simultaneously changes it, modifies it into new, more complex developmental forms, builds a theory with the help of the model. This is the third step of theory construction - the step called 'ascending to the concrete' in dialectical logic (Ilyenkov, 1982). In the diagrammatic form it may be depicted as follows.

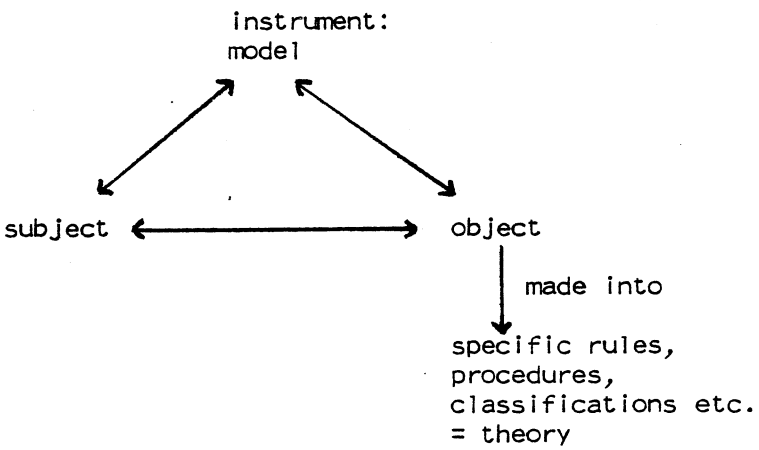


Figure 3. Ascending to the concrete as the third step of theory construction.

As Harré (1970, 54) points out: 'The total theory can be thought of metaphorically as a statement-picture complex. The iconic model is a 'picture' of a possible mechanism for producing the phenomena.' In other words: 'A theory is a relationship of the model to the things the model is supposed to represent' (Jaynes, 1982, 53). Or as Bayertz (1980, 200) puts it: 'Die Hervorhebung der Anwendung eines theoretischen Modells ist ein entscheidender Schritt, um sich von jenem statische Theoriebegriff zu lösen, wie er im hypothetisch-deduktiven Modell seinen deutlichsten Niederschlag fand: Theorien sind eben nicht nur fertige logisch-mathematische Kalküle, sondern sie sind wesentlich theoretische Tätigkeit.'

III. MODELS AS INSTRUCTIONAL TOOLS

Instruction for theoretical thinking follows the logic of ascending from the abstract to the concrete, described in the preceding section. In instruction, this logic is realised in a condensed and guided form. The new model is constructed through a series of tasks set by the teacher and with the help of information provided by the teacher.
In practical terms, this means that the general, genetically initial concepts must be constructed and learned before the specific concepts and manifestations of the system under scrutiny. The latter must derived from and connected with the former with the help of explicit models. These models must be express the general and developmentally decisive relations of the subject matter area. In the models, these relations manifest themselves graphically or symbolically in 'pure form', freed from arbitrary details.
The foremost task of a formative instructional program, aimed at qualitative changes in the thinking of the pupils, is to work out a model of the fundamental conceptual relations upon which the theory and practice of the subject matter can be built (cf. Davydov 1977).

Models as instructional tools can be hierarchically classified according to their structural quality and explanatory power. The following five types may be discerned (Engeström, 1983).:

1. Spontaneous models. A single case can function as a model of a whole class of phenomena. This occurs frequently in everyday communication. In instruction, this is the most common kind of model usage: the pupils pick up examples and details from the teaching and use them as models of subject matter area covered. Such models are not based on consciously elaborated criteria - they often take the form of vivid nonverbal images.
2. Classification models. Common attributes of phenomena function as basis for their classification and hierarchization in model form. The most well-known attempt to use this type of models in instructional theory and practice are Ausubel's advance organizers (Ausubel, Novak & Hanesian, 1978). Models of this type are essentially static and nominalistic.
3. Procedural models. Sequences of procedures for action or for decision-making are worked out in the form of algorithms or heuristic rules. The instructional theories of Landa (1969) and Scandura (1980) are typical examples. Models of this type are inherently specific because of their uni-dimensional character. The more general they are made, the less substantial explanatory power they retain.
4. Systems models. The inner components and internal reciprocal relations of systems are analyzed and described. This type of model usage is widespread in the instructional practice of natu-

ral sciences and technology. However, these models are mainly borrowed as 'finished artifacts' from the established findings of the sciences, not worked out within the framework of some psychological, instructional and epistemological theories of the learning actions or cognitive processes needed for the construction and application of models of this type. Even the Piagetian theory has very little to say about the learning and construction of substantial systems models. In any case, models of this type enable us to diagnose and plan changes within the given system. Systems models invite us to seek the equilibrium of the system and to eliminate its disturbances. The qualitative development of the system itself can hardly be grasped with the help of these models.

5. Germ-cell models. This model type, theoretically elaborated by Davydov (1977), aims at disclosing the inner source of qualitative development of the system itself. This inner source is the historico-genetically original simple relationship, the initial contradiction that has given rise to the system and continues to function as its core.

Spontaneous models, classification models and procedural models fall into the more general category of empirical models. Systems models represent a transition from empirical to theoretical models. Germ-cell models demand truly theoretical thinking both in construction and in application.
However, theoretical thinking requires movement between the different types of models. More exactly, theoretical thinking means an ability to derive lower level models from higher level models and to work out new higher level models as the available lower level models lead into conflicts that cannot be solved with the existing higher level models.
Furthermore, theoretical thinking requires conscious movement from external to internal models and vice versa. Models exist simultaneously as cultural, material artifacts and as individual mental structures. The tension-laden movement between these spheres is the object of theoretical consciousness.

The germ-cell model

A germ-cell model is instructionally and psychologically exceptionally powerful. Through it, the subject matter area appears as an integrated whole. This, however, requires that the pupils discover and follow the logic of the subject matter itself, realizing how it unfolds and evolves into more complex forms and manifestations from its initial relation.
In order to understand how development has preceeded form the historical origin to the present manifestations, we need a model through which the tensions and conflicts that have forced that development forward can be analyzed. In other words, the germ-cell model is a unity of moments which both depend upon and rival each

other (complementarity). It is by working out the tensions and conflicts between the moments that it becomes possible to explain the development of the system (subject matter area) under scrutiny.
The germ-cell model must not be presented to the pupils as finished, pre-packaged knowledge. To the contrary, the pupils must uncover the necessary conditions of the origination of the system through their own actions. The teacher helps the pupils to reproduce these conditions in the form of a model. The model is constantly tested, transformed and developed further as the pupils follow the developmental logic of the system modelled. This means that the pupils are not only taught a specific model and the corresponding content area; they are also taught to construct and apply models independently, to trust their own ability to find out and crystallize the invisible governing ideas of any branch of knowledge and activity.

IV. THE TEACHING EXPERIMENT IN HISTORY/BIOLOGY

The teaching experiment reported here took place in a Danish primary school, in a 5th grade class in a subject called 'orientation'. This subject comprises elementary history and elementary biology. It is taught from the third grade to the fifth grade. The official curriculum for this subject is very loose, to the point of vagueness. Thus, the teacher is free to choose the order of the topics dealt with in his/her class as well as the materials employed. Our experimental teaching lasted for three months. We are currently (school year 1984-85) carrying out a more comprehensive instructional experiment in a third grade class, based on the findings of the first program. The more comprehensive program will extend over the whole third grade and eventually over grades 3 to 5.
In history, it is not very common to think with explicitly externalized models. 'Historians as a profession are not given to constructing or employing models in any formal or explicit sense; where they do, it is mainly in areas bordering on other disciplines, especially economics and social studies. Most historians, if asked, would probably deny that models had anything to do with their subject. In that they would, I believe, mistaken. (...) a historian could hardly put pen to paper without having an implicit model of what he was studying. The reason for this apparent discrepancy between percept and practice lies in the seemingly empirical nature of history' (Leff, 1972, 148).
Leff goes on to show that historians do need at least three kinds of models: firstly models dealing with the specific set of historical events studied, secondly more general categories essential to the given epoch, and thirdly models of epochal periodization. Leff (1972, 153-154) then goes one step further: 'Ultimately his (the historian's) outlook must be founded upon his notion of what man is, what he takes to be right and wrong, progress and regress, and so on. (...) in that sense the historian's model of man and his values combine to provide his model of history.'

We think that it is essential to begin building up historical thinking just from the historical model of man. In this endeavour, the combination of biology and history into one single school subject is ideal. The cultural essence of man as a tool-making animal can be derived from the natural history of man's appearance.
In recent literature, some examples can be found of the use of explicit models in history teaching. One such example is the work of Armbruster & Anderson (1984) on what they call 'frames for history'. The authors suggest that certain very general frames - or model - of historical explanation should be used in teaching and evaluation. They present two such frames, namely the 'Goal frame' and the 'Problem/Solution frame'. These are schmatically depicted as follows.

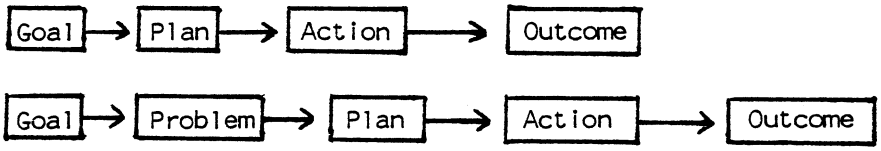


Figure 4. The Goal frame and the Problem/Solution frame for history (according to Armbruster & Anderson, 1984).

Against the background of our classification of models, presented above in section III, it is easy to notice that these frames belong to procedural models (algorithms or heuristic rules). There is nothing specifically historical in these models. They could be used as aids in the analysis and description of any human (and possibly animal) event, within any social, behavioral and human sciences. As so many general heuristics, they are very close to plain common sense thinking. They might be useful in the systematization of the subject matter and pupil tasks - but they do not lead us one step closer to the substantial essence of history.
It is noteworthy that explicit models are very actively used in biology teaching (see e.g. Schaefer, Trommer & Wenk, 1977; Stöhr, 1981). The most common examples are the various models of food chains and ecological systems, as well as those of cells. Such systems models are undoubtedly useful, especially if they are not just given to the pupils in finished form but constructed through active systems analysis. They suffer, however, from the general limitation of systems models: the qualitative change and evolution of the system itself cannot be explained through them. And it is just this kind of a problem we wanted to attack in our experimental teaching.

The aim of our teaching program was to give the pupils an insight into how human history is connected to natural history, while being at the same time different from it. Instead of a standard textbook, the following materials were used:
1. A film about how chimpanzees adapt to changed living conditions.

2. Reading material on the chimpanzees' natural living conditions.
3. A children's book about life in a pre-historic tribe (the Fire People). Further reading material on archeological findings upon which knowledge about the pre-historical man's life is based.
4. Film about a primitive African tribe - the Kung People.
5. Reading material on the Eskimoes' way of life.
6. Film about the Eskimoes' way of life.

The teaching experiment was evaluated and recorded through participant observation in the classroom. Also the pupils solutions to the various tasks given during the experiment were collected and evaluated. More rigorous methods of data collection and analysis are applied in the more comprehensive teaching experiment currently in progress.
In the following, we shall differentiate between three broad types of model usage in our teaching experiment. The first usage is the creation and application of germ-cell models for the subject matter. The second usage is the fixation of the pupils' action sequences in instruction through a procedural model. And the third usage is the modelling of the structure of the pupils' learning activity on the basis of a germ-cell model.

Germ-cell models for the subject matter in history/biology

In this instruction, it was the explanation of the jump from passive biological adaptation to the environment, over active social adaptation to transformation of the environment, that was the starting abstraction for the work with the history of man. Instruction centered around the development from hominids to primitive man and to the arising of the first historical society. Likewise, reconstruction based on archeological finds and analogy to present society were introduced as the historical methods.
In the instruction, the children have been given tasks, whereby it should have been possible to formulate a germ-cell model for natural history and the history of man.
The germ-cell model was built up and articulated through instruction tasks in the following sequence:

1. The history of man builds on natural history. On the basis of this, the problem is established which is concerned with the transition from natural history to the history of man and how the first humans lived.
2. Thereby the first elements in the germ-cell model are built up, which characterize the prehuman biological adaptation niveau in human developmental history.
3. These elements vary so that there takes place analysis of the connection in the surroundings with connections in the living conditions of anthropoids.

The tasks resulted in the formulation of model A (Figure 5).

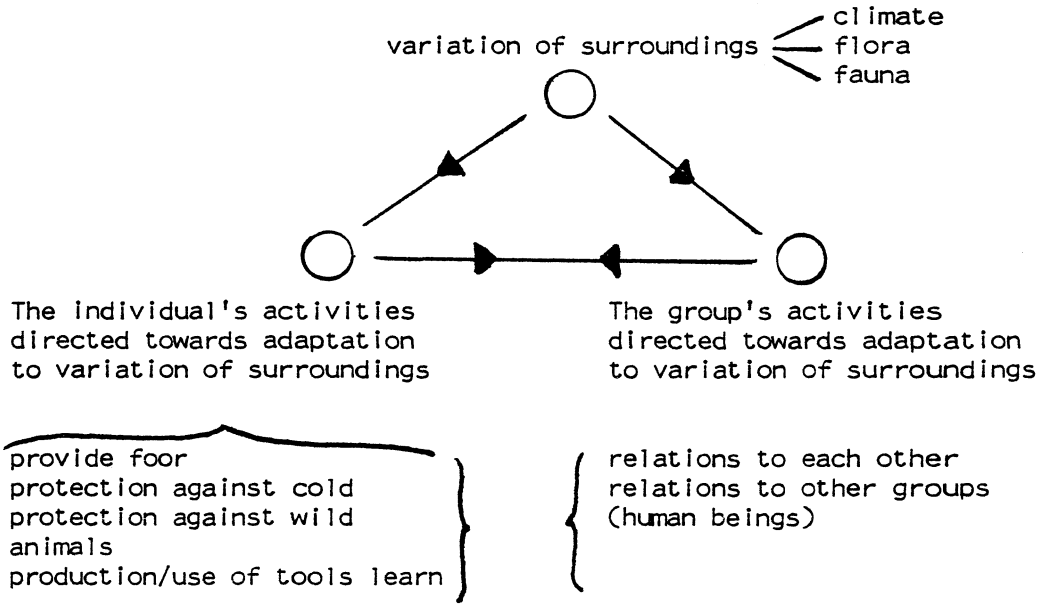


Figure 5. Model A: Passive biological adaption.

The tasks were continued according to the following steps:

4. The qualitative jump from anthropoid to primitive man is incorporated into the model, so that man, as a user and producer of tools, is included in it.
5. The dependence of the methods on knowledge is introduced through explication of historical knowledge about primitive man through reconstruction based on archeological finds and through analogy to existing primitive tribes.
6. The model is further expanded through use of the analogy method to explain the jumps that took place from anthropoids to man through mankind's gradual development of tool production. With the help of the model it is emphasized that the relation between the environment and the individual/group in historical time is no longer biologically determined, but is determined by the collective practice/production that tool use entails.

The model could now be developed further as shown in figure 6.

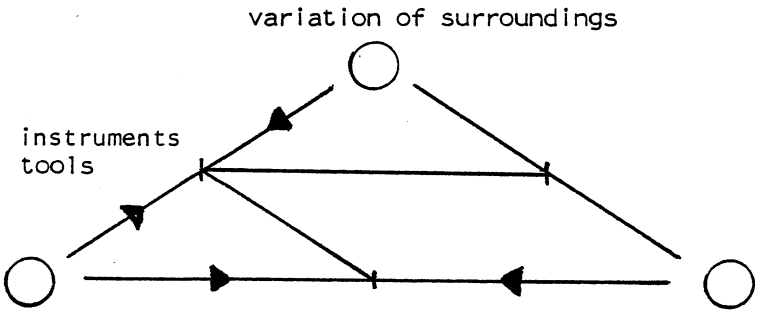


Figure 6. Model B: Passive social adaptation.

Three more steps were required for the completion of the model:

7. Continued clarification of the significance of tools for change of man's relation to the surroundings, so that it is changed from an adaptation process to a production process.
8. The dynamic relations in the model between environmental conditions and the organization of society is brought out through the setting of tasks which focus on the significance of man's acquisition of the production of work tools for the arisal of rules and the division of labour. This is the basis for the first features of society.
9. The task should now make it possible to work out that it is not only man's living conditions that determine the organization of society, but that this relation is mutually dynamic.

The children should now have acquired an understanding of relationship such as those shown in figure 7.

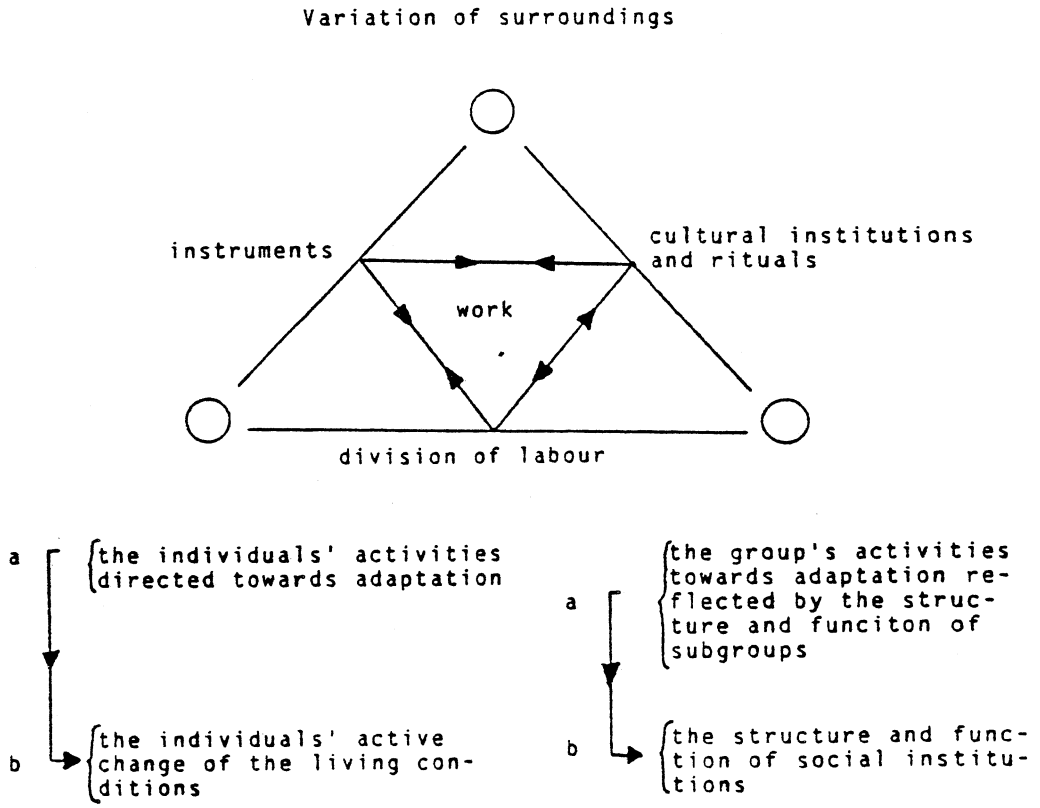
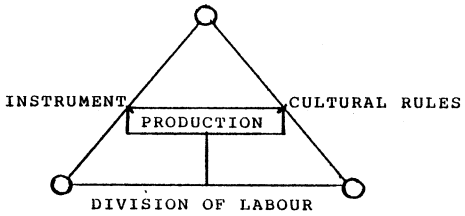


Figure 7. Model C: Active social adaptation/transformation.

Figure 8 summarizes the steps we took in our experimental instruction to construct and apply the germ-cell model of man's origination.



		USE OF INSTRUMENTS	PRODUCTION	DIVISION OF LABOUR	RELATION SURROUNDINGS - LIFE-CONDITIONS
1	APES	INCIDENTAL USE OF INSTRUMENTS	NO KNOWLEDGE	INCIDENTAL BIOLOGICALLY DETERMINED DIVISION OF LABOUR	BIOLOGICAL ADAPTATION
2	THE FIRE PEOPLE	BEGINNING SYSTEMATIC USE OF INSTRUMENTS	BEGINNING KNOWLEDGE, BUT NO PRODUCTION OF INSTRUMENTS	BEGINNING DIVISION OF LABOUR - BIOLOGICALLY MAN - WOMAN, THE STRONGEST	SOCIAL PASSIVE ADAPTATION
3	THE KUNG PEOPLE	SYTEMATIC USE OF INSTRUMENTS	KNOWLEDGE OF AND PRODUCTION OF INSTRUMENTS	DIVISION OF LABOUR MAN - WOMAN OLD - YOUNG	BEGINNING SOCIAL ACTIVE ADAPTATION/TRANSFORMATION
4	ESKIMOS	WELL-DEVELOPED USE OF INSTRUMENTS	PRODUCTION MAXIMAL UNDER THE CIRCUM-STANCES GIVEN	BEGINNING DIVISION OF LABOUR ACCORDING TO SKILL	ACTIVE SOCIAL ADAPTATION/TRANSFORMATION

METHOD: VARIATION OF THE MODEL ON THE BASIS OF THE USE OF INSTRUMENTS AND PRODUCTION

FIGURE 8. THE DEVELOPMENTAL STEPS OF THE GERM-CELL MODEL

Procedural model for the pupils' action sequence

In this instruction, a model for scientific work was employed as a supporting model, the inspiration for which we got from Aidarova (1982, 126-138), but which was apparently only employed as an initiation into working scientifically with language.
Aidarova seems only to have worked with it as a once-only sequence to get the pupils to understand the goal, the means and the way in which they had to work during her instruction (p. 126). We, on the other hand, used it as a supporting model for the pupil's work with the carrying out of the variations that characterized each of the elements in our germ-cell model for 'the origin of man'.
This kind of supporting model falls into the category of procedural models. It seems to be a necessary instrument for the construction of the germ-cell model. Note that in section II (Figure 2) we pointed out experimentation as one instrument of theoretical model building. Our supporting model is a kind of explicit tool for experimentation in the wide sense of the word.

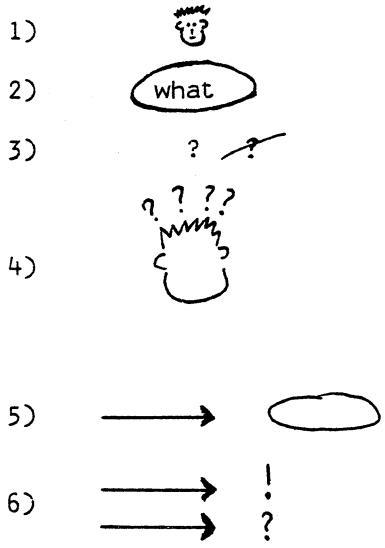
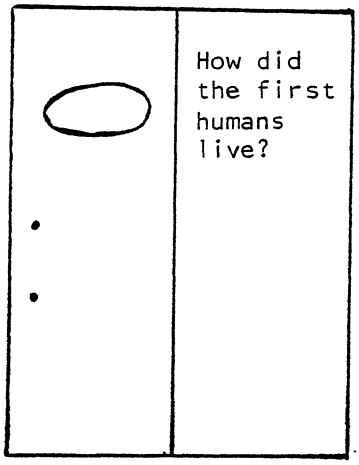


Figure 9. Procedural model of scientific work.

To illustrate how we work with this model, an extract of the description of the fifth lesson is presented below.
Through class-dialogue the children have progressed as far as the supporting model in the first lesson. Furthermore, they have seen a film about chimpanzees that are placed on an island near Estonia.

The children have not yet been informed of the task in connection with the film. In the following, the teacher attempts to get the children to employ the supporting model in the concrete problem area 'the origin of man'.

E.: 'What was our theme for investigation today?'



Peter: 'How man entered into the world and some believe that it was apes.'

Lars: 'Then all we would have to do was to get hold of a time machine.'

Esben says that that was right. 'Now, you must write in your notebooks, just like me.'

'What did we use the last time to investigate the problem?'

Bibi: 'We saw that the apes lived almost like some people.'

E.: 'That is to say, we used the apes.'

Henrik: 'It's almost 90% certain that we are descended from the apes; but that's not 100% sure. We don't know. We may just as well be descended from the giraffes.'

E. explains that 200 years ago people believed what was in the bible. E. tells them about the creation. Then it was discovered that it could not be right.

Bibi: 'No, because why could we have children, then?'

E.: 'No, but fossils were found and remains of skeletons.'

Bibi: 'From an ape, that is.'

Henrik: 'Therefore, it is not completely definite.'

E.: 'We saw that the bones from earlier archeological finds looked more and more like apes' bones, but not completely.'

Henrik: 'No, it's not 100% definite.'

Bibi: 'But why were there dinosaurs and why aren't they alive today?'

Tommy: 'People went and shot them'.

Henrik: 'I saw a dinosaur at the museum that was caught in a trap and people who threw spears at it.'

E.: 'It probably wasn't a dinosaur because no humans lived at the time they lived.'

Bjarne tells about the Super Nova. That is probably why the dinosaurs don't live any more.

The children are very eager to be allowed to tell.

Bibi tells that a crocodile is a very old animal but that they still live.

(The children tell so fast that I cannot follow).

Child: 'The Loch-Ness monster is also a dinosaur.'

Bjarne tells about a meteor.

Esben: 'There are three who have their hands up; after them we'll stop.'

Peter tells that elephants looked different in the past.

Esben: 'We have touched a little on why we use apes: Because their way of life is a little bit like the humans' way of life. All we still need to investigate is what we know something about and what we don't know anything about.'

The children are informed that we must now take our second sheet of paper.

Esben instructs the children to write

About apes

~~?~~	?

down what they know and what they do not know about the apes' way of life. The children have 10 minutes.

The second lesson

Esben asks Dorthe - 'What have you written?'

Esben writes the answers on the blackboard.

Henrik won't say anything because Esben is writing down what Dorthe is saying; he says it's not true, but gives in.

Helle

Annemette and Duy don't have anything

Tine

Esben reacts with: 'What does it mean to be clever?'

Peter:

Pernille:

Tanja wants to make a comment, but cannot remember it. Esben really wants to call the apes' intelligence in question.

WHAT DO WE KNOW ?

Humans are descended from the apes.

Apes use tools.

The apes gradually became less and less shy of humans.

They like sweet things

They are better at climbing trees than humans.

Apes make weapons of wood, stone and bones.

Apes are more clever than humans

They like fruits and roots.

They can sleep in trees

They can swim, some of them.

Esben interrupts because there is a great deal of disturbance in the class.

Jeanette has to speak for everyone at her table (4 girls).

They are very clever.

They can believe, when they look at themselves in a mirror, that it is another. - Remembers that those are the males, but that the females recognize themselves.

They do not recognize themselves when they look in a mirror.

Children's answers form their groupwork

WHAT DO WE NOT KNOW ?

(Esben has a broken leg and walks with the aid of crutches)

Can apes walk with crutches?

Esben gets the children to talk about being tame.

Are apes shy of people in their natural surroundings?

What weapons and tools do apes make?

Are they more clever than people at some things?

Do apes have enemies?

Can apes learn to read?

Why and how did some apes develop into humans?

Can apes draw?

Do apes have their own language?

Modelling the pupils' learning activity

The goals of instruction in relation to the individual pupil is to generate the special motive that characterizes human learning activity, the theoretical relation to reality (Davydov, 1982, 19). This motive can result through the pupil's active occupation with the subjects content in the form of task-sequences. When the motive has arisen, it will later effect a guiding influence in the pupil's active working out and seeking out of tasks. Therefore, this motive

both becomes a goal and embraces the content of the pupil's learning activity. The building up of this motive takes place via reflection about the vontent of the instruction and the pupil's own cognitive process. It is therefore that the application of models which make possible the pupil's focusing on steps of the cognitive process are so important in this area.
The structure of learning activity has been presented graphically by Engeström in the following way (1983, 11).

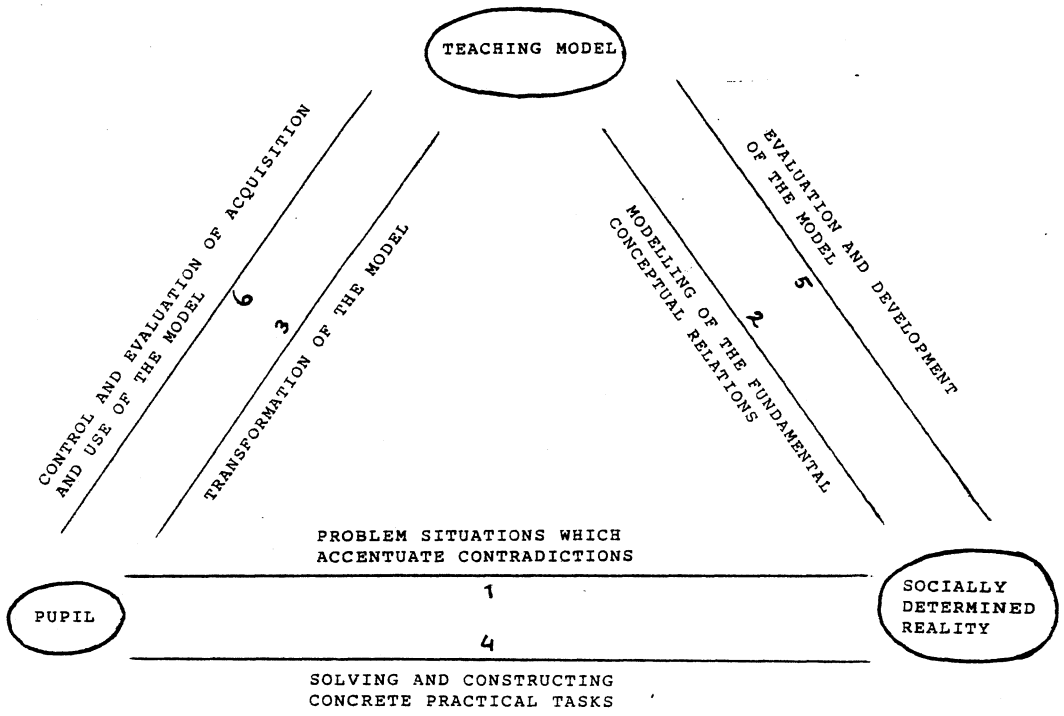


FIGURE 10. MODEL OF THE STUCTURE OF LEARNING ACTIVITY

During the 30 lessons of our experimental instruction, we managed to get through the first three steps depicted in the model of figure 10. The course of tasks used in the experiment was the following.

1a) Tasks in which transformation was required in order to elucidate the fundamental concept relations

The pupils were given tasks which showed that the living conditions of apes/anthropoids had a connection with variations in the surroundings. With this the fundamental concept relations between surroundings - living conditions and group acti-

vity were introduced.
The problem areas covered here were the following:

1. What is history?
   How did the first humans live?
   Why and how did they develop into the kind of humans we have today?
   Have there always been humans?
   Where and how do apes live?
   In what ways are they different from humans?
   What significance does change of surroundings have for apes' way of life (film about chimpanzees)?
2. Can apes exist in other surroundings than their natural surroundings?
   Conflict: Can they live on Greenland?
   Specification of the fact that variation in surroundings influences individual's living conditions and the group's activity.
3. Elaboration of variation in surroundings.
   How does it influence living conditions and the group's activity?
   These categories are analysed.
   What can apes do that humans can also do and what can't they do if they are to survive?

1b) Tasks that required analysis and comparison of features, so that the elements of the model became clarified

The pupils were given the task of analysing how variations in environmental conditions brought about different conditions for survival for apes and primitive man.
The survival requirement's necessitation of tool use by primitive man was clarified.
The problem areas covered by this instruction period were the following:

1. Primitive man was introduced (the story of the fire people).
   Primitive man's living conditions and group activity are analysed.
   Tool's significance for the improvement of living conditions are analysed.
   The arisal of division of labour, on the basis of the change in production conditions brought about by tools, is analysed.
   If the surroundings and production relations are changed, what significance does this have for man's way of life and the group's activity?
   The answers are summarized in the model.
   The method for acquiring knowledge about history is focussed on: archeological findings and analogy.
2. The method is discussed.
   Archeological findings and analogy (material about archeological findings + film about the Kung people is shown).

Relation between method and what we can find out about primitive man's living conditions is focussed on.

2) Tasks through which the presentation of the fundamental concept relations in model form, was made possible

The pupils were given tasks, by means of which differences in connection between surroundings, living conditions and the group's/society's activity were clarified as being dependent on tool production.
The problem areas covered by this instruction period, were the following:

1. The model is changed and developed by relating the living conditions and group activity of apes, the fire people and the Kung people.
2. Model variations are elaborated through the inclusion of eskimoes (the analogy method).
   The significance of tools is elaborated.
   The struggle to survive necessitated tools.
   The passing of knowledge connected to tools necessitates the group.

3) Tasks by means of which the model is transformed

The pupils were given tasks, by means of which differences among human groups (primitive man - primitive tribes (Kung) eskimoes) tool use was introduced in such a way that the significance of this variation for the other areas covered by the model (surroundings, living conditions, the group's activity) could be elucidated and developed.
The problem areas covered by this instruction period were the following:

1. Variations in the society's organization are explained through clarification of the connection with variations in man's living conditions. The mutual influence that takes place here as a result of division of labour is introduced.
2. What significance does society have for man's living conditions?
   An eskimo from a sealer society comes to Denmark.
   What does this mean with respect to changes in his living conditions?
   The dialectic between living conditions and society is explained.

Changes in quality of the classroom life

The instruction in history/biology in our experimental class was observed for several weeks before the teaching experiment started. In reading the detailed observation protocols, we find certain qualitative shifts in the course of instructional events within

the classroom. These very priliminary findings have prompted us to focus on these aspects of the classroom life in a more systematic manner during our more comprehensive teaching experiment in 1984-85. Certainly we cannot claim that these changes are direct results of the experimental teaching. Many aspects of them may be temporary artifacts created by the research situation. Yet these findings seem to be worth mentioning as impulses for further elaboration.

1) The children's comments are more in connection with the instruction than was the case earlier (irrelevant and distracting comments are less frequent).
2) The children anticipate the course of the instruction in their comments (more anticipating comments come from the children).
3) The children, when they think that the teacher is sidetracking, keep him on the subject (they take over aspects of the teacher's function of making sure that the themes that are included are relevant).
4) More 'why' questions are asked. The children require reasons for what the teacher sets them tasks in, in relation to the goal of the instruction, i.e. 'clarification of the origin of man'.
5) The children show positive intellectual surprise at results and solutions which they have not had any knowledge of.
6) The children criticize the model.
7) The children display spontaneous dialectical understanding. They look for relations rather than categorial solutions.
8) An increase in the children's fantasy and idea production in relation to those themes they are occupied with.
9) The children cooperate more.

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LEARNING PROBLEMS OF BRIGHT CHILDREN IN MOTHER-TONGUE CLASSES

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Introduction

The finnish comprehensive school is now eleven years old. The purpose of this new education system was to standardise the basic education of a certain age group. This purpose has been understood to mean that the learning conditions of pupils with learning difficulties must be improved. Thus the central themes in educational discussion have been differentiation, remedial teaching and minimum competency standards.
Many teachers and parents have been doubtful about the succes of the comprehensive school. This type of education has been blamed for supressing creative thinking and neglecting bright children. Thus, interest has been aroused in recent years in the alternative educational programmes of Steiner, Montessori and Freinet.
Descriptions of classroom discourse in finnish schools have been obtained by using Flanders' interaction analysis and its finnish variant DPA-analysis. We know that classroom instruction is teacher-directed. The finnish teacher speaks twice as much as his pupils in all. The verbal interaction is such that pupils seldom have need to reflect upon and search for causes, effects and values. Therefore one of the main goals of teacher education and teachers' in-service training has been guidance to pupil-centred teaching methods. These methods should increase creative activity in classrooms and give pupils the possibility for using language as a medium for formula ting thoughts and ideas.
Teacher education in Finland takes place in universities and practice teaching occurs in special demonstration schools which belong to universities. The aim of the university education is to guarantee a high standard of teacher education.

The object of this research

This paper is a report on research concerned with supervised practice teaching in demonstration schools. The aim is to find out how the child's creative activity is taken into consideration during lessons of student teachers.

The child can naturally be creative in many ways. In this research

creativity is defined very strictly. It is understood as a positive activity of the pupil, as an activity which the pupil directs to the subject matter of the lesson. This means that the pupil asks the teacher to explain the theme or tell more about it or the pupil wants to tell the teacher and other pupils something new about the subject matter. The pupil thus interrupts the lesson in positive sense and is not simply answering questions presented to him or her, keeping silent or disturbing the lesson.

As a teacher educator I observed 64 mother-tongue lessons in the two demonstration schools of Helsinki University in spring 1984. The lessons were part of the final training period of twenty student teachers. I followed at least three lessons from every student teacher. The lessons were supervised by a college supervisor. There are eight supervisors in mother-tongue and I observed all eight. The supervisors I graded the teaching skill of the student teachers at the end of the spring on a scale of 1 to 5 (5 is maximum). 12 students got 3 and 8 students 4. We thus regarded them as 'good' or 'very good' mother-tongue teachers.

The lessons I observed were at the upper stage of the comprehensive school and in the senior high school.

Table 1: Distribution of the lessons being observed

Comprehensive school			Senior high school		
7th class	8th class	9th class	1th class	2th class	3th class
14	17	16	8	9	-
total 47 lessons			total 17 lessons		

Pupil's questions were incredibly few, only five. Pupils asked questions twice in the 7th class, twice in the 8th class and once in the 9th class. The subject matter of all these lessons was grammar, and two of the lessons were just before an examination. There were no questions in the senior high school classes.

The passive role of the pupils has also been observed in other researches. Karavuori (1982) has analysed videotaped recordings of lessons in the 7th class. Het method is discourse analysis, developed by Sinclair and Coulthard. She writes: 'Pupils spontaneous speech during the lessons is insignificant. It is uncommon that the pupil asks something which is connected with the topic of the lesson. The teacher usually does not hear such a question or at least does not react to it. Reactions are connected to the lesson plan. On the

other hand the pupil has a right to ask about the way of acting during the lessons and the teacher is very ready to answer these questions.' Leiwo, Kuusinen and Kuusisto (1981) described classroom discourse in the same way.

When are the pupils active?

The pupils asked questions about the subject matter of the lesson only five times during the 64 lessons. These cases are as follows:

Case 1
The topic of the lesson in the 8th class was infinitive form of the verb. The pupil asked the student teacher to explain words nominal, nominative and nominal form of the verb. She was not sure what these words meant exactly.
The student teacher reviewed the concepts.

Case 2
The topic of the lesson in the 7th class was sentence analysis. The pupil had difficulties at first in distinguishing the attribute form the predicative complement. Then he could not understand the example sentence in which the infinitive form of the verb had an attribute. He said he had learned that the main word of the attribute is a substantive, not a verb.
The student teacher did not review attribute or predicate complement nor did she explain the possibilities of using the infinitive form of the verb as a substantive. She analysed the example sentence herself.

Case 3
The topic of the lesson in the 9th class was the participle form of the verb. One of the example verbs was to be. It lacks some forms. The pupil wanted to get all the forms onto the table which was made during the lesson.
The student teacher could not explain the lack of these forms. The supervisor interrupted the lesson and said that those forms don't exist for the verb to be. They would sound strange to our ears.

Case 4
The topic of the lesson in the 7th class was the partitive case. The pupil wondered aloud what would be an example word in which the root changed.
The student teacher did not react. Afterwards she said she had not heard the pupil's comment. The pupil was however sitting just in front of the teacher's desk.

Case 5
The topic of the lesson in the 8th class was negation. The student teacher used sentences like There was no trouble, These advices don't cost anything as examples of negative sentences. The pupil

asked the student teacher how this could be possible. Both sentences were affirmative: there was no trouble and the advices didn't cost anything.
The student teacher answered that the sentences were negative. Later on she explained the difference between the formal and the semantic negation but didn't refer to the pupil's previous notice.

The pupil questions seem to be very detailed. Yet they are central questions or could easily be remodelled as such, from a linguistic point of view. In no case did the student teacher or the supervisor want to continue or to widen the discussion.
In the first, second and third case the problem is the infinite forms of the verb. In the finnish language, the verb is not only conjugated but also declinated like substantives. The infinite - forms are first analysed at the upper stage of the comprehensive school. Until that time the pupils have learned only to recognize the verb as a word that informes us of an action or a state and is conjugated. This kind of basic orientation is obviously not adequate enough. It is difficult to widen it to include the infinitive forms also, which are near substantives and adjectives. The infinitive forms are not recognized later either. In a test a group of elementary school student teachers recognized 100% of the finite verb forms in example sentences but only 61% of the infinitive and 45% of the participles (Tuominen, 1984).
In the fourth case the pupil was interested in changes in the root of the word. The example word was mäki (hill) and its partitive case mäki/ä. The third variant of the root is in the genetive case mäe/n. This kind of phonetic alternation is typical to finnish. The systematic analysis of this phenomenon has been removed from the curriculum of the comprehensive school.
In the fifth case the problem was negation, which could be handled more thoroughly as a semantic and contextual phenomenon.

The reaction of the student teachers seems to be different in every case.
In the first case the student teacher reviewed the matter. The supervisor's feedback was very critical: there was no need to explain old things. The pupil would have recalled the concepts to mind after a while during the lesson. The repetition ruined the lesson plan of the student teacher and that was not a good thing.
In the second case the guidance which the student gave to the pupil was incoherent and she gave the answer herself in the end.
The pupil: Why is the word tender (hellä) not an attribute?
I have not got any answer yet. Is to open not a verb?
I don't understand.
The student
teacher : Is there something which has remained mysterious?

The pupil: No.

The student
teacher : Say predicate: We have yet many important things!

The pupil : Well, let it be. I don't know.

The student
teacher : You ought to say. How do you ask the word tender, Tero? Which were tender or what? Think everybody.

The pupil : Indeed, an adverbial phrase.

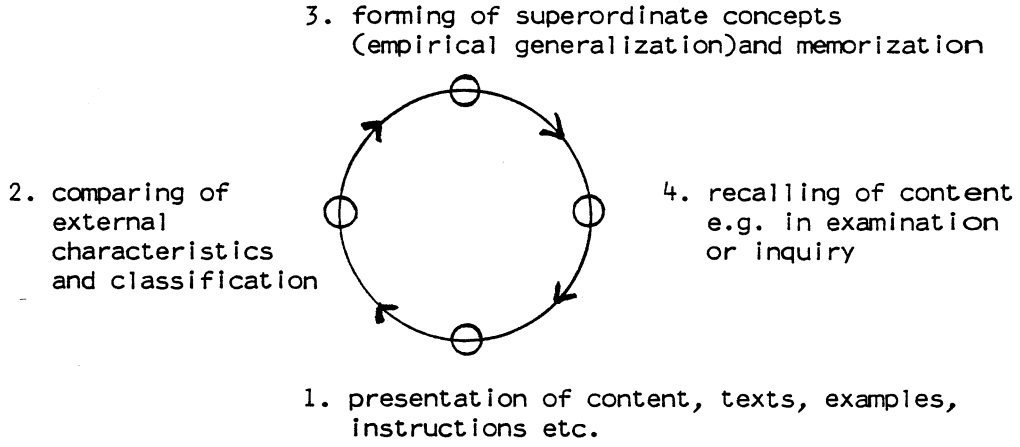
The student
teacher : How - or what kind? What were fingers like? What was the name of that part of the sentence? It was a predicate complement.
An another
pupil : Sorry Tero, take it easy.
(The student teacher then quickly takes out a new overhead with new exercises.)

In the third case the student could not answer the pupil's question. The supervisor answered but assured the class that there was no problem. She could have explained that the verb to be was intransitive and the grammatical forms which the pupil asked, are logically impossible with such verbs. The other examples at the table were transitive verbs. Het explanation, that they would sound strange to our ears, was too simple.
In the fourth case the student teacher didn't hear the pupil's wondering.
In the fifth case the student teacher didn't react because she didn't want to change the lesson plan.
In other words - in every case the student teacher avoided the issue. The pupil either did not get the correct answer, or she should not be given it according to the supervisor or the answer was superfical.

Why do the pupils ask so seldom?

The verbal interaction, the language game, between the teacher and the pupil has its own character. In this interaction the teacher has a double role: he or she ought to discuss things with pupils to develop their mental and verbal skills and to further the learning process. At the same time the teacher has to look after the order in the classroom. The teacher's speech code is therefore wielding of power which prohibits discussion.
The student teacher learns a special code during school practice and special microteaching exercises. A great deal of the supervisors feedback concentrates on the questioning language of the student teacher.
There is a certain type of learning conception behind this normal classroom discourse and its didactics. Engeström (1983) describes

it as 'The central idea is that teaching is essentially the process and the skill of maintaining the balance between three elements: teacher, pupils and curriculum. In other words, teaching means, above all, controlling the class and transmitting knowledge in accordance with the curriculum and the textbooks'. He calls the traditional learning process a circle of empirical generalisation.



This circle model works for the five cases of pupil activity mentioned above.
The first and second cases are located between points 3 and 4. The student teacher (or the supervisor) didn't want to come back to points 1 and 2 just before the examination. She tries to 'pilot' the pupils through exercises to get the circle to go around. (Lundgren, 1979). In the second case the student teacher gave the right answer herself.
The third, fourth and fifth case are located between points 2 and 3. The pupil didn't understand the forming of superordinate concepts and tries to get the teacher back to point 2.
When the student teacher tries to slow up the speed of the circle, the pupils resist it. In point 1 many of the student teachers try to discuss things with the pupils to collect examples from them.

The student teacher : Some people are anxious about computers. Can a computer replace a man?
The pupils : -

The creativity of the pupils is also located on the circle. During seven grammar lessons pupils tried to find fun in the exercices. They interpreted completion items to have a sexual connotation or used slang which confused the student teacher.

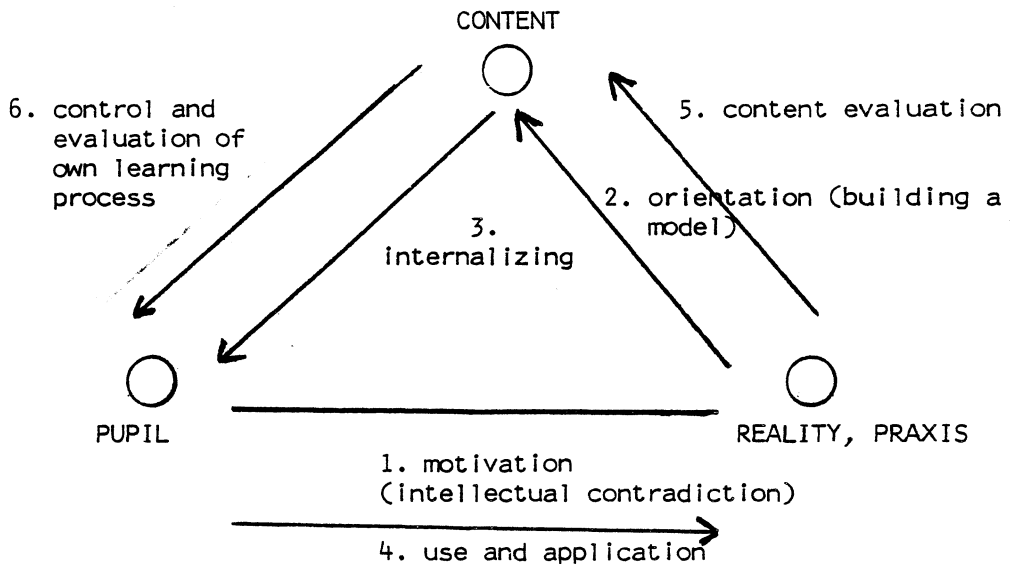
The teaching method, the learning conception and the pupil creativity

And what is the effect of this circle on the pupils' creativity? The main role of the teacher is to get the circle to go around as

effectively as possible. It is also useful for the pupil to adapt to the circle. When the pupil learns, memorizes, and then recalls the content in an examination, he get good marks. 'A good pupil' is therefore 'a cue-seeker'. He or she is oriented towards 'right answers' and 'right solutions' which are exposed in the teacher's questions and instructions. The role of cue-seeker can be directly affirmed during the lesson. During one lesson the supervisor whispered loudly in the back of the classroom: 'Petri, raise your hand now when you have the right answers'. She had helped the boy do the exercises.
We can call a good pupil's orientation 'a social dependence orientation': the pupil tries to behave so that he or she satisfies the teacher's expectations. This orientation changes easily into 'a self-defensive orientation': the pupil tries any means to get of the task without getting hurt. Answers become illogical, distractions increase which means more discipline problems in the classroom.
The pupil can also have 'an exterior orientation': he or she tries to get through the task as fast as possible. The task itself is not considered interesting and the pupil has no aspirations to perform it (Salonen, Olkinoura & Lehtinen, 1982).
The task-related orientation would develop during a learning process in which the pupil has the possibility to present his own ideas, associations and experiences and the teacher can and will use them. Pupils questions would belong to that kind of orientation.

Concluding remarks

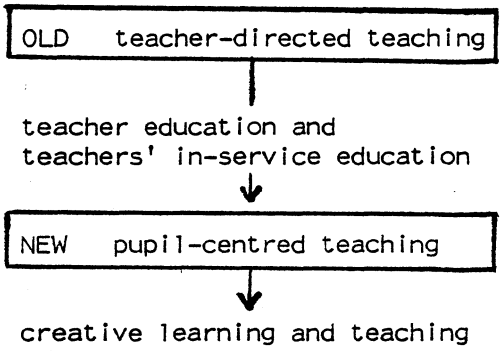
Engeström (1983, 1984) proposes a new model of learning, which breaks the traditional circle and spurs the task-related orientation.



The model itself is interesting and promising. But to incorporate it into teacher education takes time.

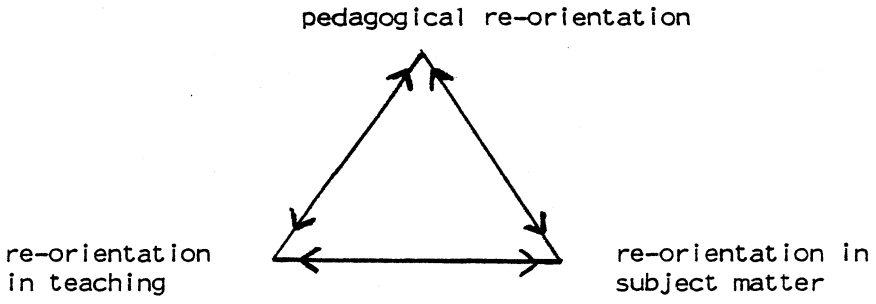
The choice of the teaching model is not only a pedagogical choice. To begin the teaching process with 'an intellectual inner contradiction' and to build with the pupils 'an orientation model' is possible only when your mastery of the subject matter includes high quality as well as quantity. E.g. to teach the finnish language so that the pupils' orientation changes to task-related orientation you ought to master general linguistic theory to some extent. Then you can for example find out the general nature of the finnish verb and build a new orientation basis, which would involve both the finite and infinite forms of the verb.

In pedagogical discussion in Finland the problems of classroom discourse and creativity are viewed too simply:



The changing of the classroom discourse is however much more complicated. Many of the 64 lessons were 'pupil-centred' because the supervisors are interested in group work. The method itself does not appear to increase the creativity of the pupils.

In Finland the subject teachers study subject in one institute and pedagogy in another institute of the university. That makes the re-orientation difficult.



Bright children had learning problems. During the ordinary classroom discourse their talents and creability were not observed. In fact, they were discouraged and prevented from expressing themselves. We teach the student teachers to master this kind of interaction technique and it is very destructive. Only when we know how we in fact guide the student teachers, could we change the classroom discourse.

My results were to myself a depressing surprise.

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THE INFLUENCE OF STRUCTURING THE LEARNING ENVIRONMENT ON TECHNICAL PROBLEM SOLVING

A research into the influence of three instructional methods for problem solving on learning outcomes in the subject of 'Technology in General Education'

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Abstract

In which way can children (12-14 years old) learn to solve general technical problems systematically and consciously. This is the central question of the research project 'Thinking and Doing'.
Three instructional methods are distinguished in the literature about problem solving. These methods (algorithmic, action structuring, self-discovery) differ in the degree of structuring the learning environment.
In accordance with these methods three curricula are developed. The influence of these curricula on technical problem solving is examined in a comprehensive school.

1. INTRODUCTION

Since 1979 the Educational Research Institute 'R.I.O.N.' has been carrying out research into the subject of 'Technology in General Education' (from now on indicated as General Technology: GT). 11 years ago this subject was introduced on a modest scale into the Dutch educational system, in particular at schools for junior vocational training. However, all Dutch children from 12-14 will be confronted with technology in society through this subject in a few years time.
The research project that this article is focussed on, aimed at providing clarity about Technical Problem Solving (TPS), which is one of the objectives of GT. In an initial research, an analysis was made of the way in which three pioneering junior vocational schools had put the objective of TPS into practice. In this research a number of practical problems were revealed, which should be taken into account at the elaboration of TPS (De Jong, 1981).
The objective is made clear when a learning environment has shown how it can be put into practice.
That's why in a second research the decision was made to design a curriculum for TPS. The implementation and the influence of this curriculum on learning outcomes was evaluated at two secondary schools (De Jong, Haanstra & Van der Wal, 1983).

In the research described in this article the influence of the three instructional methods on TPS have been evaluated.
In comparison with the second research, where a heuristic method of the curriculum was compared with an algorithmic one, a third method (discovery learning) was developed.
This article deals with the curriculum for TPS, the three instructional methods developed on the basis of this curriculum, and the design and results of the research.

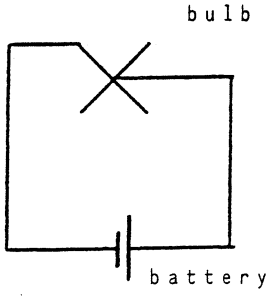
2. THE CURRICULUM FOR TPS

2.1 WHAT IS TPS

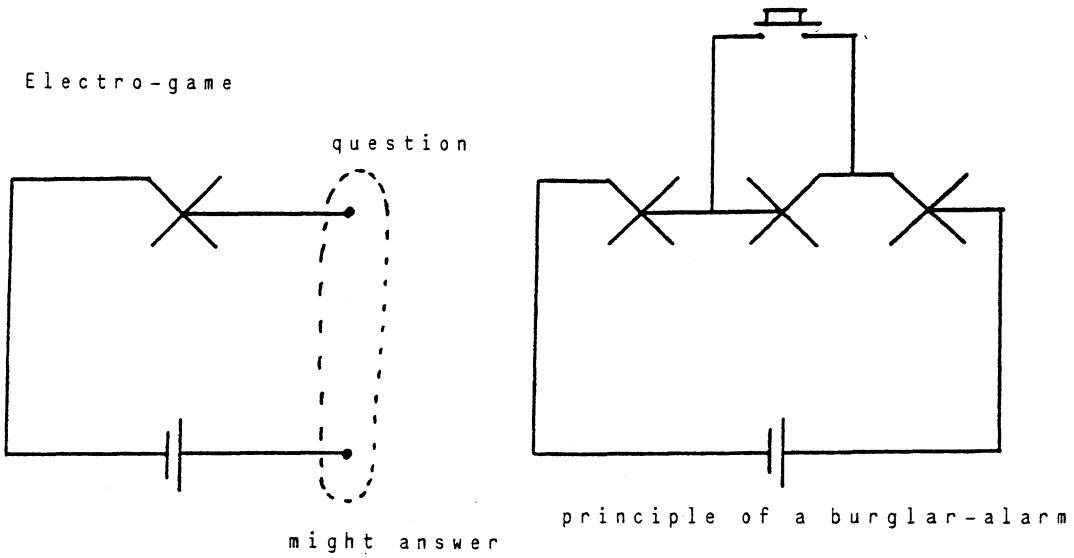
The objective of GT is to confront students with technical products and processes, since these have an ever increasing influence on our society.
Problem solving as an element of GT, is to introduce students into technical thinking and acting. Technical thinking and acting focus on solving problems arising from the aspiration to change, simplify or improve the (human) existence. (KPS, 1983).
The objectives of technical thinking and acting can be expressed in education by students making functional and technical products themselves. The problems arising from the technical development process have to be solved systematically and consciously (De Jong, 1981).
The following paragraphs will point out how this objective was translated into a curriculum.

2.2 THE CONTENTS OF THE CURRICULUM

TPS has used electricity as a study, in particular the programme of electrical connections. The choice of the subject of electricity implies that students are confronted with technical applications of a physical phenomenon that they use every day.
The principles, however, on which electro-technics are based, generally remain unknown to them.
That's why an attempt has been made for students to apply these technical principles themselves, to assignments for them in the form of problems.
The contents of the curriculum centre around the conception of the (electric) circuit. A circular course, which includes an electric device, has to be completed as a working model.



To the principle of the electric circuit variations and refinements may be applied (parallel and series connection, switches, etc.), which can be made by the students themselves.
In short, students acquire knowledge of a general theoretical (physical) principle on which many technical applications are based (e.g. signalling apparatus, electro-game, rear fog-light, burglar-alarm).



These technical applications are presented to the students as problems. The students have to design and make the technical application themselves, using the knowledge of the physical principle they have acquired.

2.3 THE STRUCTURE OF THE CURRICULUM

At the elaboration of problem situations, theories on problem solving should be taken into account, as well as the students starting situation. Kudrjavcev (in Nelissen/Vuurmans, 1984) distinguishes the following three basic knowledge and motivation factors.

1. The level of knowledge and skill of the student.
The first lessons of the curriculum are used for the acquisition of knowledge and skills concerning electric connections, in particular the principle of the electric circuit, types of switches and circuit-breakers.
Students must be able to draw schematic diagrams of the connections and fix (the different parts of) these connections together. After these lessons the students are given a (diagnostic) knowledge test. Those students who have insufficient knowledge, are in an additional

lesson instructed on the elements that they do not fully understand.

2. The motivation of the student.
There is no real problem situation until it is considered or experienced as a problem. This means that a student is eager to deal with the assignment. An attempt to increase the motivation has been made by: (a) elaborating assignments (problem situations) for which functional, technical contructions have to be made; (b) by paying a lot of attention to material and perceptive actions, and (c) by matching assignments to the students' level.

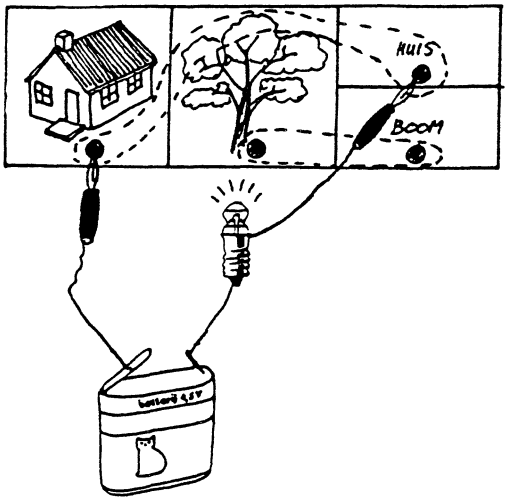
3. The complexity of the problems.
The complexity of the problem always constitutes a relationship between the assignment and the knowledge and skills of the student. Since in the first lessons knowledge is provided and skills are taught, a good estimation can be made of the starting level of the student. As for TPS, students and teachers have no experience. Therefore a number of measures have been taken so as to limit the complexity of the problems. In short these measures amount to the number of stages in the problem solving process being limited. In problem solving theories phases are found on how to go about solving a problem, e.g. the stages of finding and formulating the problem, the gathering of information about the problem, and divergent production concerning the solution of the problem.
In the curriculum for TPS:
- convergent problems have been elaborated (only one solution is right)
- the problems have been formulated in every problem situation. So the students are not required to discover and formulate the problems themselves
- the knowledge and skills required to solve problems have been dealt with in previous lessons.

Beside these measures the complexity of problems can also be influenced by the degree in which the course of action in problem situations is structured.
This will be dealt within paragraph 3.

For the development of problem situations a few other decisions have to be made with regard to:
a. the type of problem
b. the number of problems.

a. The type of problem.
The curriculum includes construction problems only. Construction problems can either be design problems or application problems. When producing, for instance an electro-game, the students first have to realize what an electro-game consists of on the inside. This means that the students have to gain insight into the way in which the principle of the circuit has been applied to the game.

This insight has to result in a schematic diagram.



When the students have gained insight into the application of the circuit of the electro-game, they have to design an electro-game themselves. This involves all sorts of facets: the form of the game and the material that might be used, the type of connections, the position of the battery, so that it can be changed easily, etc.
After having solved these problems, the students should be able to construct the electro-game themselves. A demand made concerning the elaboration of assignments (for instance) is that the students have to discover a general idea when solving the problem. So the solution has to be more than just the answer to that one assignment. The student should be able to discover a principle or general method to solve the problem.

b. The number of problems.
TPS can only be achieved if students are amply trained in solving problems. That's why several problem situations have been elaborated in the curriculum. In the previous statement five conditions have been mentioned that are required for TPS, considering a modest starting position of the students.
Now I will deal with the question in which way students can be taught to solve technical problems systematically and consciously.

3. THREE INSTRUCTIONAL METHODS FOR TPS

In the literature of problem solving and metacognition a distinction is often made between knowledge of conceptions and knowledge of rules telling one how to act in problem situations. (Fischer/Mandl, 1982; De Klerk, 1983; etc.)

Knowledge of conceptions is an important condition for TPS. Past research it has made clear that the students' knowledge explains a great deal of the variance (38%) of the problem solving test. In many problem solving models the acquisition of knowledge is a separate stage. In order to make the problem solving process more viable to the teacher and the students, knowledge and insight of the problem area were taught first in the curricula for TPS. When learning to act systematically and consciously in problem situations knowledge of rules is important too.
There are different theoretical opinions and different practical elaborations about the way in which these rules should be taught.

a. The algorithmic method
An example of this variant in a classroom situation is as follows: The students are given the assignment to change a lock on a door, opening clockwise to fit a door, opening counter clockwise.
Before the assignment is given to the students, they are taught knowledge and skills to such a degree that they are able to carry out the assignment automatically (on routine). The advantage of such an approach is that hardly any mistakes arise during the learning process. The disadvantage is that every assignment involves a great number of instructions and that solving the problem doesn't lead to the insight into the way other problem situations can be solved.

b. The self-discovery method
In this situation the opinion is that it is better for students to discover a structure of actions themselves, when confronted with several problems, because students are not motivated to use the structure of actions provided by the teachers, or to carry them out as intended. In a classroom situation, for instance this method is seen when, with a particular theme (like 'energy'), the students themselves have to choose problems and formulate them, gather information, think of a solution scheme, carry out the assignment and evaluate it. Structuring at this variant is limited, which confronts the students with many problems. They are, of course, not capable of solving all the problems, which leads to faulty (technical) products and a decline of motivation.

c. The action structuring method
This variant was considered the most promising in the research. At the elaboration of this variant it was considered which type of structuring and how much of it would be necessary to realize TPS. The definition of the objective of TPS indicates that students should be taught to act systematically and consciously in problem situations. Acting systematically is stimulated by including a structure of action in the curriculum. This structure of action called TDMC (Thinking-Drawing-Making-Checking) is based on the classification of the structure of action: orientating, constructing and checking. (Gal'perin, in Bol, 1976). The structure of action is

kept simple on purpose, since the students that take GT have no former experience with TPS. In order to make sure that the students apply the stages of thinking and checking correctly, two measures were taken. In the curriculum heuristics have been elaborated. Heuristics are specific indications that have to direct the students attention to the relevant characteristics of a problem situation. Moreover, the teacher has to devote himself to the detection and remedy of learning problems through the following stages:
- detecting (the causes of) learning problems
- thinking of solutions and carrying out and checking the effectivity of the solution designed by the teacher.

Acting consciously is especially stimulated with the help of evaluating discussions. In these discussions the main thing is the reflection on the principles, from which the students' actions and course of actions arise.

The six problems the students have to solve are elaborated on a basis of the algorithmic, self-discovery and structure of actions variant of TPS. At the self-discovery variant only the bare problem is given. At the algorithmic variant a schematic diagram of the solution is given, which the students have to elaborate themselves. Above it has been indicated how the action structuring variant has been elaborated. The three curriculumvariants, differing in their degree of structuring, were explored for their effectiveness.

4. THE RESEARCH

4.1 THE RESEARCH DESIGN

The research was carried out in five parallel classes (second form) of the Comprehensive School in Groningen. One teacher (experienced and known to be capable) who teaches five parallel classes carried out the three programmes. Because of the big differences in didactical skills and knowledge of the subject between the teachers, it was decided to have one teacher only carry out the three variants. This avoids the problem of differences in instructional and management behavior of teachers, however the differences in accuracy of implementation of the three treatments may become a problem. The instruction the teacher received aimed at distinguishing the differences of proper implementation of the three treatments.
The control programme (the algorithmic method) was carried out in one class, the two experimental programmes each in two classes.
The implementation of the treatments was recorded on video tape.
The effectiveness of the programmes was determined with a TPS test for electricity. Furthermore a knowledge test was developed measuring insight into electrical connections (KE-test). This test was developed to find out how important declarative knowledge is when solving problems. The TPS programme tried to teach knowledge of actions. The differences in effectiveness of the programmes can be assessed more reliably if declarative knowledge is included in the

design as a co-variable. The reliabilities of the KE-test and the TPS-test are respectively α = .73 and .83.
In order to find out how attractive the programmes were to the students a motivation questionnaire was completed by them.

4.2 THE HYPOTHESIS

a. From the results of research carried out in Hoogezand and Gorredijk, it has become evident that as far as the school in Hoogezand is concerned there is a significant difference in effect between the experimental (structuring) programme and the control (algorithmic) programme, for those students who score high at the knowledge test.
In Gorredijk these differences are not significant but there is a tendency in the same direction. These tests were carried out before the test in Groningen. According to us the main course why no significant differences were found between the groups that scored high at the knowledge test, is the fact that in Hoogezand the programme was twice as long as in Gorredijk.
Since the programme of the Comprehensive School in Groningen was longer than the programme in Gorredijk, the hypothesis was formulated that for students who score high at the knowledge test the structuring programme will be more effective than the algorithmic programme.
As the students at the Comprehensive School have hardly any experience in problem solving, the self-discovery programme was expected to be the least succesful link-up with the students' starting position.
It was expected that they would need more structuring than was provided by the programme and the teacher.
That is why the hypothesis was formulated: the algorithmic programme will be more effective than the self-discovery programme for those students who score high at the knowledge test.

b. As far as motivation is concerned, it was expected that the more a programme guarantees succesful results, the more the motivation of students working at different programmes will increase.
Since in the algorithmic programme all the actions the students have to perform are dictated as far as possible, and since in the structuring programme heuristics are included, the students are supported in determining the right solution, and since in the self-discovery programme the guarantee for succes is missing, this hypothesis was formulated: students who have been submitted to the algorithmic programme will score significantly higher at the motivation questionnaire than students who have been submitted to the structuring or self-discovery programme.

4.3 TECHNIQUES OF ANALYSIS AND STATISTICAL DESIGN

With regard to the research question (what are the effects of the

three treatments that were developed in terms of test results) a pretests-posttest design with two control groups was chosen, which looks schematically as follows:

O_1	X_a	O_2
O_1	X_d	O_2
O_1	X_s	O_2

X_a = algorithmic programme (cont.)
X_d = self-discovery programme (cont.)
X_s = action structuring programme (exp.)

O_1 = pretest
O_2 = posttest

For experimental groups existing classes of one school were taken. These classes have one teacher only to eliminate teacher skills as intervening variable. However, there is still the possibility of differences between the classes which were submitted to X_a, X_d and X_s and might influence O_2.
That is why it is important to check the comparability of the parallel classes. Therefore as control variables a number of important student characteristics were assessed, among which intelligence (TIB-scores), field(in)-dependence (GEFT-scores) and sex.
The statistical design used will be: a non-orthogonal univariate covariance analysis with the covariates: the student characteristics intelligence, fieldindependence and sex and the pretests KE-1 and TPS-1, the factor being treatment (three levels) and the dependent variable student results TPS-2 and motivation.
Schematically the research design looks as follows:

student characteristics	knowledge acquisition	diagnostic knowledge test	mastery learning	pre-test	classes	curriculum variants (9 lessons)	making electrogame (15 lessons)	post-test
intellegence (TIB)	2 lessons	KE-D	1 lesson	KE-1	B	algorithmic		KE-2
fieldindepen-dance (GEFT)				TPS-1	A,C	self-disco-very		MOT
sex					D*,E,G	structuring		TPS-2

KE = knowledge test Electricity
TPS = test Technical Problem Solving
GEFT = Group Embedded Figures Test
TIB = intelligence test
MOT = Motivation questionnaire

* one teacher who did not follow the training programme has implemented the structuring action method in one class.

5. THE RESULTS OF THE RESEARCH

5.1 THE RESULTS

The central research question is: Do the three instructional methods influence the TPS posttest results and would this apply to all students or only to those students who score high scores on the knowledge test?
In order to answer this question a covariance analysis was carried out, with the covariates: sex, age, field independence, intelligence, and the pretests KT-1/TPS-1.

Table 1: Covariance analysis TPS-2

Source of variation	sum of squares	DF	mean square	F	signif. of F
Covariates	592.258	5	118.452	23.039	.001
Sex	22.449	1	22.449	4.366	.039
Age	9.934	1	9.934	1.932	.167
Field independence	.107	1	.107	.021	.885
Intelligence	12.390	1	12.390	2.410	.123
TPS-1	249.858	1	249.858	48.598	.001
Main effects	10.134	2	5.067	.986	.376
Treatments	10.134	2	5.067	.986	.376
Explained	643.786	7	91.969	17.888	.001
Residual	591.255	115	5.141		
Total	1235.041	122	10.123		

Table 1 shows that there is no significant relation between the treatments and the posttests TPS. The differences in TPS scores are mainly caused by (interactions between) the covariates. Especially sexspecific differences turn out to be an important cause for differences in TPS achievements.
It also turns out that these relations can be found with students who have a high prelimenary knowledge.

The differences between the three treatments only show a significant relation were motivation is concerned. This becomes clear in the following covariance analysis table.

Table 2: Co-variance analysis Motivation

Source of variation	sum of squares	DF	mean square	F	signif. of F
Covariates	194.785	5	38.957	19.310	.001
Sex	84.845	1	84.845	42.056	.001
Age	.601	1	.601	.298	.586
Field independence	10.426	1	10.426	5.168	.025
Intelligence	.187	1	.187	.093	.761
TPS-1	7.824	1	7.824	3.878	.051
Main effects	16.170	2	8.085	4.008	.021
Treatments	16.170	2	8.085	4.008	.021
Explained	211.672	7	30.239	14.989	.001
Residual	232.003	115	2.017		
Total	443.675	122	3.637		

For the students the algorithmic programme is the most motivating and the self-discovery programme the least.

Table 3:

	motivation (0-6)	
	Mean	Std.Dev.
Algortihmic	4.57	1.29
	3.71	1.78
Heuristic	3.79	2.13
	3.80	1.96
Discovery	3.71	1.83
	2.88	2.11
Population	3.73	1.91

Declarative knowledge turns out to be an important condition for TPS. From research results it becomes clear that the more knowledge/ insight students have, the higher they score on intelligence, field independence and motivation.

Table 4:

		TPS-2 Mean	std.dev.	N	
KE-score	Low	2.69	1.75	13	
	Medium	3.88	2.45	50	
	High	7.05	2.89	77	
		5.51	3.16	140	Sig. = .0000

Declarative knowledge (KE-2) and the pretest TPS-1 explain 54% of the variance on TPS-2.

Table 5: Correlation coefficients between TPS-2 and student characteristics and pretests.

Student characteristics N=123

	TIB	GEFT	KE-2	TPS-1	R	R^2
TPS-2	*				.30	.09
		*			.34	.12
	*	*			.39	.15
			*		.58	.33
				*	.70	.48
			*	*	.74	.54
	*	*	*	*	.74	.55

The implementations of the treatments were recorded on video. The video tapes remain to be analysed. There are, however, already a few impressions on the viability of the treatments.

The algorithmic programme runs smoothly. During the self-discovery programme students appeared to have lots of problems with the assignments. Presumably this is caused by too high a level of openess in relation to the students' starting point.
This means that the teacher has to help quite often during the learning process. With regard to the assistance, this programme obviously requires too much of the teacher too.
In the structuring programme it is very hard for the teacher to carry out assistance and evaluation as intended.

5.2 INTERPRETATION OF DATA

The slight increase of the TPS scores presumably is partly caused by the limited duration of the educational programme (9 lessons) and partly because the TPS(-2) posttest was completed 6 weeks after the six problems of the programme were solved. Consequently it can be regarded as a retention assessment.
The intended effects appear to have no significant relation with the TPS-2 score. This is unlike the aforementioned research in Hoogezand, which showed that students scoring high on the knowledge test gain a higher score on the TPS test when they followed the structuring programme in stead of the algorithmic programme.
However, in this research the students were not given pretests. When in table 1 the pretests are excluded as covariates, suddenly there is a significant relation between TPS-2 and treatments. In other words: the results of the research in Hoogezand are questionable.
For the minor differences in effects of the three treatments the following explanations can be given. On the basis of empirical research Bloom has assumed that education, in general, can explain about 20% of the variance of learning achievements (Weeda, 1982). In the developed educational programme we don't deal with education in general, but with differences between educational programmes with a limited duration. This means that only a slight portion of variance of learning achievements can be explained.
Nevertheless bigger differences between the educational programmes were expected. The causes of the slight differences might be found in an interaction between the duration of the programme (the time necessarry to train the TDMC-programme) and the differences existing between the programmes and their implementation.
Recent research into the effectiveness of heuristic educational programmes of limited duration, also showed disappointing results (De Jong and Ferguson-Hessler, 1984).
From the results of this research the authors draw the conclusion that for problemsolving more attention should be paid to declarative knowledge than to heuristic knowledge.
This conclusion could seem to be premature. Several authors (Flavell, Resnick & Glaser, Simon) have stated that succesful problemsolving is more than just the application of relevant conceptions and rules (declarative knowledge). Newcomers in solving problems

often have big difficulties in planning, anticipating, evaluating, etc. (Boekaerts, 1983).
Besides, students are not eager to apply an action strategy provided by the teacher. This often requires some external pressure. (Mettes & Roossink, 1982). And it also takes a lot of time to change deeprooted ineffective action structures.
Consequently it is recommended to analyse the viability and effectiveness of heuristic educational programmes during a longer period of time. This suggestion is bound to meet with opposition of financiers, however.
Not only the duration of the education programme, but also the intensity and quality of learning seem to show an important relation with learning achievements. Teachers, however, often lack the skills and knowledge to stimulate learning with insight in students.
Apart from this, there is also the organizational problem. Adequate assistance by the teacher requires a lot of time. The needed quality of assistence, however, appears to be difficult to realize in groups of twenty to twenty-five students. On should endeavour to realize such an organization that the majority of the students can work at the assignments independently, enabling the teacher to spend more of his time to a limited number of students who need extra help.
Nevertheless there remain questions about practicability of heuristic education. Russian educational experiments show that per student dozens of hours are spent on assistence. In our educational system this can hardly be put into practice.
It will be understood form this description that it is not sufficient to prove the viability and effectiveness of an educational method in ideal circumstances. When developing methods aimed at requiring declarative and procedural/heuristic knowledge, attention should be paid to frame factors which have influence on the viability and effectiveness of instructional methods.

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RETROSPECTION

ACTIVITY THEORY: A RETROSPECTION

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Introduction

Discussions about human learning and cognitive development invariably reflect the puzzle of the autonomy of the individual mind versus the regulation of mental processes by external conditions. When Piaget describes learning and cognitive development in terms of assimilation accomodation and equilibration, we are confronted with a mind, which is highly active and self organizing. No two minds are responding exactly the same to similar external conditions, and individual differences seem of main importance. On the other hand we cannot escape from the impression that the ontogenises of different minds show similarities, and that external conditions exert essential influences. Piaget mentions the role of social conditions in this respect.
Activity theory tries to provide an explanation in which the contradicting tendences of autonomy and external control of the mind are reconciled. Activity was introduced as a basic notion in the sociohistorical theory of the Soviet scientist Lev Semënovic Vygotskij (1896-1934), who founded his work on historical and dialectic materialism propagated by Marx, Engels, and Lenin. The essence of this notion is that it is a quest for the causes of historical and genetic developments, especially in phylo- and ontogenesis of man. The contribution of the various authors in this book touch upon the role of activity with respect to cognitive development, learning, teaching, education and social conditions. But activity is not discussed explicitly. This is the reason why the editors of this book judged it useful to add a chapter on activity theory.

Sociohistorical school

The work of Vygotskij became known in Western countries in the sixties of this century, when publications from his hand were translated into English and German (e.g. 1962, 1964). Although Vygotskij is often quoted in western publications nowadays, his theoretical claims are not seldom misinterpreted because of their specific and complicated philisophical background. Moreover, Vygotskij died still a young man of thirty-eight years old, so his work was far from complete. It contained many contradictions and gaps. However, his work became an inspiring source for many Soviet

theorists like Lurija, Leont'ev, Gal'perin, Zaporozec, Il'enkov and Davydov, who explored and elaborated the ideas of Vygotskij. During the last decades psychologists form all over the world became intrigued by what is now called the sociohistorical school. We must realize that this led to different interpretations and views, not only of details but also of basic notions like activity The attentive reader of the proceedings of this symposium certainly will become aware of this state of affairs. This makes the theoretical debate significant and fascinating, not only for the cause of pure science but also for the practical implications of various conceptions with regard to e.g. education. And practical matters of education are so important here, because these problems touch the very heart of sociohistorical theory.
When one looks superficially, some elaborations of sociohistorical theory resemble theories in modern american cognitive psychology. This resemblance can be misleading, as becomes clear when one looks into the basic notion of activity.
I will try to shed some light on the problem of activity by confronting the reader with fundamental problems without pretending to depict the scenery in all its intricacies nor to provide all the adequate answers.

Philosophical basis

The aspiration of Vygotskij was to develop a psychological theory founded on the philosophical basis of historical and dialectic materialism. This enterprise means, firstly, that a mechanistic materialism must be rejected. Such a materialism either denies the existence of a conscious and mental reality or reduces this reality to an uninteresting byproduct of physiological processes (cf. behaviorism). If one accepts consciousness as an essential psychological phenomenon it does not imply automatically that one has to deny any correspondence between physiological functions and processes on the one hand and the flow of ideas in the mind of man on the other. But what it does imply is that the development of meanings, values, norms, concepts etc. is not the simple result of autonomously developing physiological systems, however complicated in terms of mechanism. It may be true that man somehow can become programmed to act according to certain ideas, but man is always able to know, to act upon and to change ideas. And the latter has an impact on the formation of physiological functions (cf. Leont'ev 1969).
The position taken by Vygotskij means, secondly, that pure idealism has to be rejected as well. Idealism leads to such notions as subjectivism or even solipsism (cf. Carnap), which are incompatible with the acceptance of objective material reality. And thirdly, historical and dialectic materialism rejects the dualistic viewpoint of two essentially different realities (cf. Descartes). As a consequence conscious and mental reality and material reality must be interrelated. Both realities must be objective, i.e. both must

exist independently from the minds of individual subjects (cf. Popper's worlds). It is evident that this creates a serious problem. The answer to this problem of historical and dialectic materialism is, that we cannot understand phenomena from what they are or seem to be, but only from their historical genesis. Although mental reality and material reality may seem essentially different to us at this moment, this does not mean that this impression is correct. We can ask ourselves the question if we can think of a way how conscious and mental reality evolved from material reality, without reducing the former to the latter. In his sociohistorical theory Vygotskij indicated and described such a way. That such a historical analysis is not without problems, we shall see shortly.

Evolution and activity

The concept of activity, introduced in the work of Vygotskij, became a central notion in the theories of Leont'ev and Gal'perin. Moreover Vygotskij started his historical analysis at that point of biological evolution, where man began his phylogenesis. But in order to draw an integral picture of one reality, which comprises both material and mental phenomena, we must not only fit the evolution of man on the biological evolution, we must also fit biological evolution on the physical evolution of the universe (cf. Popper, 1975: Leont'ev, 1973: Gal'perin, 1980).
If the physical evolution of the universe started with the big bang, it obviously took some time before organic matter and the first forms of live evolved, and it took additional time before man came into existence (see Fig. 1).

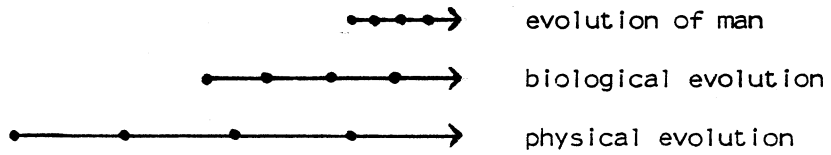

Fig. 1 Three evolutions

Now, our problem is how we can put these three evolutions together into one integral picture. To solve this problem we must be prepared to accept a few speculations. Let us analyse physical evolution a bit more precisely to begin with.

Physical evolution

The physical evolution of the universe can be described as a series of changes in a physical space. This is a dynamic space in which elementary forces constitute interacting entities. The dynamics of physical space are studied by sciences like physics, chemistry and astronomy. Nowadays it is generally accepted that particles and systems like atoms, molecules, stars and galaxies evolved stepwise from basic entities. These steps correspond with temperature and

levels of energy, and they are constituted by small quantative changes (Engels) or jumps (Popper). A point of major importance is that these steps cannot be explained purely on the basis of causal chains. Or as Popper (1975) puts it, the evolution of the universe is not running like a clock. There is room for spontanity, or variability, or uncertainty in the dynamics of physical space. How must we understand this?
In physical space entities are not completely independent from their environment. If this was the case there would be just chaos. But physical entities are also not only reacting passively to influences from there environment. In that case nothing would ever happen, or some mystic force would be needed to put the whole thing into action. Like balls on a billiardtable are to be put into action by a player. We must assume that physical entities are continuously interacting with each other by exchanging mass and energy. As a result entities are not only reacting to external conditions, they are at the same time influencing and changing these conditions. E.g., when the sun sends energy in the form of light to the earth, the latter sends some of this energy back to the sun. This exchange of energy constitutes a structural balance within the solar system. Thus, physical entities are actively contributing to the dynamics of physical space. Within these dynamics structural balanced systems of different stabilities are formed. That is, some systems are very instable and can exist only for a very short period, while others can exist for longer periods of time. Shifts from one structural balance into another occur in steps or jumps, corresponding with various levels of energy. In my opinion these steps or jumps in the interactions between physical entities form the very basis of activity. I.e. activity means that we cannot pinpoint changes in the structural balances of systems to exact causes and moments in time.

Biological evolution

In the evolution of physical space organic matter developed. And from this, within the dynamics of physical space, living organism originated. From unicellulars ever more complex forms of life evolved (plants, animals etc.). The genesis of organisms in biological evolution is not only depending upon physical dynamics, it also depends upon interactions between organisms. And this constitutes a new type of dynamics. Species originate and disappear, food-chains, ecological balances, genetical information, feedback mechanisms within organisms, brains that can learn and control actions, etc. come into existence. Maybe it is possible to draw some analogies between the development of species and the development of stars, but it seems rather unacceptable to assume that the dynamics of these processes are the same. This leads us to the conclusion that organisms create a new space with its own dynamics, i.e. biological space. This raises the question of the relation between physical space and biological space.

We can argue that biological space cannot exist independently from physical space, because it is based on the dynamics of physical space. Physical space sets the conditions for the evolution of organisms. And organisms on their side influence physical conditions. E.g., the growth of plants influence the climate. This is what Piaget calls assimilation. Does this necessarily lead us to the conclusion that biological space is subordinated to physical space? I don't think so.
Gal'perin (1980) pointed out that cybernetic mechanisms, like the mechanisms regulating body temperature in mammals, don't exist in physical dynamics. Organisms are even capable to anticipate changing external conditions on the basis of internal representations, in which experiences with events in the past are incorporated. Such mechanisms regulating and controlling actions and acts ensure a certain freedom of organisms with respect to external conditions. Or in other words, individual organisms have a certain ability to adapt to external conditions. The problem is, then, how the adaptability of organisms originated. How can we explain the development of mechanisms of regulation and control in biological space?
Science has no exact answer to this question yet. However, we can speculate in the following direction. It is essential for organisms that their life time is limited. As a consequence individual organisms are confronted with relatively stable physical conditions. I.e. as a rule the variations of physical conditions on earth remain within the limitations of the adaptability of individual organisms. Properly equiped organisms can at least stay alife long enough to reproduce. Genetic information ensures that adequately structured organisms are repeated over and over again in reproduction. However, in reproduction organisms are not copied exactly, there is always some variation. On the basis of this variation species can cope with the larger variances of physical conditions, which occur over longer periods of time. The principle of varied repetition in reproduction in combination with complexes of interactions between organisms, creates more or less stable ecological balances. The variation and combination of life forms is the essence of activity in biological space, i.e. genetic activity. My point is that the dynamics sustained by genetic activity, introduce a time scale that differs from the time scale of physical dynamics. Changes in biological systems are faster than changes in physical systems.

The evolution of man

We return to the question about the relation between biological and physical spacehow. Let us assume that biological time can not run ahead of physical time, but that during the time of a physical step more biological steps are taken. We can compare this with the different hands of a clock. They move in the same space, but they proceed with different speeds. We can analogize that biological space is not a new space, and that biological dynamics are somehow co-ordinated with physical dynamics, but that the former introduces a new order in a physico-biological, or material space (see Fig.2).

Fig. 2 Dynamics of material space

At this point of my analysis I join with the sociohistorical theory of Vygotskij. The basic idea in this theory is that man on top of his biological substratum developed higher psychological functions during his phylogenesis. These higher functions are the result of the internalization of the joint regulation of actions in man's co-operation and communication. The essence of this thesis is that during the phylogenesis of man the genetic structure of the brain did not change, but that during the ontogenesis of individuals socially based brain functions are developed (cf. Leakey, 1981). So, characteristic for the historical genesis of man is that man created a social space. This is the space of social institutions, politics, art, science, tools, language, values, norms etc. The participation in social space moulds the mind of the individual.
An important question is why man could develop such a complicated social space while animals could not. In his work Vygotskij did not pay much attention to this question. Firstly, we can remark that animals live in the same material space as man, and that many species - at least to a certain extent - are able to co-operate and to communicate. Secondly, like man animals can form complex images and representations of material reality by integrating various streams of information. E.g., there is little doubt that animals have the capacity to construct integral images on the basis of visual, auditory and olfactory impressions.
Thirdly, both man and animal can perform acts in imaginary situations, which represent real situations (imaginary acts). This capacity is demonstrated by the fact that chimpanzees can indicate solutions of problem situations presented in pictures. Finally, the brain of man and animal is capable to transform the temporal structures of events in material space in internal representations thereof. I.e. temporal structures can be condensed, expanded, or changed in order. E.g., chimpanzees can dig up bananas, buried in a large field, in an order differing from the order in which they saw them buried. What is it that man possesses and the animal lacks?
Here we have to speculate again. Suppose that the human brain is designed in such a way that it can form functions, which the animal brain cannot form. Namely, functions which enable man to compare ongoing actions and events with the results of imagenary acts based upon different temporal structure. This creates the possibility to take, in the realm of imagination, positions in time and place, which are different form the spatio-temporal structure of ongoing actions and events. E.g., when man learns about the course of events on the basis of experience, he is capable of actively looking forward and backward in his imagination, while he is acting in

some situation. And if a series of actions does not lead to a desired result, man can look backward to find out where things went wrong.This puts actions in the light of possible alternatives. This 'double' position must be considered the basis of consciousness and cognitive activity.
Because man developed the capacity to look at actions and events from different points of view, he could comment on actions and events in his imagination. Moreover, man could learn to take the position of another person in his imagination. The fulfilment of these conditions is necessary to explain how man could develop co-operation and transactional dialogues (Bruner, 1978). And this development is a prerequisite for the genesis of common language. I think it is quite possible to work these ideas out in a testable theory, but in the scope of this paper I will leave it at this. The importance of the genesis of common language is, as Leont'ev (1973) pointed out, that language enables man to go systematically beyond the limitations of the 'here and now' of actual situations. Language as a socially developed means of communication creates the possibility for man to share imaginary points of view with regard to actual situations and actions. And the sharing of viewpoints corresponds with the development of common knowledge and experience. The common knowledge incorporated in language, tools, science, art etc., developed during the phylogenesis of man, is transmitted to new generations when individuals learn to co-operate on a mutual basis with others who have already acquired the uses of common language, knowledge etc. (cf. Bruner, 1975; Cole and Griffin, 1980; Vygotskij 1978; Wertsch and Stone, 1984). In other words, the ontogenesis of the individual mind is influenced by the genesis of society (cf. Cole, in this volume).
However, we must bear in mind that the process of internalization of culture is by no means passive. The individual does not simply absorb culture. Each individual plays his own active role in social space. With respect to actions individuals repeat, vary and combine imaginary positions in relation with actual situations. Basically this is an autonomous (biological) function of the human mind. But the human mind is far from fully developed when the individual is born. And external conditions are not only a function of physical and biological factors, they are also determined by social factors. If we postulate that the human mind is tuned to material and social factors, then it becomes understandable that imagination can be moulded by social factors. As the individual is capable to influence external factors, he can also learn to manipulate such factors on a social basis. Thus, indirectly via social mediation individuals can develop common controls of imagination (e.g., by using language) Control does not mean that there is no room for spontaneity or individual variation. On the contrary, control is impossible without spontaneous variation and the acceptance of certain deviations (cf. modern cybernetics). So essential for human development is that the activity of comparing actual and imaginary positions, or cognitive activity, is partialy spontaneous and indivi-

dual and partialy socially controlled. Without the former aspect there would be no sociohistorical development, and without the latter aspect there would be social chaos. It is just because there is some individual variability in cognitive activity, leading to some social chaos, and some social control in cognitive activity, leading to some mutual understanding in communication and co-operation, that socio-historical evolution remains alive, and new social perspectives can be opened over and over again.

Social space versus material space

The question we will look into now pertains to the relation between social space and material space. My first argument is that social space and its dynamics are unconceivable apart from material space. Without material space social space cannot exist. On the other hand, however, the dynamics of social space are depentent on the cognitive activities of interacting individuals. Social space developes because individuals exchange, accept, and use ideas based upon common viewpoints with regard to situations and events.
An issue we have to clear is the status of ideas in the interaction between individuals. Where do ideas come from, and how can they be exchanged? In accordance with the analysis in the former paragraphs I think that ideas are produced by the human mind, when it relates imaginary positions to actual situations and events. E.g., when an individual observes thunder and lightning, he can look at these phenomena from the viewpoint of some man who is riding in a cart through the sky holding a flaming hammer in his hand. In his imagination the individual takes a possible material position, and by trying to relate this position to the observed phenomena he invents the idea of a specific combination of ingredients he knew already, like a man, a cart, a hammer etc. We can picture this process of invention to ourselves as the fitting of combinations of material features on actual situations and events. Such combinations are produced by the mind on the basis of immanent processes of variation, like a kaleidoscope producing different pictures when it is rotated. Of course we must know more about these processes in order to be able to describe this function more precisely.
The next question is how ideas can be communicated. It is obvious that ideas cannot be communicated directly from one person to another. Ideas can only be communicated indirectly by active manipulation of material conditions. People can change or manipulate material conditions deliberatly in order to indicate their viewpoints and ideas. This can be done by manipulating objects, performing gestures, producing speech sounds etc. The exchange of ideas can be more effective when conventional means (e.g. language) are established, which can be used to indicate ideas shared by a community. And such ideas and means are born in joint actions. We see that both the origination and the exchange of ideas lean on material processes and conditions. But this does not imply that ideas and material processes are the same. Ideas have to do with

the way these processes are organized. In cognitive activity ideas and the organization of material processes can change on the basis of physical factors (e.g. drugs), biological factors (e.g. hunger), spontaneity of individual activity (e.g. accomodation) and social factors (e.g. acquisition of theoretical concepts). It is the combination of these factors which ensures that individuals can sustain the development of social space on the one hand, and social space can influence and foster ontogenesis on the other. So with respect to the relation between social space and material space, my second argument is that cognitive activity relates intra- and interpersonal actions - and thus keeps the development of social space alive - and this is reflected in the organization of material processes.
My third argument is that the co-operation of members of human society influenced material space. Man cultivated the earth, bred new sorts of plants and animals, created new organisms (biotechnology) etc. In this process man developed knowledge and technology, which in their turn effected new forms of social live. E.g. modern society could not exist without computers, mass media, and communication technology. How could the U.N.O. do its work without all the modern facilities? Counting up these arguments I conclude that social space is not a new space, but that social dynamics add a new order to material space. And again I assume this is possible, because social development proceeds faster than physical and biological developments. Instead of a social space and a material space I prefer to speak of a socio-material space (see Fig. 3).

Fig. 3 Dynamics of socio-material space

Education for cognitive development

The central theme of this book is 'education for cognitive development'.
Our problem is how education must be organized to advance the development of cognitive activity of pupils. When we try to contribute to a solution of this problem, we must take the following factors regarding cognitive activity into account.
- Cognitive activity pertains to the functional and meaningful structure of internal and external actions.
- Cognitive activity is responsible for the organization of interactions between the individual and his environment.
- Cognitive activity will only lead to change in the organization of interactions if proper conditions in the material and social environment are met (cf. Feuerstein, Fichtner, in this volume).

- However, cognitive activity cannot be manipulated directly by acting upon external conditions. At best conditions can be created which are favourable for progressive steps in cognitive activity (cf. Van Parreren, Lompscher, in this volume).
- The effectiveness of external conditions depends on the properties of the cognitive activity of individual pupils (cf. De Jong, in this volume).

It will be obvious that education for cognitive development is not an easy task. We cannot simply shape cognitive activity by conditioning, nor by direct instruction. Both techniques have some, but only a limited value in the educational process. Ways must be found to stimulate the imaginative ability of pupils, and to guide their creativity into certain directions. That is, education should not be directed at the presentation of facts, but at presenting the pupils with models and strategies which enable them to handle new viewpoints and to construct theories explaining and generating facts. A nice example of this is presented by Hedegaard and Engeström (in this volume).

In the tradition of the socio-historical school much work has been done on the problem stated above. It has become clear that the problem is extremely complicated, and that answers will not easily be found. Therefore I cannot announce that the problem is solved in this book, although interesting and promising new perspectives are opened. Is this not what science is all about?

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The papers of the *Proceedings* have been written for the symposium *EDUCATION FOR COGNITIVE DEVELOPMENT*, held in Utrecht, The Netherlands, from 19-21 June, 1984. This symposium was the *Third International Symposium on Activity Theory* and was preceded by similar symposia in Finland (1982) and Denmark (1983).
The aim of the symposia is to create a forum, where scientists from Eastern European and Western countries exchange ideas, theoretical insights, and empirical data with recard to activity theory in human science. The creation of such a forum could enhance the application and development of the activity theory on learning and teaching.
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Therefore, speakers were invited, who are not strictly referring to activity theory, but to ideas and research related and relevant to this theory.
The contributions have been divided into four sections:
- Learning activity and instruction
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