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ABSTRACT

A study was conducted to help clarify the definitions and mutual relationships of cognitive styles and learning styles and to find a feasible instrument to be used for diagnostic purposes to help students with learning difficulties. Subjects, 81 ninth-grade suburban Finnish comprehensive school students in five classrooms, were given the Knowledge Accessing Modes Inventory (KAMI) and the Learning Style Profile (LSP). The relationships between subscales of the instruments and between styles profile and school achievement were analyzed. Results indicated that (1) hardly any subject-related differences could be discovered between the LSP and school achievement; and (2) the Cognitive Style profile subscale of the LSP correlated highly with school achievement, but that only a few subscales of other sectors of the LSP did the same. Findings suggest that parts of the LSP can be used by teachers to help identify students with learning difficulties and that the LSP can be used in preservice teacher education to familiarize students with the controversy over learning styles. (Four figures and six tables of data are included; seven pages of references and a complete list of earlier research bulletins are attached.) (RS)

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RESEARCH BULLETIN 72

Anna-Liisa Leino, Jarkko Leino and Juha P. Lindstedt

A STUDY OF LEARNING STYLES

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ABSTRACT

Styles can be inspected on different levels of an individual's life and activities. On a very general level we can speak of life styles which refer to an individual's differing ways of being and meaningfully acting. This level was not included in the study. However, the level of psycho-epistemic styles, which include an individual's orientations to knowledge accessing, is also quite general and has been included in the study, but the center of interest is learning styles. The report contains a theoretical review of cognitive styles and learning styles, and an attempt to clarify them. Learning style has been defined as consisting of cognitive styles as well as study and environmental preferences. Cognitive styles are used in a more narrow meaning of controlling and guiding an individual's learning processes and strategies.

The instruments used in the study were Knowledge Accessing Modes Inventory (K.A.M.I.) by Rancourt and Learning Style Profile (LSP) by N.A.S.S.P. The LSP consists of the following sectors: Cognitive Style Profile (CSP) by Letteri, Perceptual Response Preferences (a modified version of Edmonton Learning Style Identification Exercise ELSIE), and Study and Environmental Preferences by Dunn and Dunn. The subjects of the study represent 15-year-old Finnish comprehensive school students.

The results include a scrutiny of the relationships between the subscales of the instruments and between styles profile and school achivements. A dominant feature was the fact that hardly any subjectwise differences could be discovered. The CSP correlated highly with school achievements but only few subscales of other sectors of the LSP did the same. All the results received were quite and understandable. The instruments could be used, in particular, in teacher education.

Key words: learning style, cognitive style, style profile

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Preface

Over the years we have had a number of opportunities to discuss the problems of learning styles with many friends and colleagues abroad. This communication has happened through personal contacts as well as correspondence. We want in particular to acknowledge the discussions we have had with David E. Hunt, Charles A. Letteri, Richard Rancourt and Jean-Paul Dionne.

We are deeply grateful to Mrs. Aini Ahola, M.A., principal of Munkkivuori comprehensive school as well as the other teachers, the guidance counselors and students whose co-operation made it possible for our assistant Juha P. Lindstedt to gather the data, which he subsequently analysed.

Acting professor Juhani Jussila, Ph. D., has read the manuscript and given us comments which we gratefully acknowledge.

Our debt of gratitude goes also the the Finnish Academy for the support we received.

Helsinki, August 1989.

Anna-Liisa Leino and Jarkko Leino

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1. Introduction

The present report originates in the work that was started more than ten years ago (Leino, A-L. 1980; Leino, J.1981). At that time in Finland hardly any educational researchers were interested in styles and only a few psychologists were beginning to show an interest in questions concerning learning in the context of schools. The situation was, of course, different in the USA and Canada where a lot of research had been carried out in the field. Now things look different even in Finland: there are hardly any educational researchers who would not be, at least, aware of the existence of styles and teachers are actively seeking information about styles and their applications. The same trend is noticable in other European countries, too.

The purpose of this report is to continue the work started in the seventies even though the research ideas outlined then could not be carried out due to the lack of available resources, a phenomenon quite frequent in Finnish educational research. We have to limit ourselves to more modest aims. Our purpose is first to describe the present state of the art in a field of increasing complexity (there is a temptation to use the term confusion here). It seems that the ideas presented more than a decade ago have not been clarified at all but rather become more diverse with old theories being questioned and new theories being born with a plethora of new terminology. It has been interesting to note how psychological researchers of intelligence have shown interest in cognitive styles, how researchers of cognitive styles have become aware of learning styles and how "traditional" learning style researchers have taken an interest in cognitive styles. All these fairly recent developments justify a state of the art

description at the beginning of our report. Our original, ambitious purpose was to make an attempt at studying empirically the hierarchy of styles, as hypothesized by Royce and Powell (1983), but we had to reject the idea due to the lack of suitable instruments. The practical purpose of the study is to try to find a feasible instrument to be used as a diagnostic tool in Finnish schools.

2. State of the Art

Due to the rapid expansion of the research literature in the field our state of the art description does not claim to be exhaustive; it is based on literature available to us at the time of writing. There are at least three different areas of approaches relevant from the point-of-view of the learning individual. One originates in the psychological research of personality, perception and cognition and has yielded the concept of cognitive style. The other two approaches have most often yielded the concept of learning style. The first of these has often had a more or less phenomenological starting point, in which there is a learning individual, often an adult, faced with a learning task, and the researcher who analyses the learning process using the self-reports of the learners. The second consists of studies which use questionnaires. It is this third area which, with few exceptions, seems the most disorganized of all, at least judging by the number of instruments available. We will start with cognitive styles because they represent the oldest research tradition among the concepts relevant to our study and then continue to learning styles. After that we will briefly deal with research carried out in Finland, which we consider important because most Finnish educational researchers write in Finnish.

2.1 Cognitive Styles

Cognitive styles were studied by psychologists long before educational scientists, or psychologists themselves for that matter, became aware of their educational relevance. It was typical of these early studies that each style was separately taken up by different groups of researchers. At the present there are, however, more signs to be seen than e.g. ten years ago of attempts to integrate the different styles, to avoid overlap and to study the interrelationships between them.

In the following we will take up three cognitive styles to serve as examples of the development that has taken place in the field. These three styles are also such that they have proved relevant in the Finnish educational context. The first of these is Witkin's Field-Dependence / Independence, the second Kagan's and Kogan's Reflection / Impulsivity and the third Hunt's Conceptual Level. These styles are also examples of different approaches to the study and development of cognitive styles with Field-Dependence / Field-Independence originating in research with adults and Reflection / Impulsivity with children. Conceptual Level again is characterized by a long-term development of theoretical background and the fact that it is more pervasive and wider in scope than the others.

Field-Dependence / Field-Independence is undoubtedly the most researched style. The Witkin group started their laboratory studies towards the end of the forties and their original idea was to study how people locate the upright as quickly and accurately as they seem to do. It seemed obvious that people have their own preferred ways of integrating information coming from different sources. Three different tests were used in these early studies: body adjustment test, the rod-and-frame test, and the rotating-room test (for details see Witkin and Goodenough 1981,

8-15). These early studies showed quite clearly that primary reliance on the body would lead to more accurate performance in some situations while reliance on the visual field would lead to a more accurate performance in others. In later studies the possibility that reliance on field or body could also be conceived to involve separation of an item (body or rod) from an organized field (room or frame) was examined by means of Embedded Figures Test (EFT) (Witkin 1950). In this test the subject is shown a simple figure and then asked to find it in a complex figure in which the simple figure is effectively hidden. Subjects who had difficulties in accomplishing this task were the ones who also had difficulties in keeping body or rod separate from room or frame in the orientation task, i.e. they were field-dependent. Those who were field-independent in the orientation task could easily locate the simple figure hidden in the complex design. Further research considerably widened the scope of field dependence-independence dimension linking it to the ability to overcome embedding contexts in problem-solving tasks and to structuring ability in perceptual and intellectual functioning. Conceptually the dimension was developed by viewing analysis and structuring as complementary aspects of articulation. Thus the subject who experiences in an articulated way can perceive items as discrete from their background when the field is organized, and can impose a structure on a field which has little inherent structure perceiving the field as organized. The enlarged dimension of individual differences was now conceived as an "articulated field approach" at one extreme and a "global field approach at the other extreme" (Witkin and Goodenough 1981, 18). Even though the social domain is a late-comer in the development of research on field dependence-independence, there is evidence to show that people who function more autonomously of external visual field in the perception of the upright also function more autonomously of others in social situations. The relation between interpersonal autonomy and performance

in restructuring tasks such as the EFT is equally well established. There is, however, more research on the social characteristics of field-dependent than field-independent people. The former are e.g. characterized as warm, affectionate, tactful, nonevaluative and accepting of others while the latter are described as demanding, inconsiderate, cold and distant (p. 44). But the writers state quite clearly that there is as yet very little information of the social skills of field independent people beyond the evidence that they are limited in interpersonal competencies.

Reflection-Impulsivity, also a well-researched style, was conceptualized and operationalized in the early sixties by Kagan and his group (Kogan 1976). This style originates in research carried out on conceptualizing styles concerned with the principles used in perceiving objects as similar to one another. The style is measured by means of sorting or grouping tasks in which the individual is asked to group objects on the basis of their perceived similarity. In addition to the three conceptualizing styles (descriptive, relational, and inferential) that were discovered in this way, it also became evident that people varied in their tempo or the time it took them to give a response. This style was called reflection-impulsivity and defined by Kagan and Kogan (cited in Kogan 1976, 31-32) as "concerned with the degree to which the subject reflects the validity of his solution hypotheses in problems that contain response uncertainty". Shipman and Shipman (1985) have pointed out that the term "conceptual tempo" has been introduced to avoid confusion between the general psychological term "impulsivity", which is often assessed by means of measures of activity level or ability to delay gratification. They state that the "new" term refers to general cognitive-conceptual speed which is involved in Matching Familiar Figures test performance but that the crux of reflection-impulsivity is its focus on the child's ability to control his response in a situation of response uncertainty (p. 252).

Conceptual Level theory originates in the work of Harvey, Hunt, and Schroder (1961). The style approach developed by Hunt seems to be internationally the best-known. To him Conceptual Level is a characteristic referring to both cognitive complexity (differentiation / integration) and interpersonal maturity (increasing self-responsibility) (Hunt e.g. 1975). It is concerned with individual differences in information processing, the way a person "reads" environmental events, e.g. social stimuli (Hunt 1971). The style is measured by means of Paragraph Completion Method (PCM) developed by Hunt et al. (1978). This style has from the very beginning shown its educational relevance through the Conceptual Level Matching Model based on research results, indicating that low Conceptual Level learners profit more from a high structured environment and high Conceptual Level learners from a low structure or are less affected by variations in structure. This is a research result, which experienced teachers have always implicitly known as Hunt himself has pointed out. Hunt's theory has greatly influenced educational research and thinking in Finland. (For later developments of his thinking see Hunt 1986.)

The three styles above were taken up as examples of a highly varied field for the reason given previously. They were given only a brief description but we will return to them in later sections e.g. when we deal with the related research carried out in Finland. There are a great number of other cognitive styles and those with relevance for this study will be dealt with in proper contexts. Messick (see e.g. 1976, 1984, 1987) has thoroughly examined characteristic features of cognitive styles and the various ways in which styles differ from one another and from intellective abilities. He has listed and analysed eleven different conceptions of cognitive styles (each conception consisting of one or more styles) ranging from "structural properties of the cognitive system" to "cognitive consequences

of personality trends". After the analysis he himself conceptualizes cognitive styles as "characteristic self-consistencies in information processing that develop in congeniai ways around the underlying personality trends" (Messick 1984, 61). Messick uses the term "personality trend" to indicate aspects of personality organization that imply direction, without committing to the specific nature of the direction-giving entity. Because there is a tendency in Finland among educational researchers and practitioners often to consider cognition and cognitive styles as totally separated from affective aspects of personality. it is necessary to emphasize that cognitive styles are closely inter-woven with affective, temperamental, and motivational structures as part of the total personality (Messick 1984, 1987). (What is meant by the concept "personality" remains often unclear. Representatives of different disciplines have their own, often also varying, definitions of the term. Niskanen,1989, has written a thorough-going analysis of the concept form the point-of-view of educational science.) Another tendency is to use the information concerning cognitive styles to categorize or label people which makes it important to bear in mind what Hudson (cited in Messick 1987, 61) has written: "Cognitive styles are not categories or types but dimensions of continuous variation; not pigeon holes but sign posts for characterizing individual propensities; not merely behavioral differences but tendencies or tensions underlying the surface of intellectual life".

2.1.1 Related concepts

Concepts closely related to cognitive styles are cognitive strategies and controls. A problematic aspect is also the relationship between abilities

and cognitive styles. A quick look at the instruments used for measuring styles confirms that some of them bear a close resemblance and, what is even more interesting, are identical to instruments used for measuring abilities. The relationships between these concepts will be the topic of the following discussion.

Bruner, Goodnow, and Austin (1956) were among the first to use the term strategy to describe the ways which subjects used while looking for rules for categorizing the figure cards given to them. Later on the term has been used particularly by representatives of experimental psychology to denote ways of acting and thinking which are used in certain types of situations or tasks (Leino, J.1984a). In studies of school learning it has been used e.g. for the ways of retaining written texts (vonWright et al. 1979) or the ways of solving certain types of elementary equations (Keranto 1984). Based on the preferences for different strategies, the subjects have been categorized as e.g. holists or serialists. When strategy researchers report their results they often decontextualize their study, i.e. they do not specify the situation, the content of the tasks etc. but use the terminology in a way that seems to refer directly to cognitive styles. Strategy is expressed in performance and even though strategies are selected, organized, and controlled in part by cognitive styles, the essential distinguishing feature is the fact that they are also selected partly as a function of task requirements and problem content as Messick (1984, 1987) has pointed out. A further factor that also plays a role is the match between abilities required to employ the strategy and the abilities operative in the individual's skill repertoire (Frederiksen cited in Messick 1984,1987).

Since the time of Binet psychologists have been interested in analyzing human intellectual capabilities into component abilities. For instance, it

is generally accepted that one aspect of human intelligence relates to the ability to process language: it is involved when we read a book, understand a poem, solve a riddle, or write a paper (Carpenter and Just 1986, 221). Another ability is involved when we process spatial information, i.e interpret a picture, read a map or blueprint, or understand a graph. Abilities originate from the research tradition of psychometric tests and are conceived of as broad traits that enter into a variety of tasks and performance measures.

Though human being is a functional unity, his intelligence seems to have many different functional orientations. Several cognitive abilities are needed for the description of human intelligence. The number of the abilities depends on the level of description. Which level of abstraction is the best is a question of objectives. Within the educational context of official curriculum broad concepts may seem to be profitable whereas in teaching-learning practice more detailed description systems may be better.

From the beginning of the research of human abilities the process nature of description was aimed at, but it is only during the past few decades of cognitive psychology that the information processing approach has actualized this aspect and made it of crucial importance. Cognitive research has also shown that the items traditionally used for measuring abilities could be performed by using different strategies and processes. It has been discovered that even each of the primary abilities, such as those e.g. in Thurstone's studies (1938), consists of several "primary processes". The process approach has also made it evident that abilities can be developed and are best conceived of as dynamic concepts. Human traits or factors and processes appear to go hand in hand (Messick1987). Some theories of human capabilities focus on structural features of

individual differences in intellectual fuctioning while others focus on information-processing operations in the performance of intellectual tasks. But there have also been attempts to include both structures and processes in human functioning (e.g. Royce and Powell 1983).

Cognitive styles can be conceptually distinguished from abilities on the basis of the level of abstraction as well as the primary functional concern. When e.g. Witkin with his co-workers started to use the term cognitive style in the early sixties, they defined it as a pervasive dimension of individual functioning, being manifest in the perceptual, intellectual, personality, and social domains, and discovered its development to be closely interwoven in the development of the organism as a whole (Witkin and Goodenough 1981, 57). It involved individual differences in process rather than content variables thus referring to the "how" rather than the "what" of behavior. Because of the generality of the concept, the style was of reasonable stability over time. However, measuring e.g. field-independence as a cognitive style dimension is based (in EFT) on a subject's ability of cognitive restructuring. Though styles refer to the manner of moving toward a goal and abilities to the competence in goal attainment, we can trace styles on the higher level of the hierarchy of intelligence: a high EFT score (i.e. field independence) means that the subject's fluid intelligence G_f is high while a low EFT score (field dependence) respectively means that the subject's intelligence is probably more loaded on crystallized intelligence G_c (Cattell 1971, Horn 1986).

Messick (1984, 1987), in accordance with Witkin's ideas (cf. above), has tried to clarify the distinction between styles and abilities. Cognitive styles are typically bipolar while abilities are unipolar: abilities range from zero or very little to a great deal, with increasing levels implying

more and more of the same facility, while cognitive styles range from one extreme to a contrasting extreme, with each pole of the dimension having different implications for cognitive functioning. Abilities are measured in terms of competencies implying maximal performance, while styles are measured in terms of propensities implying either typical or contrasted performance, with the emphasis on either the customary or predominant processing mode. Abilities are specific to a particular domain of content or function, such as verbal, numerical, and spatial ability or fluency and memory ability. A cognitive style, in contrast, cuts across abilities, as well as other cognitive, personality, and interpersonal domains. Styles organize and control abilities, attention, impulse, strategies, and operations in such complex processes as problem-solving and learning.

Cognitive styles appear on different levels of human functioning. In the literature there are studies to be found in which styles play a part in controlling the processes and strategies in specific tasks within a certain context. In these studies styles are closely connected with specific performances and hence abilities. The general context may be a certain topic in some school subject. No wonder cognitive styles, intellectual abilities, and cognitive controls are used in the literature in almost the same meaning. Messick (1984) has made an attempt to distinguish abilities from styles on the basis of seven aspects which are presented in Figure1.

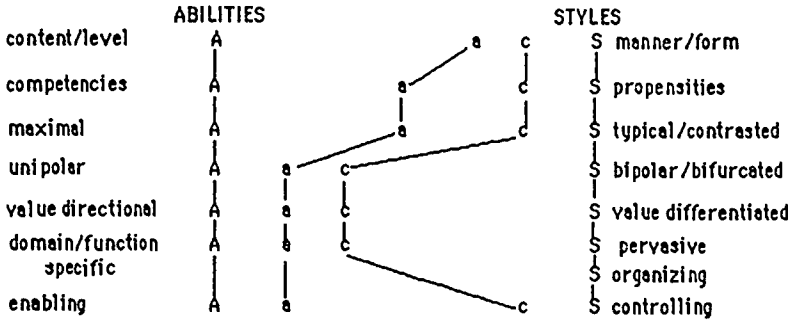

Figure 1 Contrasting properties of cognitive styles, intellectual abilities, cognitive controls, and stylistic abilities (Messick 1984, 65)

As can be seen in the Figure, Messick regards cognitive controls to resemble styles, though not always in all aspects: in the exceptional aspects cognitive controls are relatively function-specific, often unipolar and value directional, thus approaching abilities. He mentions as examples such variables as conceptual differentiation, articulation, and integration and, as another group, relational, analytic-descriptive, and categorical-inferential conceptualizing. Still more closer to abilities are stylistic abilities, such as fluency, flexibility, and originality. From a researcher's and theoretician's point-of-view, Messick's thorough-going analysis is fruitful and interesting, but from a practitioner's point-of-view it may not be suitable for clarifying a complex field.

2.1.2 Integration of concepts

From the point-of-view of educational practice, one of the major

weaknesses with research on cognitive styles is the fact that they have long been studied in isolation, each style by its own group of researchers. Still, we cannot fully endorse Shipman's and Shipman's (1987, 259) position according to which the concept of cognitive style "has not yet been integrated as a whole into any dominant theories nor has a new theory been developed to accomodate them". The work done in Canada by Royce and his associates (see Royce and Powell 1983) well represents a dominant theory which also accomodates the cognitive styles. We will discuss their theory of personality after introducing Letteri's (1982, 1985) model, which is based on information processing theory and accomodates a number of cognitive styles. The reason for introducing his model first is the fact that it is also relevant from the point-of-view of our previous discussion of the relationships between styles, abilities and strategies.

The basis for Letteri's studies can be traced from information-processing theory and brain physiology (Santostefano 1978). Cognitive styles form a control system by means of which an individual actively and consciously steers the flow of information from its reception in one of the perceptual modalities (e.g. eye, ear) through perceptual memory to a filter system where decisions are made relative to further processing of the information. These decisions vary from rejecting the information to memorizing, transforming or learning it. Memorized information is held in isolation from other existing information; learned information is assimilated and integrated into the existing relevant and related information, i.e. into cognitive structure which may be modified in this process. Figure 2 presents the main factors in Letteri's model. (As an information-processing model it is only concerned with incoming information and consequently omits such aspects as searching for information and acting on it in a purposeful way.)

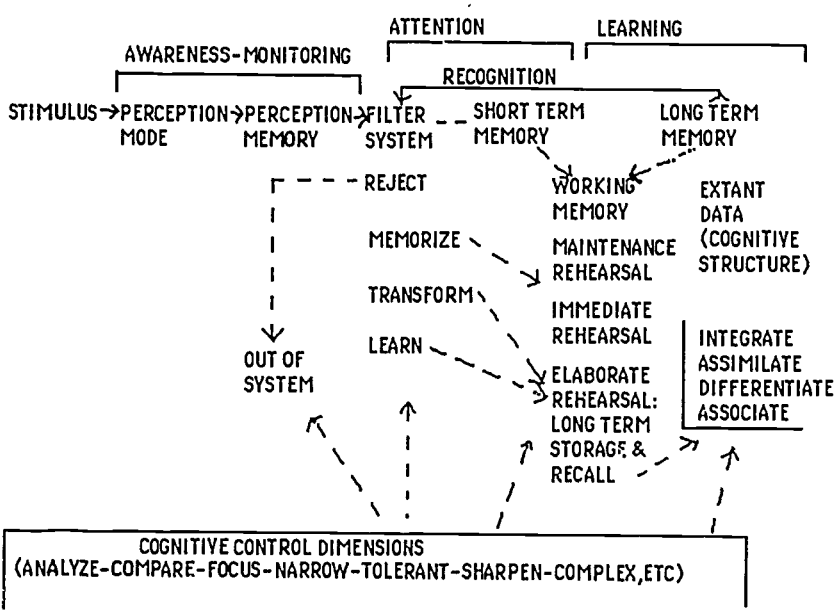

Figure 2 Information processing - general operations (Letteri 1985, 113)

Cognitive controls in Letteri's model, such as analyzing, comparing, focusing, and narrowing, might be considered abilities as well as cognitive controls or styles. What makes the difference between these two conceptions is that when dealing with styles it is the subject's typical way to approach the task that is involved; while dealing with abilities the interest lies in what the subject is able to do. Letteri's model of cognitive styles and controls concerns the very level of performance. Cognitive styles are now information processing habits and they describe how an individual learns. What is also important in Letteri's model is the fact that the individual's information processing as a whole - not only the separate style dimensions - is described by means of the profile of seven style dimensions because this gives a pervasive basis for understanding the individual's functioning. An attempt at integrating some

conception of cognitive styles into an information-processing model of cognition has later been made by Miller (1987).

A comprehensive theory of the role and importance of cognitive styles in human intelligence, personality, and individual differences is presented by Royce and his team (Royce and Powell 1983). Personality is usually conceptualized as a system with several subsystems such as cognition and intellect, affect, value and motivation, and temperament. Royce's model is basically an information-processing model, but it is not restricted only to processes and strategies with a possible box of metacognition which the cognitive psychologists usually employ. Royce's theory is a comprehensive attempt to describe the personality in the light of all psychological research made so far. Personality is regarded as a suprasystem being composed of six interacting subsystems: sensory, motor, cognition, affect, style, and value. The cognitive system and the sensorimotor system form the information-processing system also to be seen e.g. in Letteri's model in Figure 2. The affective system is located on the same level as the cognitive system. The style and value systems are hierarchically organized as the higher-level systems which have a coordinating and controlling influence on the lower-level systems, i.e. on the cognitive and affective systems and the sensorimotor system. The higher-level systems (1) are more important with respect to the processes involved in personality integration, (2) c input coordinating information, (3) are concerned with longer units of time, (4) have a higher priority of action, and (5) are more closely related to the deeper (in the sense of significant) levels or aspects of personality. Personality is considered to be a goal-seeking system with internal norms for evaluating whether actions are "successful" (Royce and Powell 1983, 12). Figure 3 presents the main components of the theory.

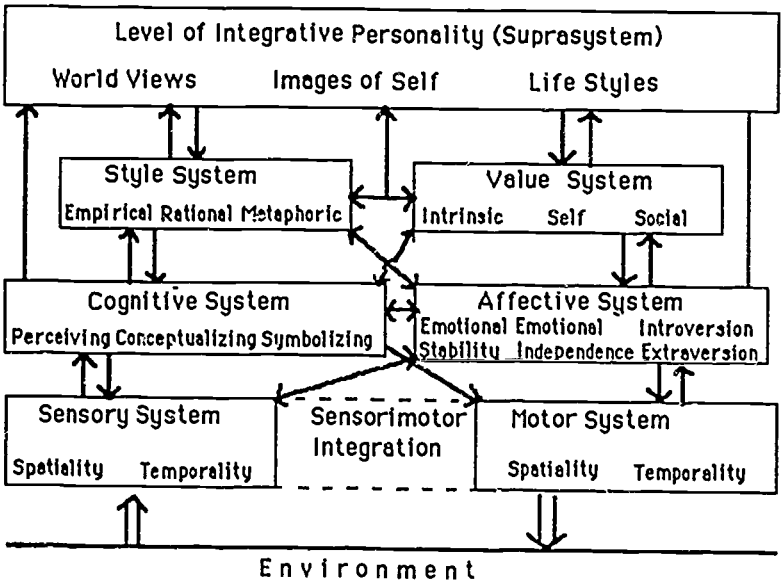

Figure 3 The basic systems of personality (adapted from Royce and Powell 1983,13)

In the theory the cognitive styles are more general and deeper in personality than abilities which are located in the cognitive systems. The part of the theory which is concerned with cognitions is based on three ways of knowing: through perceptions (with spatiovisual abilities and memory abilities), conceptualizing (with verbal and reasoning abilities), and symbolizing (with fluency and imagination abilities). Styles are activated when alternative possibilities exist or when the situation is sufficiently complex that multiple modes of response are feasible. Royce and Powell distinguish cognitive styles from affective styles but emphasizes that styles can also appear as combinations of the two. He presents two levels of styles: one of cognitive and affective styles accommodating such style dimensions as were mentioned in the beginning of chapter 2.1 and another, more general, including the so-called epistemic styles. For the measurement of these styles Royce and Mos

(1980) have developed an inventory (Psycho-Epistemological Profile, PEP) based on two long range research projects: the knowing project and the individuality project leading to the psycho-philosophical theory of knowledge emerging from the projects. The inventory has been used by Rancourt and Dionne (1982) in a study of teaching and learning styles, in which they found a high degree of congruence between the teachers' psycho-epistemic profiles and the epistemic characteristics of their field of specialization. The results were further confirmed in a later study (Rancourt 1983, Leino, J. 1987). Rancourt (1986 a,b) has also developed a much shorter and versatile version of the inventory called Knowledge Accessing Modes Inventory (K.A.M.I.), which is designed to be used in educational contexts (see Rancourt 1987, Noble and Rancourt 1987, and Rancourt 1989).

Within the framework of Royce's theory we can inspect the style models by Messick and Letteri as well as the relationship between styles and abilities, the latter including information processing and strategies. Though the nomenclature may differ the accordance is quite good.

2.2 Learning styles

The area of what is included in the concept of learning style is also very heterogeneous (see e.g. Huff et al. 1986; N.A.S.S.P. 1982; Schmeck 1988), so much so that one almost feels tempted to consider it to be in a state of disarray. There seem to be tens of different learning style systems and the number of dimensions must be hundreds. Some of the learning style models are business-oriented with their developers or "merchants" treating practitioners as consumers who have to buy the questionnaires, pay to have them scored, and pay to participate in workshops on how to use the test scores (Hunt 1986, 48). There are models and instrumentation

developed with a solid theoretical background, there are those with very little theory and research to support them and finally there are styles that originate from phenomenologically oriented research.

2.2.1 Terminological Aspects

Even though learning styles are of more recent origin than cognitive styles and the research usually has a closer connection with concrete learning situations, the two terms are often used as synonyms. Messick (1987, 37) has made a distinction between the two concepts at a very general level: "cognitive styles bear on the organization and control of cognitive processes, learning styles on the organization and control of strategies for learning and knowledge acquisition", and he adds a third, "new" concept to the field, "defensive styles on the organization and control of affect in cognition". But if one wants to be more specific and make a distinction between the key concepts of "cognition" and "learning and knowledge acquisition" the distinction becomes fuzzier. And then after all, it is mainly through the individual's performance that one gets information on cognitive styles and strategies as well as learning styles and strategies. Learning style has also been defined by other researches and often in connection with learning strategy. It seems that those two concepts are so closely interwoven that the definition of one almost automatically entails the definition of the other. There are also other concepts very closely related to the field (see also Figure 4). This is what we will discuss in the following.

Learning strategy has been defined by Schmeck (1982) as the pattern of information-processing activities that a person engages in when confronted by a learning-task. According to Snowman (cited in Schmeck 1988) a learning strategy is a sequence of procedures for accomplishing

learning and the specific procedures within this sequence are called tactics. Schmeck has given operational definitions of the terms learning tactics, strategies and styles. He and his colleagues developed a self-report questionnaire concerning the learning process of college students. Each of the items asked the students about a learning tactic (e.g. using imagery to remember the definition of a word). The clusters of tactics revealed through factor-analysis served as operational definitions of learning strategies. And because the instructions given in the questionnaire indicated that the students, when answering, should not think about a particular course but learning in general, the scores could also be considered as indicators of learning styles. Schmeck, however, preferred to use the term orientation instead of style in his latest text (Schmeck 1988).

Ramsden (1988) and Entwistle (1988) reserve the term style for what is traditionally called cognitive style in the sense that Pask used the term. They adopted the terms orientation and approach, which were originally introduced by Marton (e.g.1974) to describe the basic differences in the university students' way of reading academic texts. According to Entwistle (1988) approach, on the one hand, has been found to be variable depending on the content and conte of learning and, on the other, to show considerable consistency across situations. It was this cross-situational consistency that led him to introduce the concept of orientation to studying. It seems that orientations are what Biggs (1988) calls learning styles, which he defines as stable ways of approaching tasks that are characteristic of individuals. Learning strategies are ways of handling particular tasks, which means that strategies are focused on the task, while styles are focused on the person. Approach refers to the learning processes that emerge from students' perception of the academic task, as influenced by their personal characteristics. Approach is thus a wider

concept including both situational and personological elements (Biggs 1988) or a strategy and an intention (Schmeck 1988). Ramsden (1988) calls the two components of approaches referential and relational. The former refers to the student's intention and the latter is concerned with process or cognitive approach (deep/holistic or surface/atomistic). An interesting contribution to the discussion of the terms is introduced by Das (1988, 102), who speaks of image as a base for cognitive styles and strategies. Image was originally conceptualized by Miller et al. (1960). It refers to the knowledge-base of an individual, to his identity and to his memories, knowledge and experience.

In order to place the concepts discussed so far in a wider context and also to introduce some other relevant concepts we present a modified version of Entwistle's heuristic model of learning in an educational setting. The modifications have been done on the basis of the model of personality developed by Royce and Powell (1983), where value system and affective system play a central role. It is of great interest to note that the concept of motivation does not appear in their theory formulation at all, it is not even listed in the subject index of the book. It seems to us that their value system and affective system also well cover those aspects of personality which are traditionally called motivation. Value system, like style system, is postulated to have an integrative role in the overall functioning of personality. Values have a central role in selecting particular contents of information-processing activities. Because values have linkages to cognition and affect, there are two kinds of values: cognitive values which reflect interests and affective values which reflect needs (p. 145). It is our opinion that the concept of undifferentiated motivation in the original model instead of values and affect is somewhat misleading because motivation in some form is also involved in the approaches to learning (e.g. Schmeck 1988, 10). But then again in the concrete teaching-

learning process it is the affective system which can well be considered to cover motivation, since it, together with the cognitive system, is engaged in the active transformation of information (p. 10). Another reason for rejecting the concept of motivation from the model is its direct connection with the behavioristic theories of learning. The specifications in the original model concerning teaching were not relevant in this context and were therefore omitted.

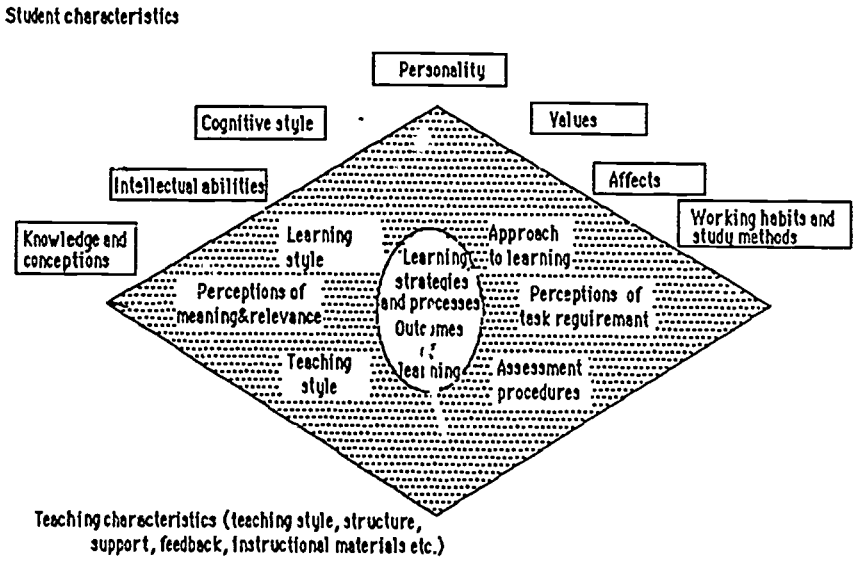

Figure 4. A modified model of learning in an educational setting (based on Entwistle 1987, 83)

2.2.2 Related Research and Instrumentation

We will in the following first (1) give a brief summary of related research and then (2) deal with learning styles which have a connection with the psychological concept of type and finally (3) discuss styles which are

based on perceptual consistencies or which can be regarded as attitudes towards learning and intellectual activities.

(1) The relevant research that has its origins in the European context can be characterized as being more closely connected with the learning tasks than the underlying personality structures. It is often phenomenologically or, to use Marton's (1981) term, phenomenographically oriented with the emphasis on the direct exploration of students' experiences of learning, and has so far mainly concerned student learning in higher education. This kind of research was started in Gothenburg and it influenced research orientations first in Britain and then also in other countries. The research concentrates on the content of what is learned and how the learning takes place. The students were given academic articles to read, knowing that they would be asked questions on what they remembered of it afterwards. In addition to questions about the content of the articles, the students were also asked how they had handled the learning tasks and how it had appeared to them (see e.g. Marton 1974; Marton and Säljö 1984; Marton 1988). Marton introduced the concept of "approach to learning " to describe the basic difference in the students' way of reading texts. The two approaches were "deep", which means that the student looks for meaning in the text, interacts actively with it and relates it to real life, and "surface", which in turn means focus on the text itself such as it is and reliance on rote learning with a consciousness of the test demands. Subsequently Svensson (1976,1984) made an independent analysis of the same data analysing outcomes as well as processes with the same intention of explaining differences in the outcomes. He came up with two variations in cognitive approach: the holistic and the atomistic. Of the two dichotomies produced, one (deep/surface) emphasized referential aspects of students' experiences (search for meaning), while the other (holistic/atomistic) concerned organisational aspects (the way the

students organized the content of the article in their reading) (Marton and Säljö 1984). An interesting study worth mentioning in this connection is Säljö's (1979) in which he interviewed a group of adults asking what learning meant to them. The study resulted in five qualitatively different conceptions of learning, which also in later studies have been found to correlate with approaches to learning (Marton and Säljö 1984, 53). The research done in Sweden by Marton and his group has greatly influenced the direction of research on learning in Britain.

While the Gothenburg group started their research into learning from concrete learning situations using only small groups of university students, Entwistle and his colleagues used large samples, various psychological variables and statistical analyses to predict academic performance among university students (see e.g. Entwistle and Brennan 1971; Entwistle et al. 1971). He was particularly interested in the questions of motivation. Later on (see e.g. Entwistle et al. 1979; Enwistle 1981, 1984, 1988) he has been concerned with developing Marton's ideas about approaches to learning trying to develop a questionnaire also incorporating Pask's (e.g.1976a, 1976b; see also Pask 1988) and Biggs's (e.g. Biggs and Collis 1982) ideas. The domains in his questionnaire are as follows: Meaning Orientation (e.g. Deep Approach), Reproducing Orientation (e.g. Surface Approach), Achieving Orientation, and Learning Style (Comprehension Learning, Globetrotting, Operation Learning and Improvidence) (Entwistle 1988). The domain of learning style is based on Pask's research.

Pask and his colleagues have employed experimental procedures often monitored by computer systems and completed by psychological tests and inventories. Entwistle (1978) has written a summary of Pask's research stating in the Introduction as follows: "Complex theoretical ideas derived

from epistemological considerations are expressed in what amounts to a new language - a whole string of invented terms together with re-definitions. This theoretical structure is then allied to descriptions of specially developed computer programs, and to equally complex descriptions of the knowledge structures found in esoteric subject-matter areas, particularly in the sciences. The range of prior knowledge necessary for a full understanding of Pask's research is rarely to be found. Even to come to grips with the main message presented by Pask and his colleagues is extremely difficult" (p. 255). Here we are again reminded of what Hunt calls (1986, 51) "the mystique of learning style". Entwistle's and his colleagues' factor analytic studies resulted in three learning styles or orientations called meaning, reproducing, and achieving each being related to different kind of motivation. Meaning involves intrinsic motivation, while reproducing and achieving each involve extrinsic motivation. Reproducing is related with fear of failure and achieving with hope for success.

Research closely related to Entwistle's but more clearly originating from psychological information-processing theory has been carried out by Biggs and Das. Biggs (e.g. 1984) identified factors similar to Entwistle's naming them utilising, internalising, and achieving. Students adopting a surface approach are instrumentally or pragmatically oriented, while those adopting a deep approach are motivated by intrinsic interest in the task and the expectation of enjoyment in carrying it out. Students adopting an achieving orientation want to manifest their excellence relative to other students, particularly in obtaining as high grades as possible. Das identified by means of factor analysis simultaneous and successive modes of information processing, which can also be regarded as cognitive styles (Das et al. 1979; Das 1988). Even Schmeck (e.g.1982) used factor analysis, as was mentioned earlier, and identified four learning styles factors

named deep processing, fact retention, methodical study, and elaborative processing.

The research previously discussed has almost entirely concentrated on learning in various academic settings. The most notable exception is, however, Das whose samples included normal and retarded children as well as adults in various cultural and ethnic groups.

(2) Vernon, in the early seventies (cited in Messick 1984), pointed out some resemblance between the earlier concept of style and the psychological concept of type. Nowadays the difference between the two concepts seems to be growing more and more vague at least in the case of the systems using the theory of psychological types of the Swiss psychologist Jung whose theory is well on the way of arousing the interest of educational researchers and getting educational adaptations. This is mainly due to the type indicator developed by Myers and Briggs during twenty years (Briggs, Myers and McCaulley 1985). The writers emphasize that "type" is to be seen as a dynamic, not a static concept. Their instrument is a self-administering questionnaire covering the following dimensions: sensing / intuition, thinking / feeling, extraversion / introversion and judgement / perception. The first three dimensions are based directly on Jung, the fourth was added by the writers to make explicit what was implicit in Jung's work. It seems that the first two dimensions have a closest resemblance with learning styles. The number of types yielded by the indicator is sixteen, designated by combinations of letters referring to the dimensions. For educational adaptations of the system see e.g. Huff et al. (1986), Lawrence (1982), and Morguis (1981).

Kolb (1976, 1980, 1984) has developed an experiential learning theory, which provides a model of a learning process and conceptualizes it in such

a way that four individual learning styles can be identified. The learning model is based on the Jungian concept of types and the theory on ideas and theories presented by Dewey, Lewin and Piaget. The experiential learning model consists of four different ways in which learners interact with their world. The orientational dimensions are Concrete Experience / Abstract Conceptualization and Reflective Observation / Active Experimentation. The crossing of these two dimensions gives the four styles which are the Diverger, the Assimilator, the Converger and the Accomodator. The Diverger takes in information concretely and processes it reflectively, while the Assimilator begins with an abstraction and processes it reflectively. The Converger also begins with an abstraction but processes it actively while the Accomodator takes in information concretely and processes it actively. The styles are measured by means of nine sets of four words. The learner rank-orders the words in each set by assigning number four to the word that best characterizes his learning style, number three to the word that next best characterizes his learning style etc. The learning style inventory is very easy and quick to use, which obviously is the reason for its great popularity even in European countries. Attempts have been made to get some empirical indication of the validity of relationships between Jung's personality types and the learning styles by correlating individuals' scores on the type indicator developed by Myers and Briggs and Kolb's own inventory (see Kolb 1984, 80-81). There is much research carried out on academic specialization and the learning styles, and the ideas and the model have been developed to be applied in practical school situations by e.g. MacCarthy (Huff et al.1986). Hunt (1986, 149-160) has used Kolb's model and developed it further into a C-RE-A-T-E cycle to be used as a basis for practitioners to apply their implicit theories to their concerns and to share their experienced knowledge. (Kolb's model describes an indivudual's learning process more comprehensively than typical information-processing models because it

includes experimenting one's ideas and acting on incoming information. However, generalizing any part of this circle as an individual's learning style and typifying individuals accordingly is an oversimplification.)

A learning style instrument that closely resembles Kolb's, in its outer format and the use of individual words as stimuli, has been developed by Gregorc (1982a, b). It has also the dimension of Concrete / Abstract but instead of Active Experimentation / Reflective Observation he uses the dimension Random / Systematic. The data used as the basis for developing the instrument was phenomenologically derived through interviews of "successful" students, protocols and documents written by the individuals themselves and by the researcher describing what went on in the semi-structured interviews. Gregorc is well aware of the difficulties involved in the translation of the results of a phenomenological study into a concrete tool which could be used by "nonphenomenologically-oriented" individuals. "The question of how to 'reveal' flowing, subtle, and potent metaphysical forces through a static, hard-data physical instrument is awesome" (Gregorc 1982b, 4). The styles are described as follows: the concrete sequential person is careful with details, objective and persistent, while the abstract sequential person is analytical, logical and oriented to research. The abstract random person is spontaneous, sensitive and aesthetic, while the concrete random individual is creative, risk taking and intuitive. Gregorc's system seems to be used rather widely and has many educational applications (e.g. Butler 1982; Huff et al.1986). There is a try-out of his instrument on a Finnish sample (Leino, A-L. 1987).

(3) Learning styles have also been based on perceptual consistencies or brain hemisphericity. The former is exemplified by Reinert (1976, 1977), who developed Edmonds Learning Style Identification Exercise (ELSIE). It

is based on the idea that the learner's pattern of internalization of his native language reveals his learning style, but the sources do not reveal any further information of the theoretical background to the instrument or related research. The instrument gives a profile of students' perceptual style according to the way they respond when hearing fifty common English words read one at a time at five second interval. They are asked to give a spontaneous indication of which of the following responses occurs to them: vizualization (a mental image of what was heard), written word (a mental image or the word spelled out), listening (no mental image but meaning comes from the sound of the word), or kinesthetic reaction (emotional or physical feeling about the word) (see also Keefe 1982; Leino, A-L.1980). Information concerning different sense modalities can be applied in practical teaching/learning situations and it also has a close connection with the questions of brain hemisphericity (see e.g. Huff et al. 1986), which has aroused a great deal of interest among behavioral and educational scientists (see e.g. N.A.S.S.P.1982; Torrance and Rockstein 1988). It seems that educational practitioners are directly mislead by the unfounded claims made by brain researchers in Finland. Our school system is accused of teaching only to the left hemisphere and neglecting the right, as if the two hemispheres functioned independent of one another. It should be remembered that much of research is so far contradictory or inconclusive and based on studies of animals and brain damaged people. Hunt states of the "brain mystique" that it is highly unlikely that we will ever be able to measure brain activity directly to assess learning style (1987, 52).

Learning styles have also been considered to be consistent attitudes toward learning and intellectual abilities. This view is in particular represented by Dunn et al. (1977, 1978; Price et al. 1976). In their approach students indicate their preferences for different environmental

(sound, light, temperature, and design), emotional (motivation, persistence, responsibility, and structure), sociological (peers, self, pair, team, adult and varied), and physical (perceptual preferences, food intake, time of day, and mobility) elements. The original form of the inventory consisted of a hundred statements with which the learner agrees or disagrees. The analysis of the inventory is computerized providing the teacher with a summary of each student's learning style. Experiments with this inventory have been carried out over the years. At one stage a fifth group of elements or a new dimension was added and that was the psychological dimension consisting of analytic / global, reflective / impulsive and cerebral dominance (Price 1982; Dunn 1984). The instrument has also been modified to be used with adults (Dunn, K.J. 1982). The inventory seems to be popular and there is also research related to it (e.g. Dunn, R. 1982; Dunn et al. 1989), even though most of it seems to be unpublished. It has been almost impossible to find literature or research pertinent to the development of the instrument, it is the rationale or the theoretical background which seems to be missing. The inventory has been critically examined by Davidman (1981) and also Chiarelott and Davidman (1983), who added a third response alternative, "uncertain", and stated that almost a third of the students picked this third alternative in twenty percent of the items, which obviously was contrary to the expectations of the writers of the instrument. There is a version of the inventory nowadays containing five response alternatives, which is included in the instrument employed in this study.

2.3 Research carried out in Finland

As we mentioned earlier Finland was rather late to join other researchers in the international arena to study learning styles, which may be due to the research traditions in Finland favouring more research on teaching than on learning. In one of the first studies (Leino, A-L. 1980), started in the mid-seventies, an attempt was made to lay a foundation for an extensive study of learning styles and their practical implications for school life. At that time getting information on learning styles in general and instrumentation in particular was not very easy.

Our first attempt was thus limited to a discussion of the theoretical background based on Hunt's Conceptual Level theory and a try out of two widely differing instruments, one of which was Paragraph Completion Method (Hunt et al. 1978) and the other Field Dependence / Field Independence (Witkin 1971), neither of which had been used before in educational research in Finland. This information was completed by means of a learning style questionnaire and teacher-assigned grades. The results (n= 93), by and large, verified results received in similar studies in other countries. In a continuation study (Leino, A-L. 1982) complementary data was gathered at an individual level by orally interviewing extreme groups of CL and FD/FI (n=18). Complementary data concerned various aspects of structure, social and environmental elements of learning, motivation, career expectation, and responsibility as well as specific foreign language learning strategies and performances. The results were in accordance with the CL theory: in interview situations the students with high Conceptual Level considered different aspects of the questions, saw several alternatives, did not give either-or answers and verbalized their

responses more than did students with low Conceptual Level. As for FD/FI, the results were less clear-cut: there were, e.g., those FI:s who favoured careers in which analytical skills are required and FD:s who favoured careers involving social intereaction, but this was not systematic. As for performing the linguistic tasks given to the students, it was the high Conceptual Level group who could "think aloud" or verbalize their thinking process while performing the tasks. For the others this was almost impossible.

The styles were also used to study the entrance examination results of those accepted to teacher education in Helsinki University (Leino, A-L. and Puurula 1983) and in another context to study the leadership conceptions and cognitive styles of school principals (Leino, J. 1984b). In addition to the styles mentioned above, J. Leino also used Kelly's Repertory Grid Method to study Conceptual Complexity. The degree of structure required in the teaching of different subject matter areas and the specialization of each principal was also examined. Most of the principals (n= 87) were teachers whose specialization was mathematics, history, biology or physical education. According to the results the principal is typically field independent, cognitively complex, and his conceptual level is high. A minority of the principals were field-dependent, cognitively simple and had a low conceptual level. The principals' conceptions of leadership could not be explained by any single organisation theory. Their work seems to be organisational and task-oriented rather than demanding personal involvement.

The battery of cognitive controls used by Letteri (1980) was used by Aimo and Viilo (1984) in a master's thesis supervised by J. Leino to study what kind of student groups could be formed on the basis of the cognitive

controls or styles and whether the school achievements of these groups were different. Even though the research design differed from Letteri's, who had formed the groups of students on the basis of their school achievements and then compared their cognitive profiles, the results closely resembled those of Letteri's with two exceptions, which concern the Tolerance of Ambiguity and Breadth of Category of the high achieving group. When comparing the results we have, of course, to remember that the sample of this study was small (n=24) and that the test of categorization is culturally biased favouring students familiar with North American culture. In another study (Ristolainen and Viilo 1985) the cognitive profile of students was found to be rather stable in the upper grades of the comprehensive school with slight increases in reflectivity and field-independence.

Letteri's ideas have also been made use of in Lapatto's dissertation (1983) in which she studied the role of field-dependence / field-independence and reflection / impulsivity in the performance of mathematical tasks (n=147). Only if the test of mathematics contained many tasks closely resembling each other, did the impulsive students perform worse than the reflective ones. Field-independent students did better in the tests which were of a problem-solving character. The students were also asked to report their preferences concerning teaching methods. The impulsive students preferred independent work while the reflective students liked working under the guidance of the teachers. There was a difference in the type of mathematical tasks these students liked with impulsive students favouring tasks given in verbal form and reflective students having no preference as to the type of the tasks. The data of this research was gathered in a well-known experimental school in Helsinki and it led to an experimentation in which students were grouped on the basis of their

cognitive styles.

Grouping students in our school system has always been a problem with attempts being made to solve it in many different ways. After the comprehensive school reform we had a streaming system in the upper grades with the students having a choice among two or three different courses ("short" or very basic, "medium" and "long" or advanced) in certain subjects (mathematics and languages). Right from the beginning this system was considered to be very undemocratic and it was consequently abolished a few years ago. A new system was created, according to which the schools get a certain extra amount of money to be used to divide students into smaller groups when the teachers consider it necessary. We will not go into the problems this new system has created. In the experimental school the students in the upper grades are grouped on the basis of cognitive styles instead of using alphabetical order or some other random method. The styles that have been used are reflection / impulsivity and field-independence / field-dependence. In the sixth grade the students are tested for the two styles and after that a decision is made which test results are going to be used. The former has been used more often than the latter, because it seems to work better. The system is reported to function well in different subjects and has led to variations in the teaching methods or styles with the teachers trying to match their teaching to the styles of the students (Lapatto et al. 1987).

Laine (1981) has been interested in the problem-solving processes of ten-year-old children. He studied reflection / impulsivity as measured by eye-movements in situations where the children solved multiple-choice problems. His research confirmed the results received in some earlier studies: the more reflective the children were the more sophisticated

ways of solving the problems they used. They also remembered the tasks better than the impulsive children.

An experiment based on Letteri's ideas was arranged by Malinen (1987), who organized experimental teaching in mathematics for low-achieving comprehensive school students (n=10) in the seventh grade. The objective was to develop analytical skills, the use of mathematical strategies and metacognitive thinking. School achievements and cognitive features developed during the experiment but similar development also took place in the control group (n=10). The researcher discussed different possibilities to develop the cognitive features of low-achieving pupils through school teaching.

Another study making use of both Letteri's and Hunt's ideas was carried out by Kristiansen (1988). Her objective was to find out whether the foreign language (Swedish) learning outcomes of the poorest performers in school can be improved by intensive remedial teaching. The rationale behind the experiment is Hunt's Conceptual Level Matching Model and the principles of inferential elaboration. Ideas about augumentation developed by Letteri were also used. The experimental group consisted of four poor, four average and four good performers from the sixth grade. The first set of remedial teaching sessions was given to a mixed ability group for half a term. The remedial teaching doubled the amount of time allotted to Swedish teaching. After this period the poor performers showed a significant improvement in comprehension but not in production. During the second half of the term the poor performers were given remedial teaching as a separate group. The number of lessons was the same as before but the rest of the experimental group only got half of the amount. At the end of the period the poor performers improved significantly in

production but not in comprehension. The permanence of the effect was checked by a follow-up test one year later. The poor performers had lost all they gained from the remedial teaching but the average performers did better than their classmates who had received no remedial teaching. The background of the pupils was carefully controlled. The poor performers, e.g., scored significantly lower on Conceptual Level and Raven's nonverbal reasoning, while FD/FI was not related to foreign language learning.

Hunt's theory and research have also attracted the attention of other researchers in Finland. Puurula (1982), who worked in the original project (see Leino, A-L. 1980) and translated the manual (Hunt et al. 1978) into Finnish, has reported results concerning the Conceptual Level of different age groups. Sarmavuori has carried out a follow-up study of the development of the native language skills and personality in the comprehensive school. An important indicator of personality was conceptual level. At some point in the project reflectivity / impulsivity was also tested. Several research reports have come out of the project (e.g. 1983, 1984, 1986).

A number of studies have been published in Finnish reporting results received by means of Kolb's Learning Style Inventory (1976). In our own prelimary experimentations the reliability of the instrument (translated into Finnish) did not seem to be quite satisfactory. In the Finnish research in which the LSI has been used (Heikkilä 1983, 1987a) neither the reliability indices on the Finnish sample nor the translations of the stimulus words of the inventory have been reported which makes it difficult for the reader to know what the basis of all the results is. According to the results (Heikkilä 1987, 73 - 76) the learning style profiles of many groups of subject teachers deviated to a large extent

from those expected on the basis on Kolb's theory. One advantage of this particular inventory is its feasibility: it is easy to use, the data are quick to produce, and the visual diagrams are quite informative. In a continuation report Heikkilä (1987b) has used another instrument, the Learning Style Questionnaire by Honey and Mumford (1986). The theoretical basis of the LSQ seems to resemble that of Kolb's LSI, but the two main dimension are named Activist - Theorist and Reflector - Pragmatist instead of Concrete - Abstract and Reflective - Active. The re-test reliabilities of the LSQ were quite high as was the correlation between the Theorist and the Reflector (.71, p. 43 - 45). Kolb's LSI instrument has also been used in other fields, particularly in adult education. Jaakkola (1989) carried out a factor-analytic study of adult students' (n= 282) self-assessed learning styles. The Likert-type of questicnnaire was mainly based on Kolb's instrument but other sources were also used. The factor-analysis yielded four factors called analytical, concrete, theoretical and doctrinal learning styles. The learning styles were also examined in relation to the students' background and obstacles to learning.

So far the only study published in Finland of styles based on Royce's and Powell's theory (1983) and making use of Rancourt's ideas and inventory (1983, 1986a, b) is J. Leino's (1987). The purpose of the study was to study an individuals' knowledge accessing modes and preferences, the ways in which they typically acquire knowledge about the environment. According to the theory three general stylistic orientations were presented: empirical, rational, and metaphorical. The subjects of the study were pre- and in-service teachers of different levels from kindergarten up to the senior secondary school, nursing students, and secondary school students (n=390). Part of the data has been reported in another context

(Leino, A-L. 1987). All fields of knowledge were represented though some groups of teachers were rather small. The results showed that the teachers' epistemic styles differed greatly at different school levels. The higher the school level was, the more rational were the teachers. Metaphoric style was dominant in the groups of art teachers, mother-tongue and foreign language teachers. Empirical style was dominant for math and science teachers as well as for teachers of home economics. Rational style was emphasized in the group of history teachers and also represented in the group of teachers of mathematical subjects. Finnish nurses were more metaphorical than their Canadian counterparts. One of the main results of the study was that the Finnish secondary school students had an epistemic style profile similar to that of the teacher of his/her favourite subject beginning from the first grade of senior secondary school (Leino, J. 1987).

There is also a study in progress (Aitola 1989) with the purpose of finding out to what extent the epistemic styles and cognitive styles form a hierarchy, as suggested by Royce and Powell (1983), and how they relate to strategies employed in performing mathematical tasks. The results seem to be in accordance with the theory but we also have to remember that there are limitations concerning the instrumentation of the styles.

Ropo has used a different starting-point in his doctoral dissertation (1984), which was an empirical study of the styles of learning and studying in the sixth grade (n=106) and the ninth grade (n=450) of the comprehensive school and also in the university (n=238). The comprehensive school pupils filled in a Likert type five category questionnaire based on Entwistle, Marton, Hask, and Vauras (see Vauras et al. 1981). The university students' style questionnaire was a translation of Entwistle's

instrument containing thirty items. All the data were factor-analysed. The group of sixth-graders yielded the following factors: school orientation, guided studying, social self-conception and surface orientation. The factors of the ninth-graders were: school orientation, the pupils' social self-conception, experienced learning results and motivation for competition. The university students' factors were: meaning orientation, reproducing orientation, extrinsic-intrinsic motivation and achievement orientation. The relationships between the factors and academic achievements were also studied. By and large, the results confirm to some extent the results of the previous foreign studies.

As a summary of the research carried out in Finland we can first of all notice the most outstanding influences at the early stages, which have been the research carried out by Hunt and Letteri. Most studies carried out have represented a survey kind of research with a try-out of instruments in another cultural setting. There have also been empirical experiments with the purpose of helping students with their learning difficulties. This kind of research, however, is rare. Among the teachers there is an increasing interest in the learning styles and their practical applications. The teachers we have been working with have reported how the styles give them a better idea and more information and knowledge of their students. Among the researchers there has been hardly any discussion of the basic question concerning the information given by the learning styles and the question of match/mismatch and the idea of deliberately changing the styles.

3. Empirical Part

The purpose of the empirical part of the study is to concretisize the concept of learning style, in a wider meaning, and experiment in Finnish school conditions the feasibility of a new instrument developed for American schools by N.A.S.S.P. (National Association of Secondary School Principals) with the assistance of the national Task Force (1986), to comprehensively diagnose the learning style characteristics of students. The learning style characteristics of students include their cognitive styles as well as environmental preferences that affect the students' learning in school settings. There is another purpose that runs parallel to the one mentioned above and that is to modify K.A.M.I. (Rancourt 1986b) in such a way that it could be used in Finland in a lower age group than has been the case so far. The incompatibility of the theoretical backgrounds of the two instruments prevents any deep-going comparisons between the two instruments.

3.1 Problems

The concept of learning is defined in terms of cognitive psychology: learning is an activity of the mind that involves the application of specific and controlled operations to new information, with the result that this information becomes a part of long-term memory (Letteri 1988, 23). In this definition the responsibility for the learning process belongs to the learner who directs and controls his or her mental operations on the tasks under consideration. Cognitive styles are used in the meaning of cognitive controls and they, combined with other developmental, psychological, and environmental preferences, form a student's learning style. A learning style is composed of several components which together characterize an individual student's Learning Style Profile (LSP). A part of

this profile can be distinguished as a student's Cognitive Style Profile (CSP). An additional theme is to to find out if the general psycho-epistemic styles or knowledge accessing modes of students at the comprehensive school level have already developed to an extent to be reliably measured.

The importance of students' learning styles and style profiles has been discussed in several reports (e.g. Messick 1976, Witkin et al. 1977, Leino, A-L. 1980, Leino, A-L. and Leino, J. 1982, Letteri 1982). Knowledge of learning styles helps teachers to understand the way students learn. Teachers may want to match their teaching to the learning styles or try to change the styles. Knowing one's own learning styles is also important for students: they learn to learn and can get ideas as to how to orient their studies in the future.

The first problem of the study is to check the technical properties of the instrument to be used: the structure and the reliability and compare these with the data gathered in the US. As the reliability index of the study we use Cronbach's alpha which measures the consistency of each subscale.

The second problem is to describe the LSP and its components, the CSP in particular, of Finnish comprehensive school students. Again we use as a comparative basis the data gathered for the US students.

The third problem is to find out the relationships between the LSP (with its components) and students' school achievements in different school subjects. The CSP is a shortened form of what was used earlier by Letteri (1982) and in our project (Aimo and Viilo 1985, Ruotsalainen and Viilo 1986). The new group-test version of the CSP could be of practical importance if its connections with school achievements are clear.

3.2 Learning Style Profile

The instrument employed in this study is Learning Style Profile (N.A.S.S.P. 1986). The original idea was to find a feasible inventory which could be used on Finnish samples. In school situations the test battery used by Letteri and adapted to suit our conditions had proved promising, the only difficulty was that it was very time-consuming with all the tests being individual. Since we knew through personal contacts that a group test based on Letteri's profile was being developed, the decision to use it was quite natural. (However, it turned out that the profile for the most part includes elements other than those we originally had in mind.) What follows is a brief description of the instrument and its development.

The instrument was developed by the Task Force formed by N.A.S.S.P. consisting of leading persons in the field. The goal was to study the field, evaluate the current assessment methods, and develop a conceptual model for examining learning styles. The group adopted "after much debate and considerable disagreement" (Keefe 1988, 9) an information processing model as the logical background for theory and instrument development. Letteri's (see p. 14) model was chosen as the underlying basis for relating styles to information processing theory (see also Letteri 1988). Learning style was defined by Keefe and Languis (see N.A.S.S.P. 1986, 1) as "the composite of characteristic cognitive, affective, and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment. It is demonstrated in that pattern of behavior and performance by which an individual approaches educational experiences. Its basis lies in the structure of neural organization and personality which both molds and is molded by human development and the learning experiences of home, school, and society".

The version of the profile available to the writers consists of the following four major factors: Cognitive Skills, Perceptual Responses, Study Preferences, and Instructional Preferences (Letteri 1988). Perceptual responses is based on ELSIE (see p. 27) and study and instructional preferences on Dunn's and Dunn's instrument (see p. 28). The detailed variables on each subscale are as follows:

Cognitive skills which, as a whole, form the Cognitive Style Profile and were validated by e.g. the Group Embedded Figures Test (GEFT)

1. ANALYTIC SKILL - To identify simple figures hidden in a complex field; to use the critical element of a problem in a different way
2. SPATIAL SKILL - To identify geometric shapes and rotate objects in the imagination; to recognize and construct objects in mental space
3. DISCRIMINATION SKILL - To visualize the important elements of a task; to focus attention on required detail and avoid distractions
4. CATEGORIZATION SKILL - To use reasonable vs. vague criteria for classifying information; to form accurate, complete, and organized categories of information
5. SEQUENTIAL PROCESSING SKILL - To process information sequentially and verbally; to readily derive meaning from information presented sequentially or verbally
6. MEMORY SKILL - To retain distinct vs. vague images in repeated tasks; to detect and remember subtle changes in information.

Perceptual response which is validated by the Edmonds Learning Style Identification Exercise (ELSIE)

7. VISUAL - Initial reaction to information as visual response

8. AUDITORY - Initial reaction to information as auditory response
9. EMOTIVE - Initial reaction to information as emotional and/or physiological response

Study or instructional preferences which is validated by Learning Style Inventory (LSI)

10. PERSISTENCE ORIENTATION - Willingness to work at a task until completion
11. VERBAL RISK ORIENTATION - Willingness to express opinions, speak out, etc.
12. VERBAL-SPATIAL PREFERENCE - For verbal vs. nonverbal activities
13. MANIPULATIVE PREFERENCE - For "hands-on" activities
14. STUDY TIME PREFERENCE: EARLY MORNING - For studying early in the morning
15. STUDY TIME PREFERENCE: LATE MORNING - For studying in the late morning
16. STUDY TIME PREFERENCE: AFTERNOON - For studying in the afternoon
17. STUDY TIME PREFERENCE: EVENING - For studying in the evening
18. GROUPING PREFERENCE - For whole class vs. small group vs. dyadic grouping
19. POSTURE PREFERENCE - For formal vs. informal study arrangements
20. MOBILITY PREFERENCE - For moving about and taking breaks vs. working until finished
21. SOUND PREFERENCE - For quiet study areas vs. background sound (radio, TV)
22. LIGHTING PREFERENCE - For brightly vs. less brightly lit study areas
23. TEMPERATURE PREFERENCE - For studying in a cool vs. a warm environment.

The average internal consistency reliability for subscales was .61, with a range from .47 to .76 (N.A.S.S.P. 1986, 2). The reliabilities were not high but acceptable because of the short tests (most variables were measured by only 5 or even fewer items) and the intended use to collect initial diagnostic information. The 30-day test-retest reliabilities were even lower with a range from .21 to .76 and the average of .47.

The validities of the subscales of the LSP on the basis of the tests mentioned above were not high. The GEFT correlated only with the Analytic skill signifantly (as a significance level was used .002, correlation was .39) but not with the other cognitive skills, the ELSIE correlated signicanfly with Perceptual Responses (the correlations were .64, .51 and .60) and the LSI with Study or Instructional Preferences significantly in all other variables except Noise Level and Persistence (the range of the significant correlations was from .13 to .50).

As to the recommended use of the LSP the N.A.S.S.P. (1986, 6) regards the instrument valid for students in the sixth to twelfth grades but, because of the low reliabilities obtained, several of the scales may be somewhat sensitive contextually. "Students with extremely strong styles, those for whom a particular style is very significant in their learning, should be less subject to this variation." For individual students the instrument offers only a basic diagnosis which can be completed by the original more comprehensive style inventories but for groups of students the instrument can be regarded reliable.

The measuring instrument of students' epistemic styles in the study was a modified version of Knowledge Accessing Modes Inventory (K.A.M.I.) by Rancourt that was used in our former studies (Leino, J. 1987, Leino, A-L. 1988).

3.3 Gathering Data

The data were gathered in a suburban comprehensive school in Helsinki in April and May 1988. Learning Style Profile is recommended to be used in all the grades from 6 to 12. We chose grade 9, the grade in the middle, since taking more grades or a larger sample would have exceeded our limited resources. The age of the students in that grade in Finland is fifteen on the average. All the five classes on that level were included in the study. The original number of the students was over a hundred but, due to some students being absent on the days when data were gathered and some answer sheets that had to be discarded, the final n was 81-91 depending on the subtest.

Data gathering had to be planned with particular care, first of all because of the timing. On our latitudes the changes of the seasons are very remarkable. It was late spring with summer holidays approaching and students getting restless, which made it very important to motivate the students to co-operate. It was made clear to the students that they were not going to be tested for knowledge or "intelligence" but all that the researchers were interested in was their learning styles. They were also promised that information about their learning styles would be given afterwards. This promise was kept and the students eagerly took this opportunity. There were a couple of those who obviously had not taken the tasks very seriously and seemed to regret having missed this opportunity to learn something about themselves.

Data gathering took place during the regular school hours, with the time of the day varying in different classes from late morning till late afternoon hours. Judging by the student reactions, it was easier to motivate the students during the morning hours, a fact which is known to every experienced teacher. Because LSP is a fairly extensive instrument, two

hours were required for each group on different days. The question of timing in general, and, in particular, the fact that performing the tasks in LSP had to be interrupted and then continued at a later point of time, are sources of error of which the influence cannot be controlled. In spite of the problems of timing, we got the impression that the students, with few exceptions, tried their best in performing the tasks and reflecting over their learning styles. The most often occurring comment afterwards was that LSP should be shorter.

3.4 Results

The first problem was to investigate the reliability of the measuring instruments and compare it with the data gathered in the U.S. Table 1 gives the means, standard deviations and internal-consistency reliabilities of the subscales of the N.A.S.S.P. instrument.

Table 1 Learning Style Profile: subscale means, standard deviations and Cronbach's alphas in Finland and the U.S.

Subscale	In Finland				In the U.S.			
	n	Mean	S.D.	Alpha	n	Mean	S.D.	Alpha
1 Analytic Skill	89	3.56	1.35	.66	4852	2.50	1.46	.56
2 Spatial Skill	90	2.93	1.41	.63	4967	2.45	1.51	.60
3 Discrimin. Skill	91	3.05	1.17	.32	5131	3.20	1.35	.51
4 Categoriz. Skill	77	11.0	2.62	.63	3702	10.3	5.00	.74
5 Sequent.Proc.Skill	91	5.60	1.01	.81	4997	4.89	1.50	.72
6 Memory Skill	87	5.89	2.49	.60	4467	5.91	2.53	.62
Perceptual response:								
7 Visual	83	8.36	2.96	.50	4766	8.72	2.89	.51
8 Auditory	83	4.12	2.33	.56	4766	4.61	2.42	.49
9 Emotive	83	7.52	2.40	.37	4766	6.67	2.54	.48
10 Persist. Orient.	82	13.2	2.67	.62	4844	13.7	2.87	.67
11 Verb.Risk Orient.	81	11.7	2.72	.68	4745	12.3	2.90	.55
12 Verb.Spat.Orient.	84	13.5	2.28	.39	4220	12.9	3.21	.76
13 Manipul.Prefer.	81	5.36	1.53	.67	4766	5.77	1.76	.69
Study Time Preference:								
14 Early Morning	85	5.87	2.06	.59	4783	5.87	1.89	.47
15 Late Morning	85	10.6	1.77	.84	4973	9.97	2.21	.67
16 Afternoon	84	8.49	2.34	.56	4[illegible]65	9.14	2.64	.60
17 Evening	87	3.54	1.46	.63	4903	3.74	1.92	.58
18 Grouping Pref.	81	14.7	2.04	.22	4760	17.8	3.42	.64
19 Posture Pref.	84	13.2	3.06	.61	4750	11.9	2.97	.52
20 Mobility Pref.	80	11.4	2.29	.51	4726	13.5	3.18	.64
21 Sound Pref.	84	11.7	3.33	.66	4819	11.9	3.61	.69
22 Lighting Pref.	84	14.7	3.43	.68	4810	14.8	4.09	.73
23 Temperat.Pref.	82	11.6	3.17	.36	4802	11.7	3.37	.72

The reliability indices are, with few exceptions, of the same magnitude in the two countries. The exceptions are the reliabilities of the subscales of Discrimination Skill, Emotive Perceptual Response, Verbal-Spatial Preference, Grouping Preference, and Temperature Preference, which in our sample remained rather low. With this in mind we can draw the conclusion that the reliabilities of the subscales in our study are comparable to those received in the U.S. (However, the subscales with low reliabilities were not disgarded because we wanted to maintain the comparability of the results between the two countries.)

There are some notable differences between the means of the subscales. Several means of the cognitive style dimensions, namely Analytical Skill, Spatial Skill and Sequential Processing Skill, are higher in the Finnish sample than in the American. The differences on the other Cognitive Skills dimensions are not significant. An explaining factor may be differences in the age of the samples or cultural differences between the two countries or both. Unfortunately, no exact age distribution of the samples used in the studies carried out in the U.S was available to us.

Learning Style Preferences, Perceptual Response Preferences (ELSIE) as well as Affective and Environmental Preferences (LSI), are quite similar in both countries. Some exceptions, however, can be noticed: Finnish students are more Emotive in their Percectual Responses, their Grouping, Manipulating, and Mobility Preferences are clearly lower, but Posture Preferences higher than what is reported of the students in the U.S. Almost significant differences can also be found in some Study Time Preferences: Finnish students prefer morning study to afternoon or evening study.

The differences found in the study are quite understandable and confirm

our preconceptions of these two cultures and school systems: the Finns are more individualistic and less sociable than the Americans, our schools prefer individual study and learning from the books or teachers to co-operative, perceptual and manipulating learning. This fact may also explain the differences on Cognitive Style subcales.

The more general level of styles measured in the study was that of Psycho-Epistemic Styles. We used the K.A.M.I. (Knowledge Accessing Modes Inventory) devoloped by Rancourt, which we have translated into Finnish and used previously (Leino, J. 1987, Leino, A-L. 1988). In the present study the subjects were younger than in any of the previous studies carried out either in Canada or Finland. The age of this sample necessitated some changes in the wording of the items of the earlier Finnish version. In this study we were especially interested if the students' psycho-epistemic styles have already developed at the age of 14 - 15 year to the extent that can be reliably measured. The Table 2 presents the results.

Table 2 The Psycho-Epistemic Styles of the comprehensive school students

Style Dimensions	N	Mean	S.D.	Cronbach's Alpha
Noetic (Metaphoric)	81	34.6	4.17	.58
Rational	81	35.9	3.64	.45
Empirical	81	30.4	3.24	.31

The relability indices are rather low, much lower than in the previous adult sample (Leino, J. 1987, 24), which may mean that young students have not yet developed thoir knowledge accessing preferences to the extent adult persons have. As to the proportions of different epistemic modes in the profile, an essential feature can be noticed: the empirical dimension is quite low. Providing the reliability of the result which fits very well with the learning style preferences mentioned above, we can

draw the conclusion that the Finnish comprehensive school and young people's ways of life indeed neglect concrete and manipulative learning modes.

In order to see the connections between Learning Style Profile and school achievements in different subjects, the students were divided into three groups on the basis of school achievements, and the profile of each group was described. The groups are designated as low, medium and high. The school subjects chosen for the analysis were foreign language, mathematics, physics and fine arts. These subjects represent different academic fields of knowledge. The results, i.e. the means of the profile components of the groups, are presented in Table 3.

The components are presented in the same order as in Table 1. The results make it evident that most of the components of the Cognitive Styles Profile (CSP), i.e. Cognitive Skills, are significantly related to school achievements. The differences between the means of the three achievement groups on the subscales of Analytic Skill (Variable 1) and Spatial Skill (Var. 2) are highly significant ($p < .001$) in all academic subjects and significant ($p < .01$) also in fine arts: the higher Analytic or Spatial Skill, the higher the achievements. Also Memory Skill (Var. 6) is significantly ($p < .01$ or $p < .05$) connected with school achievements in all academic subjects. Categorizing Skill (Var. 4) is also almost significantly connected with achievements, or quite close to that, in all subjects: the higher the skill the higher the achievements. The statistical method used in the study was variance analysis.

On the subscales of Perceptual Response (Variables 7 - 9) (ELSIE) there are a few significant differences between the means of achievement groups, but no systematic trend can be seen.

Table 3 Learning Styles of different school-achievement groups in foreign language, mathematics, physics and fine arts (n= 80 - 84).

	Foreign Lang.			Mathemematics			Physics			Fine Arts		
Var.	Low	Med.	High	Low	Med.	High	Low	Med.	High	Low	Med.	High
01	3.00	3.28	4.59	2.79	3.46	4.24	3.20	3.19	4.42	3.12	3.19	4.22
02	1.87	2.78	3.95	1.74	2.69	4.00	1.90	2.62	4.15	1.89	2.65	3.56
03	2.75	3.15	3.23	3.10	2.91	3.31	3.00	3.05	3.23	2.89	3.05	3.22
04	9.93	11.0	11.5	9.68	11.1	11.6	9.90	11.1	11.6	9.62	11.6	11.7
05	5.44	5.65	5.89	5.39	5.57	5.83	5.48	5.46	5.88	5.11	5.53	5.81
06	4.75	5.78	7.00	4.60	6.06	6.62	4.48	6.03	6.88	4.22	5.81	6.50
07	8.57	8.58	8.18	8.05	8.79	8.38	8.26	8.00	9.27	10.1	8.23	8.35
08	3.69	4.60	3.18	4.61	4.48	3.24	4.47	4.66	2.96	3.75	4.34	3.77
09	7.54	6.85	8.64	7.22	6.76	8.38	7.26	7.31	7.77	6.12	7.36	7.87
10	12.1	13.1	14.3	12.1	12.7	14.7	12.1	13.1	14.3	12.1	13.1	13.7
11	11.7	11.8	11.6	12.2	11.6	11.5	11.2	12.2	11.4	10.7	11.7	12.0
12	13.4	13.7	13.5	13.6	13.4	13.9	13.0	13.8	13.8	13.3	13.1	14.2
13	5.21	5.37	5.10	5.26	5.24	5.33	4.95	5.50	5.21	4.43	5.69	4.90
14	5.81	6.00	5.50	5.65	5.66	6.10	5.10	6.27	5.73	5.11	5.79	6.03
15	10.1	10.5	11.1	9.55	10.8	11.1	10.2	10.4	11.1	9.44	10.6	10.9
16	8.75	8.52	8.04	9.05	8.46	8.00	8.71	8.76	7.76	9.00	8.52	8.19
17	3.64	3.65	3.43	3.50	3.80	3.39	3.74	3.57	3.52	4.00	3.53	3.56
18	14.4	14.8	14.7	14.6	14.8	14.6	15.0	14.7	14.5	14.3	14.9	14.5
19	12.0	13.7	13.4	12.6	12.7	14.5	12.6	13.0	14.9	10.8	13.8	13.2
20	11.2	11.2	11.8	11.7	11.4	11.0	11.0	11.6	11.3	12.3	11.3	11.2
21	12.8	11.7	11 0	12.3	12.4	10.5	12.9	12.1	10.3	13.9	11.5	11.5
22	16.0	13.8	15.0	15.0	14.9	13.8	14.5	14.5	14.7	13.9	14.9	14.3
23	12.3	11.9	10.6	12.2	12.0	10.7	12.4	11.8	10.7	11.6	11.7	11.5

The sector of Affective and Environmental Preferences consists of different aspects and, hence, the results are different. Only few systematic trends in terms of achievements can be found. Persistence Orientation (Var. 10) is significantly connected with achievements in foreign language, mathematics and physics ($p < .001$ or $p < .05$): the more persistent the higher achievements. Another clear connection can be found

on the variable Sound Preference (Var. 21): the higher the achievements the quieter the environment needed. Still another systematic and almost significant relationship can be found: the more formal study arrangements (Posture Preference, Var. 19) the higher the achievements.

Differences between different school achievements in relation to Learning Style Profiles are suprisingly small. Though the connections are most clear in the so-called academic subjects (foreign language, mathematics and physics), which are also experienced as difficult by students, the same connections can also be found in fine arts.

As a conclusion we can state that the closest relationships between Learning Style Profile and school achievements are in Cognitive Style components of which, in particular, Analytic Skill and Spatial Skill are the most crucially important. Because the relationship is so clear one can only wonder why these components have never gained a prominent position in educational practice. Why do we never teach these general strategies in any subject? (See Letteri 1987.)

The connections between Psycho-Epistemic Styles (K.A.M.I.) and school achievements in different subjects were checked only tentatively and presented in Table 4.

Table 4 Psycho-Epistemic Styles and school achievements in foreign language, mathematics, physics and fine arts (n = 78 - 82).

	Foreign Lang.			Mathematics			Physics			Fine Arts		
Var.	Low	Med.	High	Low	Med.	High	Low	Med.	High	Low	Med.	High
N/M	35.1	34.9	33.8	35.2	34.1	34.9	35.0	34.2	35.0	35.0	35.7	33.1
R	35.4	35.0	34.4	35.2	36.2	33.2	34.4	36.3	33.2	34.2	34.9	35.1
E	29.5	30.1	31.7	29.6	29.7	31.9	30.5	29.5	31.7	30.8	29.3	31.8

The differences between the means of the three groups are significant ($p < .01$ or $p < .05$) in half of the cases but no clear-cut trends can be noticed. The profiles are guite similar in different school subjects and achievemont groups. The Empirical dimension is quite low in all groups and the high achievers are also high on the Empirical dimension. Contrary to this, it is not necessary to have high scores on the Noethic (Metaphoric) or Rational dimensions in order to have high achievements.

As to the structural features of the style instruments, our study gives only few results worth mentioning. The correlations between the subscales of different instruments were quite low. E.g. Analytic Skill and Spatial Skill of the CSP (Cognitive Style Profile) correlated significantly with Empirical and Rational dimensions of the K.A.M.I. (Knowledge Accessing Modes), but even these correlations were only about .20 - .30 and other correlations were lower.

The correlations between the subscales of the same instrument were in some cases high, e.g. the Psycho-Epistemic dimensions correlated from. -.29 to -.65 with each other and, respectively, Visual, Auditive and Emotive Responses from -.22 to -.63, but the origin of these high correlations is technical due to the way these scales were measured. Some proper correlations between the different skill components could be found. Perhaps the most interesting and also astonishing results aro the correlations between the different subscales of Cognitive Style Profile. These are presented in Table 5.

Table 5 Correlation matrix of the dimensions of Cognitive Style Profile (n = 81 - 84).

	AnS	SpS	DiS	CaS	SeS	MeS
Analytic Skill						
Spatial Skill	.33					
Discrimination Skill	.18	.03				
Categorization Skill	.01	.23	.22			
Sequential Processing Skill	.07	.27	.13	.06		
Memory Skill	.09	.26	.24	.83	.05	

All correlations are positive. This is what was expected because different skill variables usually correlate and, in addition to this, all other subscales except Categorization Skill were basicly visual. The suprisingly high correlation .83 between Categorization Skill and Memory Skill is not easy to explain. The tests are guite different: the items of the subscale of Categorization Skill are verbal and the ones of Memory Skill visual. One explanation may be that all items in both tests need perceptual attention but in the former test the question is of the past and in the latter of the present time. Analytic Skill correlates with Spatial Skill by .33, Spatial Skill with Categorization Skill by .23, with Sequential Processing Skill by .27 and with Memory Skill by .26, and, in addition, Discrimination Skill with Categorization Skill by .22 and with Memory Skill by .29; other correlations are non-significant. These correlations are understandable when we think about what kinds of performances are needed in the test items.

The correlations between the subscales of Environmental and Affective Learning Preferences of Learning Style Profile are presented in Table 6.

Table 6 Correlation matrix of the subscales of Affective and Environmental Learning Preferences of LSP (n = 78 - 83).

	PeO	VRO	MaP	EMP	LMP	AfP	EvP	VSP	GrP	PoP	MoP	SoP	LiP	TeP
10 PeO														
11 VRO	.14													
12 MaP	.28	.21												
13 EMP	.07	.26	.21											
14 LMP	.08	.19	-09	.43										
15 AfP	.18	-28	-03	-23	-20									
16 EvP	.05	.22	.26	.18	-05	-10								
17 VSP	.02	.11	-07	.10	.28	-25	.10							
18 GrP	.07	-05	.11	.03	-21	.12	-18	-13						
19 PoP	.22	.14	-04	.18	.26	-04	-08	-01	-00					
20 MoP	-21	.05	-05	.06	-06	-15	.11	.05	-18	-27				
21 SoP	-09	.01	.05	-24	-11	-09	.20	.03	.04	-51	.10			
22 LiP	.04	.15	.01	.21	-12	.05	.06	.10	.12	.04	.03	-11		
23 TeP	-30	.00	-20	-01	-08	-15	-06	.09	.01	.02	-00	-14	.24	

We can notice that the correlations are, as a rule, low and non-significant. However, there are some exceptions which might also be of importance. The negative correlation -.51 between Posture Preference and Sound Preference tells us that students have a high esteem of a quiet study environment and formal order. The correlation -.30 between Persistence Orientation and Temperature Preference means that students with Persistence Orientation prefer cool study conditions and is as such quite understandable. Study Time Preferences are connected with some Study and Environmental Preferences: Verbal Risk Orientation and Verbal-Spatial Preference correlate positively with Morning Study. We can also find that "Morningness" is connected with quiet (not Sound Preference) and formal (Posture Preference) study but "Eveningness" with Sound Preference and Manipulation Preference. Manipulation Preference correlates with Persistence Orientation. Though correlations are not high they are quite logical, and behind these Study and Environmental Preferences we can easily find Finnish students' typical living styles.

4 Discussion

The definitions and mutual relationships of cognitive styles and learning styles have so far been diffuse. An attempt to clarify the field has been made in the present study. Learning style has been defined as consisting of cognitive styles as well as study and environmental preferences. Hence learning styles include cognitive controls and also affective factors which have effects on an indivudual's preferences of study and environmental conditions. Cognitive styles are used in a more narrow meaning of controlling and guiding an individual's learning processes. Styles refer to individuals' typical performances and preferences. We want to distinguish styles from abilities in a way similar to what e.g. Messick and Royce have done: styles are deeper in the personality than abilities and become activated when alternative possibilities exist or when the situation is sufficiently complex for multiple modes of responses to be feasible. Abilities include information processing and strategies, and are, though dynamic, more specific with respect to tasks.

Styles can be inspected on different levels of an individual's life and activities. On a very general level we can speak of life styles which mean individual's different ways of being and meaningfully acting. We have neglected this level of styles in our present study. The level of epistemic styles, which include an individual's orientations to knowledge accessing, is also quite general and has been included in our study. Epistemic styles develop to their full extent later than abilites (Royce and Powell 1983, 138-140). The main levels of our study are, however, those of learning styles and cognitive styles.

The instruments used in the study were Knowledge Accessing Modes Inventory (K.A.M.I.) by Rancourt and the Inventory of Learning Style Profile

(LSP) by N.A.S.S.P. The LSP instrument consisted of several sectors, namely that of Cognitive Style Profile (CSP) by Letteri, of Perceptual Response Preferences which was a modified version of Edmonton Learning Style Identification Exercise (ELSIE), and of Study and Environmental Preferences which was a shortened version of Learning Style Inventory by Dunn and Dunn. The subjects were 14 - 15 -year-old ninth graders and can be regarded as representative of the age group of Finnish students. The data were gathered in a suburban comprehensive school in Helsinki during two regular school hours at the end of the academic year. K.A.M.I. took only fifteen to twenty minutes and the LSP instrument the rest of the time which meant that performing the tasks in LSP had to be interrupted and continued later on.

The reliabilities were estimated by means of Cronbach's Alpha. The reliabilities of the subscales of K.A.M.I. remained quite low (from .58 to .31) which was much lower than another study carried out in the senior secondary level and, hence, interpreted to indicate that the epistemic styles of the young students of our study were not sufficiently developed to allow reliable measurement. The reliabilities of the subscales of LSP varied from .84 to .22 with the average of .57. With the exception of 5 subscales all other 18 subscales can be regarded as satisfactory. The results were comparable to those received in large samples in the U.S.

The means on the subscales of LSP were of the same magnitude as in the studies carried out in the U.S. with some exceptions. Of the cognitive style dimensions, Analytic Skill, Spatial Skill and Sequential Processing Skill were higher in the Finnish sample than in the American. Of the subscales of Affective and Environmental Preferences, Emotive Response and Posture Study Preferences were higher but Grouping, Manipulating and Mobility Study Preferences lower in the Finnish sample than in the

American. Finnish students also preferred morning study to afternoon or evening study compared with the Americans. The differences were understandable because according to our experiences the schools here prefer individual and formal study to co-operative, perceptual and manipulating learning.

Variance analysis was used in order to study the relationships between LSP and school achievements. A dominant feature in these results was the fact that hardly any subjectwise differences could be discovered. Of the areas included in LSP, it was the Cognitive Style Profile which had the strongest connections with the school achievements. On the basis of the results received in this analysis, we would particularly suggest that teachers check students' Analytic and Spatial skills, and also Memory Skill which was significantly connected with the achievements. No systematic connections could be found on the subscales of Perceptual Response Preferences. Of the subscales of Study and Environmental Preferences only Persistence Orientation and Sound Preference were significantly connected with the achievements, the former positively and the latter negatively.

The scores individual students receive on the subscales of LSP are intended to help their teachers to identify the students' learning style strengths and weaknesses so that they can organize instruction more efficiently and effectively. The LSP is a first level diagnostic instrument that can support greater personalization of instruction and learning (N.A.S.S.P. 1986, 15). As a practical advice for using students' LSP we suggest that their teachers can check if any of an individual student's scores on different subscales deviates more than one standard deviation from the mean of normative population, in which case the student belongs to the extreme end of 16 percent. (If no other standard is available then

our study and the American standard can be used.) Studies carried out suggest that students with very weak cognitive skills need a special augumentation program or another type of complementary instruction. In the same way students with very strong study preferences or perceptual responses are likely to benefit from special instructional arrangements that fit to their preferences or responses. There still remains the unsolved problem of whether optimal instruction should be based on the idea of match or mismatch between learning styles and instruction. On one hand, there are studies according to which students' weak cognitive styles can be improved by special augumentation programs, and, on the other hand, studies which support the idea of matching learning environment to the styles of the learners. The two approaches have been found to improve students' learning outcomes and motivation, which is beneficial for the short-term development of the learner. As for his long-term, all-round personality development, it would be reasonable to assume that some kind of balance between match and mismatch approaches would be desirable.

Of course teachers will also find class profiles, i.e. the profile means of the students of the whole class, helpful in organizing instruction for students with similar cognitive strengths or weaknesses, with similar perceptual response tendencies, or with similar instructional preferences (N.A.S.S.P. 1986, 15). Students with Analytic Skill and Categorizing Skill deficiences, for example, will benefit from focused problem-solving activities, or those with low Verbal Risk Orientation will fare better in smaller groups and in the early morning activities where elements of embarrassment can be minimized and useful interaction can be guaranteed.

An attempt was made to clarify the structural questions of the areas and subscales of Learning Style Profile on the basis of the intercorrelations. The correlations between the subscales of the different sectors

(Cognitive Style Profile, Perceptual Responses Preferences, and Study and Environmental Preferences) were rather low. However, the inter-correlations between the subscales of the areas may have some importance. The highest correlation (r= .83) was between Categorization Skill and Memory Skill. The distribution of the two variables were quite normal and unbiased. Because the two tests are quite different, one is verbal and the other visual, it may be necessary to verify this result on another sample. Our tentative explanation is that the two tests need perceptual attention. Other correlations between the cognitive style components had an approximate variation from .10 to .30. Spatial Skill seemed to be most comprehensive in the meaning that it correlated with almost all other cognitive skills.

Few subscales of Study and Environmental Preferences correlated with one another. The negative correlation (r=-.51) between Posture Preference and Sound Preference tells us that Finnish students have a high esteem of a quiet study environment and formal order. Verbal Risk Orientation correlated with Morning Study Preference which suggests that teachers should find morning time for students' verbal presentations. Persistence Orientation was negatively connected with Temperature Preference and positively connected with Manipulation Preference which means that persistently-oriented students prefer cool study conditions and learning with "hands on" tasks.

One of our original ideas was to find a feasible instrument to be used for diagnostic purposes in our schools to help students with learning difficulties. The instrument, the Learning Style Profile, which we used, is not very easy to use. It is rather time-consuming and the students also experienced it as rather difficult. To get results that are sufficiently reliable would need students with a strong motivation. Also the scoring of

each subscale by hand takes a lot of time. It is our opinion that it will not be used as a group instrument in our country, also on account of practical problems involved in our bureaucratic school system. It is, however, quite obvious that parts of it offer valuable tools for teachers who want to check their teaching styles in terms of their students' learning styles or who want to use it individually with students who have learning difficulties. Because the Learning Style Profile consists of very heterogeneous elements, all reflecting different background theories and ideologies and different degrees of research contributions, it is an instrument that could be used in teacher education to familiarize future teachers with this, so far unfortunately quite controversial, area. The whole vast area of learning styles is what every teacher needs, first to understand his own learning process and then to understand that of his students. Knowledge of learning styles are a crucial component in the process of learning to learn.

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