Päivi Tynjälä

TOWARDS EXPERT KNOWLEDGE?

Academic dissertation

A Comparison Between a Constructivist and a Traditional Learning Environment in University

To be published in the International Journal of Educational Research

INSTITUTE FOR EDUCATIONAL RESEARCH
UNIVERSITY OF JYVÄSKYLÄ

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ABSTRACT

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The study is based on recent theories of the development of expert knowledge, on the constructivist view of learning and on cognitive theories of writing. Drawing on these starting points, a constructivist learning environment was built on an educational psychology course. The purpose of the study was to examine students' learning outcomes in this experiment as compared with the traditional teaching and studying in the same course. At the beginning of the course the students were divided into two groups, a constructivist group and a traditional group. The contents of the course were exactly the same for both groups, consisting of three textbooks on learning and human development. The constructivist group students studied the books with the help of different writing assignments requiring knowledge transforming processes, discussed their assignments in groups and wrote a long essay. The assessment of the constructivist group students was based on students' performances, the essays and other assignments as well as the group discussions. The traditional group students studied the books on their own, attended lectures and took an exam.

The students' learning outcomes in the constructivist and the traditional group were investigated from three different viewpoints: 1) as

the students' subjective learning experiences, 2) as changes in the students' conceptions of learning, and 3) as measured by traditional examination questions. Of these viewpoints the first and the second are in harmony with the constructivist view of learning, while examination assessment represents the traditional knowledge transmission paradigm of teaching and learning. Both approaches were included in the study because one of its aims was to investigate whether different methods of measuring learning produce different pictures of learning outcomes. The constructivist group students did not have to take an exam as a basis of their course grade, but they were asked to answer the examination questions in order to provide research material.

Data on the students' subjective learning experiences were gathered by interviewing them after the course. During the interview the students were also asked to fill in a self-assessment form on their learning. Answers to open interview questions were analysed by the phenomenographic procedure, after which the categories of description resulting from the analysis were tabulated by group. Changes in the students' learning conceptions were studied by having the students write a short essay on their conceptions of learning at the beginning and at the end of the course. The essays were analysed by using the phenomenographic method and concept maps. Furthermore, a categorisation of theoretical viewpoints was used. The examination answers were analysed by means of the SOLO Taxonomy and an epistemic categorisation derived from earlier studies of student learning.

The analysis of the students' subjective learning experiences revealed both similarities and differences between the groups. All students in both groups described their learning in terms of knowledge acquisition. However, most constructivist group students also emphasised the acquisition of an ability to apply knowledge, the development of their critical thinking skills, changing their conceptions of the topics studied and a shift from epistemological dualism towards a more relativistic view of knowledge. These types of description were rare among the traditional group students.

The students' conceptions of learning appeared to change quite similarly in both groups. The behaviorist views decreased and the cognitive

views increased in both groups. However, constructivist views and the idea of experiential learning became more common only in the constructivist group. The examination of the development in the students' ideas of learning produced a category system of seven types of change in learning conceptions: 1) adding new concepts; 2) re-defining, specifying or particularising concepts; 3) linking specific aspects of a given conception; 4) moving from one category of explanation to another; 5) adding a theoretical viewpoint; 6) replacing a theoretical viewpoint with another; and 7) forming an explanatory framework. These types of change suggest that changes in learning conceptions may occur on at least four levels: I) on the semantic level, involving the meaning of individual concepts; II) on the level of relationships between the concepts; III) on the level of shifts between ontological categories; and IV) on the level of a background theory or a framework theory.

The examination answers were longer in the traditional group, including more detailed descriptions. However, the answers of the constructivist group students contained more classifications, comparisons, evaluations and generalisations, and their SOLO level was higher than in the traditional group.

The results show that the constructivist group students felt that they had acquired not only formal knowledge but also many skills that are required from experts in working life. Furthermore, the constructivist group students' knowledge of the topics studied seemed to be more complex and coherent than that of the traditional group students, who tended to accumulate more detailed information. On the whole, the constructivist learning environment seemed to produce the kind of learning outcomes that correspond with the general aims of higher education, thus fostering the prerequisites of professional expertise.

Keywords: constructivism, higher education, expertise, active learning, writing assignments, conceptual change

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Chapter 1

HIGHER EDUCATION AND CHANGING EXPERTISE

Changing Expertise as a Challenge of Higher Education

In today's society, expert professionals face demanding requirements. Increasing internationalisation, the growing proportion of symbolic-analytic or knowledge-intensive work, increasing use of information technology, and a new organisation of work based on networks and teams have extended the range of abilities needed in professional work. What employers expect of their employees is not only a good command of domain knowledge but also diversified social, communication and co-operation skills, ability to work in different contexts with experts from other domains, and ability to critically select, acquire and use knowledge. Peculiar to today's society and working life is rapid change which means that experts continuously have to construct and re-construct their expertise in a process of lifelong learning. Altogether these requirements pose considerable challenges to educational systems, which are expected to produce experts for working life of the future.

Recent discussions about the aims of higher education seem to go well together with the demands presented by working life. For example, Allan (1996) has described the general aims of higher education in terms of desired learning outcomes, classifying them

into subject-based, personal transferable and generic academic outcomes. The subject-based outcomes are discipline-based while the personal transferable and the generic academic outcomes include general skills such as critical thinking, using of information, teamwork, communications skills etc. Similarly, Atkins (1995) suggests that the general purposes of higher education include: 1) providing a general educational experience of intrinsic worth in its own right, 2) preparing students for the creation, application and dissemination of knowledge, 3) preparing students for a specific profession and 4) preparing them for general employment. These general aims may be further divided into sub-components. For example, general educational experience includes the development of a "trained mind", that is, critical thinking skills and an ability to think conceptually, and establishing a base for lifelong learning. Preparation for knowledge creation, application and dissemination involves acquisition of the conceptual frameworks of the subject studied, deep knowledge of some aspects of the subject, an understanding of the subject's methods and experience of knowledge creation. Preparation for a profession requires, for example, integration of theoretical and practical knowledge, development of skills and competencies such as interacting with clients and an ability to reflect on one's own practise. Finally, the aim of preparing students for general employment covers the ability to reflect on and learn from practical experiences, the development of communication skills including oral presentation and report writing, and development of technical skills such as use of communications technology and foreign languages and so on.

These types of general and specific skills and knowledge are widely accepted as aims of higher education in today's society. However, educational practices in general, and practices in higher education in particular, have been criticised for not developing these prerequisites of professional expertise. For example, Mandl, Gruber and Renkl (1996) have noted that in traditional forms of university instruction students often acquire inert knowledge. Such knowledge

can be used in instructional settings but cannot be transferred into complex problems of working life. Similarly, Bereiter and Scardamalia (1993, p. 184) assert that the educational system looks like being designed as if its purpose were to produce nonexperts rather than experts. Geisler (1994), too, argues that in addition to producing some experts, education produces a host of consumers of expertise. The main point of all these critics is that educational practices differ from the practices and activities required in real expert environments for which students are supposed to be prepared. Experts often work in teams, they communicate and share their knowledge with colleagues in pursuit of common aims, they search for new knowledge, apply it and transform it for novel uses. By contrast, students in schools and colleges work mainly individually, are often forbidden to cooperate and share their knowledge with peers (in exams), and are encouraged to simply memorise and reproduce the knowledge they have acquired. Examinations in particular seem to function as obstacles to students to achieve deep personal understanding (e.g. Entwistle, 1995; Entwistle & Entwistle, 1991; 1992, Entwistle et al., 1993). An important challenge to today's higher education is to develop instructional practices that would integrate studying domain-specific knowledge with practising the personal transferable and generic academic skills. The present study represents one effort to develop such instruction, grounding on recent accounts of the development of expert knowledge and on the constructivist view of learning. The following sections will first briefly examine the nature of expertise and then go on to outline the constructivist basis of the empirical study.

What is Expertise?

On the basis of his analysis of research on expertise during the past 20 years, Sternberg (1997) states that expertise can be seen as a

multidimensional prototype including, in varying degrees, the following attributes: 1) advanced problem-solving processes; 2) a great amount of knowledge; 3) advanced knowledge organisation; 4) an ability to use knowledge effectively; 5) creative ability, which involves creating new knowledge on the basis of knowledge that one already has; 6) automatised actions; and 7) practical ability, which involves knowing how to get ahead in one's field. The attributes of the prototype may vary over time and space and they may also differ from one domain to another. Expertise is thus domain-specific (cf. Chi et al., 1988; Ericsson & Lehman, 1996). However, independent of a domain, a general, essential part of expertise is expert knowledge and its organisation rather than talents, intelligence, diligence, practice, etc., although these factors, too, have an important role in expertise. Therefore, research on the development of expert knowledge is of fundamental importance from the viewpoint of understanding the acquisition of expertise.

Recently, several analyses have been presented about the nature and different constituents of expert knowledge (Bereiter & Scardamalia, 1993; Eraut, 1994; Eteläpelto & Light, 1999). In spite of their differences in details and terminology, these accounts usually divide expert knowledge in three main components: 1) formal knowledge, 2) practical knowledge, and 3) self-regulative knowledge.

Formal knowledge belongs to the category of what cognitive psychologist have called declarative knowledge. Such explicit and factual knowledge has played a major role in education and learning, and as such it constitutes the core of professional competence. The second constituent of expertise, practical knowledge, often called procedural knowledge, manifests itself as skills or "knowing-how". While formal knowledge may be described as universal and explicit, practical knowledge is, rather, personal and tacit, being thus intuition-like and difficult to be expressed explicitly. The third component, self-regulative knowledge, consists of meta-cognitive and reflective skills that individuals use to monitor and evaluate their own actions.

Traditionally, different components of expert knowledge have been studied separately in research of learning and expertise. While educational studies of school learning have focussed on the acquisition of formal knowledge, the development of practical knowledge has been examined in working-life contexts. Self-regulative knowledge has got attention both by educational and working-life researchers although theorists of adult education have discussed it in terms of reflective thinking (Mezirow, 1991; Mezirov et al., 1990; Schön, 1983, 1987; Järvinen, 1992; see also King & Kitchener, 1994), and the theorists of student learning in terms of metacognitive skills. In recent years, attention has begun to be paid to the integration of the components of expert knowledge in learning and in the development of professional expertise (e.g. Bereiter & Scardamalia, 1993; Bromme & Tillema, 1995; Boshuizen et al., 1995; Desforges, 1995; Eteläpelto & Light, 1999; Leinhardt et al., 1995). This is congruent with the view that knowing and doing are inseparable, the view put forward by several learning theorists, starting with Dewey (1916/1966), and appearing later in different forms of experiential learning (e.g. Kolb, 1984) and situated learning views (e.g. Brown, Collins & Duguid, 1989; Resnick et al., 1991; Mandl et al., 1996).

How is Expertise Acquired?

One of the most frequently cited descriptions of the development of expertise is the five-stage model presented by Dreyfus and Dreyfus (1986). According to this model, at the initial stage of skill acquisition a *novice* rigidly follows limited rules. An *advanced beginner* still applies rules but now in a more flexible way. At the level of *competent* performer an individual carries out goal-directed plans, and at the next level, that of a *proficient* performer, one has accumulated enough experience to see what is most important in a

situation and to make decisions flexibly on the basis of situational factors. At the final stage of development the *expert* no longer relies on rules but is instead able to act intuition-like without continuously thinking about his or her on-going activities.

The stage models of this kind have been criticised for not being able to explain how the development from novice to expert comes about, that is, how learning takes place. One attempt to account for the acquisition of expertise is to see it as a result of *deliberate practice*, an effortful activity motivated by the goal of improving performance (Ericsson & Charness, 1994, 1997). However, the notion of deliberate practice does not in itself explain what the mechanisms of learning are. In order to achieve this goal expertise research has therefore to move closer to research on learning and instruction.

A well-known learning theory that has been often used to describe expertise development is the *experiential learning model* (Kolb, 1984), the basis of many pedagogical applications in adult education. Experiential learning involves a continuous learning process grounded on an individual's experiences and transactions with his or her environment. The experiential learning model emphasises the equipotent role of both concrete experiences vs. abstract conceptualisation on the one hand and active experimentation vs. reflective observation on the other hand. Reflective thinking has a central role also in Schön's (1983, 1987) accounts of reflection-in-action as a basis for learning and development of a practitioner. Similarly, Mezirow's (1991) descriptions of *transformative learning* present a learning process that makes the learner conscious of the presuppositions that underlie his or her conceptions and perceptions of the world. This process enables the learner to transform such underlying beliefs. Common to all these three approaches is the strong emphasis given to metacognitive and reflective activities in learning: the key to professional development is making explicit that which has earlier been tacit and implicit, and thus making it open to critical reflection and transformation.

While the above-mentioned theorists have emphasised the role of the learner's deliberate mental activities in learning, those who speak in the name of situated cognition stress the significance of situated authentic activity and apprenticeship as vehicles for learning and expertise (Brown et al., 1989; Lave & Wenger, 1991; Mandl et al., 1996). Apprenticeship gives the learner an opportunity to observe and practise the behaviour of skilled performers, pick up relevant terminology and gradually start to act like a full participant in a professional group. The development of expertise is here understood as a process of legitimate peripheral participation (Lave & Wenger, 1991) through which learners become enculturated into a community of practice. Interaction between beginners and experienced experts is regarded as pivotal in learning. Similar elements are present also in the Vygotskian model of learning, in which apprenticeship is realised in the zone of proximal development. Cognitive apprenticeship, as it is called by Collins, Brown & Newman (1989), is an approach where students are enculturated into authentic cognitive practices through activity and social interaction in a way similar to craft apprenticeship. It has been suggested that this model is very suitable for higher education (Mandl et al., 1996).

Recently, situativity theorists have been criticised for inadequate consideration of the different components of expert knowledge and especially for lacking explanations for abstraction and the acquisition of complex theoretical knowledge (Bereiter, 1997; Ohlsson & Lehtinen, 1997). As earlier described, experts' knowledge consists of a well-integrated body of formal, practical and self-regulative knowledge. The development of expertise is a long process during which the different elements of expert knowledge are integrated into a coherent whole. Thus, peculiar to high-level expertise is the integration of theoretical and practical knowledge. Accordingly, from the educational viewpoint the central question is how this integration takes place. When examining the integration of professional knowledge, Leinhardt and colleagues (1995) describe

professional knowledge acquired in practice as typically procedural, specific and pragmatic, while professional knowledge gained in university tends to be declarative, abstract and conceptual. Using knowledge in practical contexts involves executing, applying and prioritising it, while using knowledge in educational settings entails labelling, differentiating, elaborating and justifying it. Leinhardt and others argue that the true integration of the two kinds of professional knowledge is best fostered when university students transform abstract theories and formal knowledge for use in practical situations and, accordingly, employ their practical knowledge to construct principles and conceptual models. Thus, *theorising practice and particularising theory* are suggested as keys to the development of expert knowledge.

Grounding on Anderson's (1982, 1987) view of skill acquisition, Bereiter and Scardamalia (1993) emphasise the significance of *problem-solving* as a tool for pursuing the integration of expert knowledge. For them, pivotal in the development of expertise is converting formal knowledge into an expert's informal knowledge and skills. This takes place when formal knowledge is used for problem-solving. Thus, formal knowledge acquired from textbooks and lectures is converted into an expert's informal knowledge by being used to solve problems of understanding. Similarly, formal knowledge is converted into skill by being used to solve problems of procedure. Pedagogically this implies that when formal knowledge is studied by reading textbooks and attending lectures, carrying out different problem-solving tasks is a much more effective way for a student to develop expert knowledge than taking tests of factual information and reproducing book knowledge as such.

Expertise as a Product of Education

The educational system has been strongly criticised recently from the viewpoint of expertise. For example, Geisler (1994) suggests that education has two contradictory functions: that of producing experts on the one hand and that of producing consumers of expertise on the other. Geisler argues that education deals with these contradictory tasks by using the "technology of literacy" to separate expertise into two distinct dimensions of knowledge, *domain content* and *rhetorical process*. This separation of expertise is a mechanism by which society delivers expertise to some people but withholds it from others. Formal education provides all students with a naive understanding of the formally explicit knowledge of domain content but withholds an understanding of the more informal and tacit rhetorical process that is reserved for producing professional experts. Bereiter and Scardamalia (1993, 187) have similarly noted that schooling deals only with the visible parts of knowledge, formal knowledge and demonstrable skills. Informal knowledge that students will need in order to function expertly is ignored in schooling.

According to Geisler (1994), during general education students operate in both problem spaces, content and rhetoric, with naive representations. In the early years of undergraduate education some students begin to work with more abstract representations in the problem space of domain content. At the same time, however, their rhetorical problem space remains basically naive. Late in their undergraduate education or graduate school, this naive representation of the rhetorical problem space undergoes in some students a major reorganization and abstraction process, where the rhetorical dimension of expertise emerges as distinct from domain content. This growth of an expert representation of the rhetorical problem space is the final stage in the acquisition of expertise. It is only when both the domain content and the rhetorical process of a field are

represented in abstract terms that they can enter into the dynamic and mutually transformative interaction that produces expertise. *Knowing that* and *knowing how* are linked with each other. Only a few people develop integrated expert knowledge of this kind, although, as Bereiter and Scardamalia (1993, 183–220) state, schooling could be organised in a way that would promote expertise in everyone.

Although the relationship between institutionalised education and the development of expertise is far more complicated than Geisler and Bereiter and Scardamalia present, it can be concluded that the culture(s) of schooling and the culture(s) of expertise have been operating along different lines. The three authors have also sought to find out how these different cultures of expertise and schooling could be brought closer together. Bereiter and Scardamalia (1993) define expertise as *surpassing oneself* in a *process of progressive problem-solving*. That is, an expert continuously defines and re-defines his or her tasks as problems at higher and higher levels. Problems already solved do not lead to routine action but to the investment of the expert's mental resources into a continuous effort to build deeper understanding of one's domain. The scientific community is a good example of a working environment that requires its experts, researchers, to engage in such progressive problem-solving. In fact, the scientific community survives only by maintaining the process of progressive problem-solving. Bereiter and Scardamalia suggest that the scientific community or a research group could also serve as a model for restructuring schools. A classroom would then function as a knowledge-building community similar to the knowledge-building communities that make up the learned disciplines. The members of a knowledge-building community share their knowledge, support one another in knowledge construction and develop a collective knowledge base in a knowledge-building discourse. Bereiter and Scardamalia (1993, p. 208) assert: "If we want to have schools that produce experts, we need to have schools that support progressive knowledge building discourse".

Even though the scientific community has been presented as a model for educating experts, teaching and studying within the scientific community, i.e. in universities, are often far removed from the ideas of knowledge-building discourse, resembling, rather, knowledge transmission. This state of affairs has been widely discussed recently. Many attempts to develop learning-enhancing teaching, such as process-oriented instruction, in university education indicate that certain kinds of knowledge building communities are emerging alongside the traditional knowledge transmission models (e.g. Duffy et al., 1993; Lonka & Ahola, 1995; Vermunt, 1995; Volet et al., 1995). These developments are based on the constructivist view of knowledge acquisition and its pedagogical applications, which will be discussed in the following section.

Chapter 2

CONSTRUCTIVISM AND DEVELOPING TEACHING PRACTICES

Diversity of Constructivism

Constructivism is a theory of knowing whose origins may be traced back to Kantian epistemology and the thinking of Giambattista Vico in the eighteenth century, American pragmatists such as William James and John Dewey at the beginning of this century and the great names of cognitive and social psychology, F.C. Bartlett, Jean Piaget and L.S. Vygotsky. Constructivism is not a unified theory but rather a conglomeration of different positions with varying emphases. In recent literature, it is possible to find at least the following branches of constructivist thought:

- radical constructivism or cognitive constructivism
- social constructivism
- the sociocultural approach
- symbolic interactionism
- social constructionism

(Confrey, 1995; Derry, 1996; Ernest, 1995; Gergen, 1995; Marshall, 1996; Phillips, 1995; Prawat, 1996; Richards, 1995; Steffe, 1995; von Glasersfeld, 1984, 1995a,b). Common to these diverse views is that the acquisition of knowledge is metaphorically described as a building process in which knowledge is actively constructed by

individuals or social communities. Thus, constructivism rejects the idea that knowledge is passively received.

These schools of thought differ from each other mainly in the role which they give to the individual and the social in learning. While the radical constructivist or cognitive constructivist view stresses individuals' knowledge construction processes and mental models, social constructivists or constructionists are more interested in social, dialogical and collaborative processes and put great emphasis on language and discourse. The sociocultural approach, symbolic interactionism and Dewey's social constructivism are all attempts to include both the individual and the social aspects, although only Dewey's view seems to assign both equal priority. (Gergen, 1995; Phillips, 1995; Shotter, 1995.) In addition to these explicitly constructivist approaches, the phenomenographic tradition of research on learning has also been seen as a version of constructivism (Biggs, 1993, p. 74), although phenomenographers themselves make a distinction between their own position and constructivism (Marton & Booth, 1997). However, it seems that while phenomenography differs clearly from radical or cognitive constructivism, it has fundamental similarities with social constructivist views.

Although there are great differences between the emphases of different constructivist positions, there seems to be no fundamental contradiction or incompatibility between the theories, only the practical difficulty to include different aspects of each view at once (Bereiter, 1994; Cobb, 1994). As a result of recent animated discussion and critique between different views, cognitive constructivist and social constructivist theories have come closer to each other, and integrative approaches seem to be developing. The present study is located somewhere between the individual and the social constructivist views, representing an integrative approach often suggested in recent literature (e.g. Cobb, 1994; Driver et al., 1994; Vosniadou, 1996). Thus, in the following, constructivism is dealt with as one view of knowledge acquisition, although the considerations

that will be presented may sometimes derive from radical constructivism, sometimes from the social approaches (cf. Ernest, 1995).

Pedagogical Implications and Applications of Constructivism

According to constructivism, learning is not passive receiving of information but a learner's active continuous process of constructing and reconstructing his or her conceptions of phenomena. Because learners interpret new information on the basis of their existing knowledge, constructivist pedagogy[1] is grounded on students' previous conceptions and beliefs about the topics to be studied. It emphasises understanding instead of memorising and reproducing of information, and it relies on social interaction and collaboration in meaning making. Although common language and culture enable us to understand things in basically the same way, people, because of their individual experiences, may attribute same things different meanings. It follows that it is useful to organise learning on the basis of interactive and co-operative forms of studying in which individual interpretations and understandings meet each other. Teaching is not transmitting of knowledge but helping students

[1] The term "constructivist pedagogy" or the concept "constructivist learning environment" is logically somewhat problematic because constructivism, purely as an epistemological view, does not imply any specific pedagogy or environments. It only implies that we acquire knowledge by constructing it and that this knowledge construction takes place where ever we learn – even when teaching is based on the knowledge transmitting paradigm and empiristic epistemology. Logically speaking, therefore, any learning environment is in itself neither "constructivist" nor "non-constructivist". However, the concept "constructivist learning environment" has become a general term to describe teaching and learning situations which are explicitly based on constructivist epistemology and are designed to support learners' knowledge construction processes. In the present study the concepts "constructivist learning environment" or "constructivist pedagogy" are used in this sense.

to actively construct knowledge by assigning them tasks that enhance this process. This does not mean that lectures should be entirely removed from constructivist learning environments. Rather it means that lectures should be accompanied by assignments in which learners must reflect on and use the information given them in the lectures.

Moving from the knowledge transmitting paradigm of learning towards constructivist instruction requires fundamental changes also in assessment procedures (e.g. Biggs, 1994; Biggs, 1996; Entwistle et al., 1993; Jonassen, 1991). In constructivist learning environments assessment is not a separate exam at the end of the course but instead assessment methods are integrated into the learning process itself. The purpose of assessment is not to find out how much of the information studied a student can remember but to promote the learning process and to find out what kind of qualitative changes are taking place in students' knowledge base. Traditional examinations often lead students to adopt a surface approach to learning and studying and to attempt to memorise the material instead of trying to understand it (Biggs, 1996; Entwistle & Entwistle, 1991, 1992; Entwistle et al., 1993). Furthermore, traditional examinations are not able to capture the actual changes in students' knowledge. In contrast, assessment methods that emphasise the learning process itself and encourage students to engage in meta-cognitive and reflective activities are in harmony with the constructivist view of learning. Authentic assessment or performance assessment represent this type of alternative assessment ideology. Assessment is based on authentic learning assignments instead of separate test situations and it focuses on the process of learning as much as (or even more than) on the final outcomes.

Constructivism also emphasises the situational and contextual nature of learning (Brown et al., 1989; Kirshener & Whitson, 1997; Lave & Wenger, 1991). The situations where we learn and the way how we learn affect what we learn and how

we transfer it into new situations. Situativity theorists therefore emphasise that the information to be studied is being used and applied already in the studying phase in tasks that simulate the real-life situations where the knowledge is to be applied in future. The most extreme forms of situated learning employ the apprenticeship model of learning. Recently, the approach of situated cognition has been criticised for focussing on the use of concrete, episodic information and for ignoring the development of generalisable, abstract knowledge and higher-order thinking (Bereiter, 1997; Ohlsson & Lehtinen, 1997).

Although the constructivist view of knowledge acquisition applies to all educational levels, it has been suggested that the constructive approach to learning is most appropriate for advanced learners, that is, university students and adults (Jonassen et al., 1993). Furthermore, universities are communities for producing knowledge and, as a matter of fact, scientific activity in its very nature is a constructive learning process. Therefore, creating constructive learning environments for university students is in harmony with universities' other mission, conducting scientific research. The use of constructivist applications may promote the integration of research and teaching, which has been considered an important aspect in developing university instruction. At the same time, it may be seen as a precondition of producing competences relevant to the acquisition of professional expertise for today's ill-defined and complex tasks.

In sum, important pedagogical implications of constructivism include:

- the significance of learners' previous knowledge, beliefs, conceptions and misconceptions (Dochy, 1992; Duit, 1995; Hendry, 1996; Vosniadou 1992a,b, 1994)
- paying attention to learners' meta-cognitive and self-regulative skills and knowledge (Boekaerts, 1996; Brown, 1987; von Wright, 1992; Silvén, 1992; Vermunt, 1995).
- an emphasis on negotiation and sharing of meanings through

discussion and different forms of collaboration (Dillenbourg, 1998; Gergen, 1995)
– the use of multiple representations of concepts and information (Ernest 1995; Feltovich, Spiro & Coulson, 1993; Lehtinen & Repo, 1996; Lehtinen & Rui, 1995; Spiro et al., 1995; van Someren et al. 1998)
– the need to develop instructional methods that take into account the situational nature of learning and thus integrate knowledge acquisition and knowledge use (Eraut, 1994; Lave & Wenger, 1991; Mandl et al., 1996)
– the need to develop assessment procedures that are embedded in the learning processes, focus on authentic tasks and take into account learners' individual orientations and foster their metacognitive skills (Biggs, 1996; Boud, 1990,1992, 1995; Dochy & Moerkerke 1997; Jonassen, 1991).

These principles also guided the designing of the experiment that is the focus of the present study. The following discussion deals with those implications of constructivism that were given particular consideration: 1) learning as conceptual change and 2) writing as a constructive activity that can be used as a tool for learning.

Learning as Change in Students' Conceptions

One implication of the constructivist view of learning is that the development of students' conceptions of the phenomena studied has begun to be seen as a central learning outcome. Research on conceptions and conceptual change has proceeded along two broad lines: cognitively orientated research on mental models on the one hand and more experientially orientated phenomenographic studies on the other. While cognitive studies seek to uncover mental representations and their processes of change, phenomenographic research aims to capture the different ways in which people understand and describe phenomena.

Phenomenographic studies of conceptions have examined how students understand basic concepts in different disciplines, for example in economics (Dahlgren, 1989), physics (Prosser, 1994), social sciences (Dahlgren & Franke-Wikberg, 1980), psychology (Nuutinen, 1995, 1999) and biology (Nuutinen, 1999). These studies have produced descriptions of the variation in understanding a phenomenon in a specific student population. Cognitive studies of conceptions, in contrast, have mainly described individual cognitive structures and the changes in them. The most significant work in this area involves understanding concepts of the natural sciences (e.g. Chi et al., 1994; Vosniadou, 1992a, 1994). These studies have revealed, for example, that the framework theories underlying conceptions and their ontological and epistemological presuppositions may hamper the acquisition of new knowledge and even produce misconceptions. Consequently, the representatives of this approach consider that awakening students' metaconceptual awareness before they are introduced to new information is the key element in promoting conceptual change.

The mainstream of research on conceptions has concentrated on scientific conceptions while research on conceptions and conceptual learning in other areas have been less popular. Conceptions of learning have received attention since the late seventies (e.g. Pramling, 1983; Säljö, 1979; van Rossum & Schenck, 1984). However, it is only recently that researchers have become interested in how learning conceptions develop and change (e.g. Lonka, Joram & Bryson, 1996; Marton, Dall'Alba & Beaty, 1993; Tynjälä, 1997a, 1998b). Most studies of learning conceptions have followed the phenomenographic approach (e.g. Bruce & Gerber, 1995; Ekeblad, 1995; Marton et al., 1993; Prosser, Trigwell & Taylor, 1994) or have applied the categorisations produced by phenomenographic research (van Rossum & Schenck, 1984) although studies with other orientations have also been carried out (Berry & Sahlberg, 1996; Boulton-Lewis, 1994; Lonka & Lindblom-Ylänne, 1996; Lonka et al., 1996; Roth & Roychoudhury, 1994).

The broad study of conceptions and conceptual learning has been based on different definitions of conceptual change, used different methods in measuring the change and has, not surprisingly, produced conflicting and inconclusive results (see, for example, Dagher, 1994; Guzzetti et al., 1993). Despite the great volume of research devoted to the area, there are frequent calls for more research and new theories. For example, Achtenhagen (1995) has emphasised that the development of a theory of conceptual change is one decisive factor in the progress of research on professional expertise. According to Dykstra, Boyle and Monarch (1992), we have to answer the questions like what is changing when conceptual change occurs, i.e. what are conceptions; are there different types of conceptual change; and what induces conceptual change. Almost no consideration has been given to such questions in the literature on learning conceptions. In the present study, special attention is therefore focussed on the development of students' conceptions of learning, and to the question that Dykstra and colleagues (1992) have named as the most fundamental issue: *what* changes when conceptual change occurs?

White (1994) has pointed out that it is important to make a distinction between "conceptual" and "conceptional" change. While the term "concept" refers to classifications of phenomena and a person's knowledge of individual concepts, "conception" involves larger mental structures, systems of explanation. However, it seems that even if existing research has focussed on how *conceptions* change rather than restricting itself to studies of changes in single *concepts*, the wording "conceptual" has been used more often than "conceptional". Among other things, the present study deals with the systems of explanation used by students to account for learning. Consequently, its subject is "conceptional" change. However, in the following the authors' original terms have been retained when speaking of different types of conceptional change.

Two basic forms of learning identified in the study of conceptual change derive from Piagetian concepts of assimilation

and accommodation. For example, Posner and others (1982) use the term "radical conceptual change" in the sense of a kind of "scientific revolution" in a person's mind when speaking about the kind of cognitive change that Piaget calls accommodation. Correspondingly, assimilation-type change, i.e. the mere addition of new information to an existing knowledge structure without restructuring it has been called, for example, "enrichment" (Vosniadou, 1992a; 1994). For Chi (Chi et al., 1994) radical conceptual change means a cognitive shift across different ontological categories, while "normal" conceptual change takes place within an ontological category. Chi and others (1994) assume that concepts belong to one of three ontological categories: matter, processes or mental states. Conceptual change occurs when a concept is reassigned from one ontological category to another. Larreamendy-Joerns and Chi (1994) have suggested that the term conceptual change should be reserved for a type of knowledge acquisition that is radical.

In addition to these two basic categories of conceptual change, published research includes various descriptions of types of change taking place in the process of conceptual and conceptional learning. For example, Carey (1991) has found in research literature the following forms of conceptual change: 1) What is periphery becomes core, and vice versa; 2) Concepts are subsumed into newly created ontological categories or reassigned to new branches of the ontological hierarchy and; 3) Concepts are embedded in locally incommensurable theories. On the basis of her own research findings Carey concludes that the changes range from enrichment of concepts that retain their core to the evolution of one set of concepts into another that is incommensurable with the original. Some resemblance to these forms of learning can also be seen in a study by Fellows (1994) of the effects of writing and group collaboration on learning. She found that students 1) adopted new concepts and used them to explain new phenomena, and 2) added new principles to their schemata and/or organised them more logically so as to generate more useful descriptions that were closer to accepted scientific explanations.

Hewson & Hewson (1992) have distinguished, among various forms of change, between extinction of the former state, increase or decrease in the amount of something, and exchange of one entity by another. They conclude that usually the term conceptual change has been used in the last meaning, although much of student learning may also be characterised by the second type of change. Dykstra and others (1992) have similarly described three types of conceptual development, differentiation, class extension and reconceptualization, while Thagard (1992a) has identified as many as nine specific categories of change: 1) adding instance, 2) adding a weak rule, 3) adding a strong rule, 4) adding part relation, 5) adding kind relation, 6) adding a new concept, 7) collapsing part of a kind hierarchy, 8) branch jumping and 9) tree switching.

Vosniadou (1991, 1992a, 1994) has described conceptual change either as an "enrichment" of an existing conceptual structure or as a "revision" of it. Enrichment is the addition of new information to existing knowledge structures while revision is needed when the information is inconsistent with existing beliefs or presuppositions. In Vosniadou's account it is assumed that concepts are embedded in "theories". These theories are of two kinds: there are "framework theories", a person's compilation of ontological and epistemological presuppositions regarding a certain phenomenon, and there are "specific theories" which describe the internal structure of the conceptual domain in which the concepts are embedded. Conceptual change may take place concerning both types of theory but it is more difficult to achieve when it requires the revision of fundamental presuppositions of a framework theory.

In phenomenographic studies, the development of students' conceptions may be seen in the increase in the number of categories of description identified. For example, Ebenezer and Gaskell (1995) found that the categories of description comprising students' conceptions of solution chemistry increased as a result of instructional intervention. However, new categories did not necessarily replace the students' initial conceptions.

The emergence of the theory of conceptual change has inspired the development of diverse instructional interventions with the aim of making conceptual change easier. Some of the methods have focussed on student activities while others have involved study materials. Student activities used in attempts to encourage conceptual change include group discussions (Kobayashi, 1994), writing activities and group collaboration (Fellows, 1994), laboratory experiments, group work and vee diagrams (Ebenezer & Gaskell, 1995) and computer-assisted instruction using scaffolding (Biemans & Simons, 1995). Among study materials created for the same purpose may be mentioned instructional analogies (Thagard, 1992b; Dagher, 1994; Suzuki, 1994), application questions (Wang & Andre, 1991) and "conceptual change texts" (Wang & Andre, 1991), also called "refutational texts". They are texts that explicitly challenge students' intuitive understandings of the phenomena to be studied by confronting them with scientifically accepted theories. In their meta-analysis of instructional interventions to foster conceptual change Guzzetti and others (1993) point out that the studies have been conducted using incompatible approaches and have accordingly produced disparate results. The authors conclude that in general it is strategies that cause cognitive conflict that best promote conceptual change. Not only the instructional aspects but also student approaches to learning seem to make a difference. In their review of studies examining the role of anomalous data in theory change, Chinn and Brewer (1993) conclude that it seems clear that processing strategies affect theory change and that deep processing promotes it. Furthermore, students' motivational beliefs may also aid or hinder conceptual change (see Pintrich et al., 1993).

In the background of many studies of conceptions is Piaget and Garcia's (1983) assumption that conceptional and conceptual learning resembles the development of scientific theories (e.g. Niaz, 1995; Thagard, 1992a; Villani, 1992; Vosniadou, 1994). If this assumption is applied to the human sciences, we may conjecture that "scientific revolutions" of some kind may occur also in

conceptions of learning. According to Vosniadou (1994), the change of students' framework theories in physics is difficult because they are based on students' everyday experiences of physical phenomena. What, then, about students' theories or conceptions of learning? It might be assumed that if their everyday experiences of learning and studying are based mainly on situations that reflect the behaviourist view of learning, then their conceptions of learning will develop in the same direction. Similarly, a learning environment based on the constructivist view may influence the students' views of learning in the direction of constructivism. An aim of the present study is to examine how conceptions of learning change during an educational psychology course and whether the nature of the learning environment makes a difference.

Writing as a Tool for Learning

Extensive research on writing and its effects on learning has produced contradictory results (see, for example, Ackerman, 1993; Geisler 1994; Quinn, 1995; Penrose, 1992; Schumacher & Gradwohl Nash,1991; Young & Fulwiler, 1986). While some studies have reported positive learning outcomes due to writing, other studies have found no significant differences in learning effects as compared to other study methods. Inevitably, a critical factor explaining the conflicting results is the research methodology applied, and especially how learning has been assessed and what kind of learning has been pursued. In general, learning has been measured by using objective recall or comprehension tests that provide exact quantitative indicators of learning. However, assessing learning in this way does not tell us very much about the quality of learning. In other words, it does not tell us how students' knowledge has actually changed, how their thinking has developed and how they themselves experience their learning. For this reason there have been calls for qualitative measures that would capture the conceptional

change or knowledge change instead of simply measuring students' recall of facts (Eigler et al., 1991; Schumacher & Gradwohl Nash, 1991). This is congruent with the constructivist view of learning.

Some studies suggest that if the aim of studying is the simple memorising of facts, then writing is a less effective method than "studying for a test" (Penrose, 1992). However, when higher-order learning such as critical thinking is sought for, writing seems to offer an effective tool for learning (Tierney et al., 1989). In general, writing appears to be suitable for tasks where the aim is fostering understanding, changing students' conceptions and developing their thinking skills but less suitable if the goal is the simple accumulation of factual information (Schumacher & Gradwohl Nash, 1991).

Another factor that explains the contradictory findings of writing research is the nature of the writing tasks used in the studies. Different writing tasks entail different thinking processes, which consequently generate different kinds of learning (Applebee, 1984; Langer, 1986; Newell & Winograd, 1989). Furthermore, an important factor is how students perceive the task and approach it (Biggs, 1988; Penrose, 1992; Entwistle, 1995). Like any other study assignment, a writing task may be approached at a surface or a deep level. A general conclusion that may be drawn from studies of different writing tasks is that the more a writing assignment involves active manipulation of the information to be studied, the better are the learning outcomes likely to be (e.g. Applebee, 1984; Greene & Ackerman, 1995; Langer, 1986). Some studies suggest also that reading, writing or group discussions are more effective in combination than as separately used methods (Dysthe, 1996; Tierney et al., 1989).

A form of writing that has gained popularity recently as an educational tool is journal writing or learning logs (e.g. November, 1996; Commander & Smith, 1996). Journal writing seems to be especially effective in developing students' metacognitive or reflective skills (McCrindle & Christensen, 1996; Morrison, 1996). For example, in a study by McCrindle and Christensen (1996)

keeping learning journals during a university course was found to be more effective than writing scientific reports. In a learning task the group that wrote learning journals made more use of metacognitive strategies and applied more sophisticated cognitive strategies. The journal group also expressed more sophisticated conceptions of learning and performed significantly better in the final exam than the scientific report group.

The dissimilarity between the writing tasks and the thinking processes they require may be best understood in the light of a theory presented by Bereiter and Scardamalia (1987), who have identified two separate models of the writing process. Under the *knowledge telling* model a writer makes use of his or her readily available knowledge about the content and the discourse. Writing of this kind requires no significantly greater amount of planning or goal-setting than does ordinary conversation. Writers just simply put down thoughts that they already have in their mind. It is easy to write in this way, and it is a method typical of novice writers. According to Bereiter and Scardamalia (1987, p. 88) many educational practices, such as testing content taught as such, encourage the use of the knowledge telling strategy.

While the knowledge telling model primarily requires writing down already existing knowledge and thoughts, the *knowledge transforming* model can be depicted as problem-solving where the writer's thoughts are still developing during the process of writing itself. Peculiar to this model is interaction between text processing and knowledge processing. Knowledge telling is still a part of the process but now embedded in the problem-solving process. Writers are not just telling what they know. Instead, their content knowledge and discourse knowledge affect each other during the writing process, transforming their thoughts. Thus, new thoughts emerge throughout the composing process itself, and in the process of rethinking and restating they finally take the form of fully developed ideas. The knowledge transforming model is more typical of expert writers than of novices.

The distinction between the knowledge telling model and the knowledge transforming model of writing probably explains why merely answering reproductive study questions, for example, is not as effective a study strategy as essay writing. While reproductive questions may be answered by using the knowledge telling strategy, essay writing involves manipulating, integrating and reorganising information, i.e. strategies that require knowledge transforming and higher-order thinking (cf. Langer, 1986; Linnakylä, 1986; Spivey, 1995, 1997).

While examining the relationship between literate expertise (reading and writing) and domain expertise, Scardamalia and Bereiter (1991) have argued that literate expertise involves a dialectical process that serves to advance domain knowledge. The authors hypothesise that the knowledge transforming model of writing simultaneously enhances both writing expertise and subject-matter understanding. Therefore Scardamalia and Bereiter recommend that experts in learned fields should continuously read and write about their special domain in order to develop their expertise.

Many educational and assessment practices in schools and universities encourage the reproduction of knowledge and the use of the knowledge telling strategy. For example, testing the content taught as such is very usual even in university examinations. When considered against recent views on the development of expert knowledge through problem-solving (Bereiter & Scardamalia, 1993) or through theorising practice and particularising theory (Leinhardt et al., 1995), examination-based studying of this kind does not seem a particularly effective way of promoting expert learning. Studying methods that encourage students to transform the knowledge that they are studying, for example by applying or criticising it, are more promising from the viewpoint of developing integrated professional knowledge. In addition to writing, knowledge transforming may be fostered through methods like group discussion or project work. Very effective seem to be learning environments that are based on

writing assignments such as brief learning tasks and broader essays combined with group discussions (Fellows, 1994). Such findings imply that it is important to incorporate knowledge transforming into the learning process itself rather than using it only as a part of assessment procedures.

Spivey (1990, 1995, 1997) has described the acts of transformations that students perform while writing on the basis of sources. She recommends using learning tasks that integrate reading and writing processes. When students write based on texts written by other people, reading and writing processes will blend. We cannot say where construction from reading stops and construction for writing starts. When using a text as a source of information a person is already mentally composing meaning from the text when reading the source text, before putting pen to paper. Building of meaning is for the text being written as well as for the text being read and it involves making various kinds of transformations. These transformations may be, for example, selective. When writers select content from reading multiple texts to produce comprehensive reports, they tend to make their judgements on the basis of intertextual importance. The transformative process is also integrative. Writers have to build a coherent text of their own and therefore they often need to break down the structure of the source text and to organise their own production in a new way. This requires compressing the contents of the source text. Writers also have to make connections between their previous knowledge about the topic and the new information given by the source texts as well as across the multiple source texts. Thus, the process of reading to write can produce rich inferences and elaborations.

To conclude, what kind of writing assignments would, in higher education, best enhance learning and the development of expertise, converting book knowledge into an expert's informal knowledge? Current theories of learning and of the acquisition of expertise together with the studies of writing summarised above allow us to reach the following conclusions. First, writing tasks

should promote active knowledge construction. They should induce students to engage in knowledge transforming processes instead of being content with reproductive activities. For example, students may be asked to apply or criticise the information of the textbooks. Second, the tasks should make use of students' previous knowledge and existing conceptions of and beliefs about the topics they are studying and lead them to reflect on their conceptions in the light of the new knowledge. Third, the tasks should encourage students to reflect on their own experiences and to conceptualise and theorise them. Fourth, they should involve students in applying theories to practical situations. Fifth, writing tasks should preferably be accompanied by group discussions. Finally, writing assignments should also include solving either practical problems related to the given professional field or problems of understanding, which involve conceptualising phenomena and engaging in personal meaning making. These types of writing task may be carried out either as limited learning tasks or as extended essays or personal learning journals.

Summary of the Theoretical Foundations of the Study

The central considerations behind the present study can be summarised as follows:

1. Professional expertise requires, among other things, an ability to think critically and reflect on one's own thoughts and actions as well as problem-solving, communication, co-operation and continuous learning skills. Consequently, these are the competencies that higher education should foster. However, the educational system has been criticised for not developing these prerequisites of working life expertise. Traditional teaching is claimed to produce inert

knowledge in students, knowledge that can be used in educational settings such as tests and exams, but cannot be transferred into real life situations. It is suggested that more transferable knowledge be produced by instructional methods that support understanding, emphasise application and integrate theoretical and practical knowledge (Leinhardt et al., 1995; Lynton & Elman, 1987; Prenzel & Mandl, 1993).

2. The constructivist view of learning provides an approach to creating educational practices that are in harmony with the above-mentioned requirements and thus may produce prerequisites for professional expertise of the kind needed in working life. Therefore, creating constructive learning environments is an important challenge to higher education (e.g. Biggs, 1996; Duffy et al., 1993; Entwistle et al., 1993). [2]
3. Formal knowledge is converted into an expert's informal knowledge by being used to solve problems of understanding (Bereiter & Scardamalia 1993).
4. The knowledge transforming model of writing enhances both writing expertise and subject-matter understanding (a hypothesis put forward by Scardamalia and Bereiter 1991).
5. Combining writing tasks and group discussions is an effective way of enhancing textbook learning (Fellows, 1994; Dysthe, 1996; Tierney et al., 1989).

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[2] On the other hand, this is extremely important also in basic education because learning conceptions and approaches to learning and studying develop during early school years.

Chapter 3

METHODS

Study Design

The aim of this study was to examine whether students' learning outcomes would differ between a constructivist learning environment and a traditional examination-driven study mode. For this purpose, a quasi-experimental design was devised and carried out during an educational psychology course at the University of Jyväskylä, Finland, in spring 1995. At the beginning of the course the students were allocated, alternately, on the basis of the alphabetical order of their surnames, into the two groups, either the constructivist group (the experimental group) or the traditional teaching and studying group (the control group). Three exchanges of students between the groups and four transfers from the experimental group to the control group were allowed because of the students' time schedules. As a result, the experimental group consisted of 16 students and the control group of 23 students. After the course the students were asked to come for an individual interview. The interviews were attended by 15 students from the experimental group and by 13 students from the control group.

The course content was exactly the same for both groups, based on three textbooks (Crain, 1992; Entwistle, 1981; Sugarman, 1986).

The students in the experimental group studied the books with the help of writing assignments requiring knowledge transforming, discussed their assignments in groups and wrote a long essay. The students in the control group studied the books on their own, attended the lectures and took an examination. The author did not teach either of the groups but only observed the classes and collected the research material. A more detailed description of the two groups is presented below.

Constructivist Group (Experimental Group)

The theoretical foundation of the experiment's instructional design was integrating the constructivist view of learning, recent accounts of the development of expert knowledge, and cognitive theories of writing. As a whole, the course was a pedagogical application of the knowledge transforming model of writing, assumed here to have the potential to help students understand domain knowledge (Bereiter & Scardamalia, 1987; Scardamalia & Bereiter, 1991). Its other theoretical starting points were the idea of developing expert knowledge through problem-solving (Bereiter & Scardamalia, 1993) and by theorising practice and particularising theory (Leinhardt et al., 1995). Furthermore, the importance of metaconceptual awareness in conceptual change (e.g. Vosniadou, 1994) as well as earlier research results on using writing to enhance learning (e.g. Langer, 1986; Lonka & Λhola, 1995; Tierney et al., 1989) were also taken into account in designing the course. For example, group discussions were combined with writing tasks because it has been found that reading, writing and group discussions are more effective in combination than as separately used methods (Tierney et al., 1989; Dysthe, 1996).

The purpose of the experiment was to create a course that would free the students from examination-driven learning and a surface approach and, instead, promote learning in its constructivist sense. The main idea was that while reading each textbook the

students would also carry out several learning tasks that compelled them to engage actively with the information they were studying. The learning tasks were planned so that the students could not use the knowledge from the books as such. Instead, they had to transform it in different ways, apply it, criticise it and so on. The learning tasks were different types of writing assignments which were discussed in groups once a week during the course (30 hours altogether). The assignments included:

- activating students' previous knowledge;
- comparing previous knowledge with the knowledge presented in the textbooks;
- comparing different theories or approaches;
- examining the theories in the light of students' own experiences;
- criticising the theories;
- describing thoughts that the theories aroused in the students;
- applying theoretical concepts to real-life situations;
- writing a fictional or true story using theoretical concepts;
- writing summaries;
- writing down the most essential aspects of the theories.

Examples of the writing tasks:

1) Activating previous conceptions and comparing them with the knowledge presented in the textbook (the textbook chapter dealt with Maslow's concept of the self-actualising person and Allport's account of the mature personality):
   "Before you read chapter two, describe briefly your idea of what a) a self-actualising person and b) a mature person is like."

2) Examining theories in the light of students' own experiences (the textbook chapter was about learning strategies):
   "Write a one- or two-page description of yourself as a student, comparing your experiences with aspects presented in chapter five."

In addition to these learning tasks, the students also wrote a long essay (about 10 pages) towards the end of the course. The students were given twelve topics to choose from or they could also pick a topic of their own. The writing process was supported with collaborative planning (see Flower et al., 1994). At the beginning of the planning process the students presented their ideas and essay plans in a group where the teacher and the other students commented on them. When the first drafts had been written they were again discussed in the group. This way the students were given an opportunity to talk out their essay plans and drafts before completing the essay.

Because moving to constructive learning requires also giving up traditional assessment procedures (Biggs, 1996; Entwistle et al., 1993, p. 353; Jonassen, 1991), the assessment of the experimental group was based on the learning tasks (the writing assignments, participation in group discussions and the extended essay) instead of an exam. (However, although the experimental group students did not have to take an exam to determine their course grade, they were asked to participate in the exam together with the control group and answer the questions in order to provide research material. The students were naturally aware that their answers would not be graded because otherwise they might have turned to traditional reproductive examination preparation, which was not the purpose.)

Traditional Group (Control Group)

While the students in the constructivist group carried out writing tasks and engaged in group discussions, the traditional group attended lectures on the topics dealt with in the coursebooks (three hours per week, 30 hours altogether). The students in this group had to take a traditional examination at the end of the course, and they were not given any learning tasks to help them prepare for the examination. Instead, they studied the textbooks on their own and made their preparations in their usual manner.

The study design is presented in Figure 1.

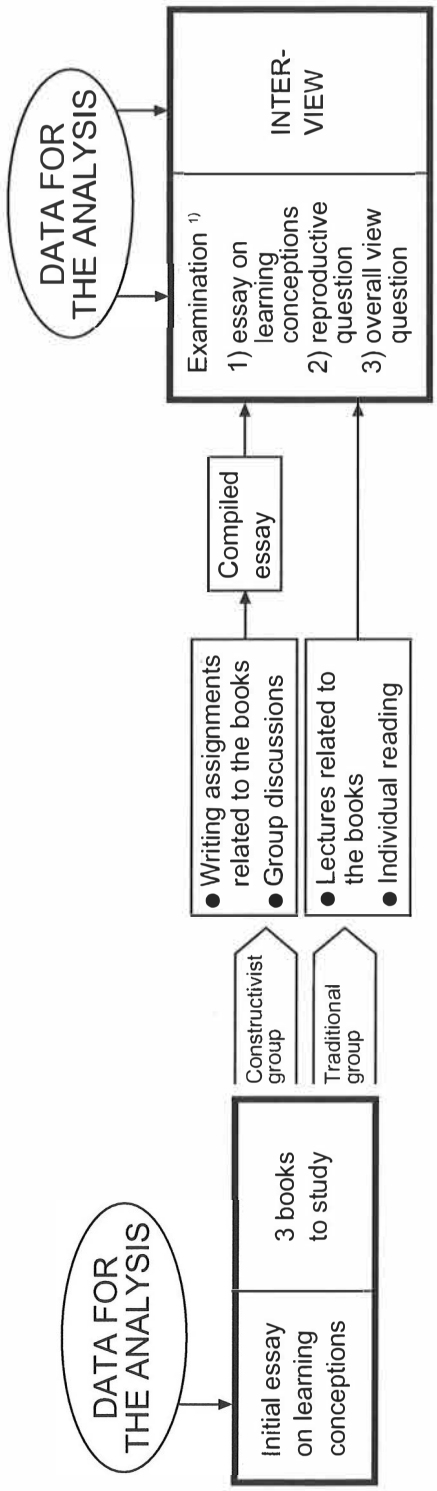

Figure 1. Study design.

1) The constructivist group students' course grades were not based on examination answers. Their answers were treated only as a research material.

Research Problems

The aim of the study was to investigate students' learning outcomes in a constructivist and a traditional learning environment. Learning outcomes were examined from three different viewpoints: 1) as the students' subjective learning experiences, 2) as conceptional change and 3) as measured by traditional examination. More specifically, the following research questions were addressed:

1. *What were the students' subjective learning experiences like, i.e. what did the students feel that they had learned during the course?*
2. *How did the students' conceptions of learning develop during the course?* (One of the textbooks dealt with theories of learning).
3. *What were the learning outcomes like as assessed by traditional examination questions that involved a) reproducing information studied and b) giving an overall view of one main topic?*

These three research questions represent three different approaches to assessing student learning. The first question emphasises students' self-assessment of their own learning and students' personal experiences. The second question derives from two sources, the phenomenographic tradition of studies of people's conceptions of different phenomena on the one hand, and cognitive studies of conceptual change on the other. The third research question represents traditional assessment procedures where the aim is to find out how much of the study material students can reproduce in an examination. The first question and the second question are in harmony with the current constructivist view of learning, while the third question represents the knowledge transmitting paradigm. Both approaches were included in the study because one of its aim was to investigate whether different methods of measuring learning produce different pictures of learning outcomes.

Methods and Data

Each research question was examined by using different methods and data:

1. The students' subjective learning experiences were studied by open interview questions, and the data were analysed by the phenomenographic method (Marton, 1988,1994). The categories of description resulting from the analysis were then compared between the constructivist and the traditional group. In addition to open questions the students also filled in a self-assessment form concerning certain aspects of their learning.
2. The development of the students' conceptions of learning was examined by having each student write a short essay titled "My conception of learning" at the beginning and at the end of the course. The final essays were written as a part of the examination. The essays were analysed by using the phenomenographic method and concept maps, and by categorising the framework theories that could be identified lying behind the students' learning conceptions.
3. The traditional way of assessing student learning was represented by examination questions that involved a) reproducing the information studied in the textbooks and b) giving an overall view of one main topic of the course. The students' examination answers were analysed by means of an epistemic categorisation derived from earlier studies (Leiwo, Kuusinen, Nykänen & Pöyhönen, 1987; Ohlsson, 1996) and by using the SOLO Taxonomy (SOLO = the Structure of the Observed Learning Outcome) (Biggs & Collis, 1982; Biggs, 1992).

Table 1 shows the number of students participating in each phase of the study. The following sections will describe the different analytic procedures in greater detail.

Table 1. The number of students participating in each part of the study

	Experimental group n	Control group n
• At the beginning of the course: essay on learning conceptions	16	23
• At the end of the course: essay on learning conceptions (in the examination)	14	17
• At the end of the course: traditional examination questions	14	18
• After the course: interview	15	13

Analysis of the Students' Subjective Learning Experiences

The data on the students' subjective learning experiences were gathered in the interviews conducted after the course. All students in both groups were asked to take part in the interview, but one student from the experimental group and ten students from the control group did not attend. The total number of the interviewed students was thus 15 in the experimental group and 13 in the control group.

The students' learning experiences were examined by using two methods, the phenomenographic analysis and a self-assessment questionnaire. In the interviews the students were asked to answer the question "What do you feel that you have learned during the course". The phenomenographic analysis of the students' answers was carried out following the procedure described by Marton (1988; 1994). Accordingly, in the first phase of the analysis the analytic unit was not an individual. Instead, the answers were handled as a whole to find out what Marton terms as "the pool of meanings". The transcribed answers were read repeatedly in order to determine the distinct ways in which the students described their learning. In addition to differences in forms of expression, attention was also paid to similarities. When two expressions differed at word level but carried the same meaning, they were placed into the same

category. The categories resulting from the analysis cover the whole variation of different ways in which the students described their subjective learning outcomes. Establishing such categories of description is the main result of phenomenographic research. In this study an additional aim was to compare the students' answers between the experimental and the control group, for which purpose the categories of description expressed by the individual students were tabulated by group. It is important to note that the categories do not exclude each other at the level of an individual. In other words, each subject may have expressed more than one conception. The category system cannot therefore be treated as a single variable with each category as a separate class. Instead the proportions will be examined separately for each category of description.

At the end of the interview the students also filled in a five-point self-assessment form containing nine items that described the quality of their learning: 1) surface vs. deep learning; 2) detailed vs. holistic learning; 3) rote learning vs. understanding; 4) book learning vs. applicable knowledge; 5) rapid forgetting vs. long-term retention; 6) little development in one's own thinking vs. much development in one's own thinking; 7) mostly dull vs. mostly fun; 8) few perceived changes vs. many perceived changes in one's conceptions of the topics studied; and 9) externally vs. internally motivated learning.

Analysis of the Students' Conceptions of Learning

Changes in the students' conceptions of learning were studied by using essay writing. At the beginning of the course all the students wrote an essay "My conception of learning". They were given 45 minutes for completing the task. At the end of the course – as a part of the examination questions – the students again wrote an essay about their learning conceptions. This time 14 experimental group students and 17 control group students wrote the essay. Since each of the 31 students composed two essays, there were 62 essays

altogether. For the analysis, the students' hand-written products were first re-written into the text files of a computer program that was used in the analysis. Furthermore, text structures and meanings were visualised by means of concept maps.

The texts were analysed using multiple methods: 1) a categorisation of the theoretical viewpoints that the essays reflected, 2) concept mapping which revealed not only the contents but also the structure of each essay, and 3) phenomenographic analysis.

1) Categorisation of Theoretical Viewpoints

The subjects of this study were university students who were supposed to base their conceptions of learning on scientific theories instead of common-sense knowledge. Therefore the first step of the examination of the students' learning conceptions was to identify those larger structures or learning theories in which the students' conceptions were embedded. For this purpose, the students' essays on their conceptions of learning were analysed against the theoretical constructions of learning articulated in the scientific community. The aim was not to capture the ontological or epistemological presuppositions behind the students' conceptions (cf. Vosniadou's 1994). Instead, it was assumed that – in this case of young adult learners required to study learning theories – presuppositions of this kind would surface in the theoretical constructions that the students had already formed during their university studies of education. That is why the aim of the analysis was to find out which scientific theories or theoretical approaches could be identified in the students' texts. In this study, the scientific positions that the students expressed in their essays are called *theoretical viewpoints*.

The analysis of the theoretical viewpoints was carried out by assigning sentences or paragraphs to categories of scientific theories that they resembled. The categories were not strictly defined beforehand, although it was anticipated that behaviourist or cognitive views, for example, would appear. The logic of discovery

in the analysis was grounded on abductive inference. That is, theoretical knowledge and preconceptions served as heuristic tools for the construction of categories which were then elaborated and modified on the basis of empirical data (Kelle, 1993).

The analytic unit was not strictly defined, either, because meanings can be expressed in different units: in individual sentences, groups of sentences, paragraphs, etc. Furthermore, meanings may exist within each other or overlap one another. That is why the same text segments could be marked with more than one qualitative code if necessary. The limits of the segments were flexible so that overlapping was also possible.

2) Concept Mapping

The nature of the changes that took place in the students' conceptions was examined by analysing, side by side, the students' texts and the concept maps prepared to visualise the structures of the texts and the relations between the concepts used in them. Earlier studies have proved that concept maps of different kinds may be very effective tools for presenting students' knowledge structures and for examining changes in their conceptions (e.g. Novak, 1990; Novak & Musonda, 1991; Fellows, 1993, 1994; Morine-Dershimer, 1993; Morine-Dershimer et al., 1992)

The idea of concept mapping is that the concepts related to each other in students' presentations are united with lines and linking words that form a proposition. Because some concepts are more general or more specific than others, Novak and Musonda (1991) recommend that concept maps be drawn in a hierarchical form. However, it is not easy to determine the levels of hierarchy in a concept map nor, when there are a great number of maps, to assure that all levels in all maps would be equally determined. For this reason, it was assumed in this study that the concept maps should be formed against a theoretical model that would provide a fixed structure for mapping the conceptual structures. In this case,

involving students' overall conceptions of learning, the relevant model was a general theory of learning presented by Biggs (1987, pp. 9, 96; 1993, pp. 74–76). The theory describes learning holistically with the help of *presage, process* and *product* variables. The presage variables refer to the background factors of learning, such as prior knowledge, abilities, home background, etc. The process factors consist of strategies and approaches to learning while the product variables refer to outcomes of learning. Thus, the concept maps were structured in columns according to these three basic variables, and the concepts presented in the texts were placed in appropriate columns. This procedure, called here *a structured concept map* proved very illuminating in forming an overall picture of the essays.

The concepts and propositions that the students presented in their essays were placed in the structured map according to which category they belonged, whether they described the *presage* factors of learning or illustrated the learning *process* or the *products* of learning. These three categories are called here *categories of explanation*. In addition to the categories of presage, process and product, the basic structure of the maps included the category of *meta-level*. Those expressions in which the students referred to the source of their conceptions, such as the authors cited in the textbooks or their own experiences, were placed in the category of meta-level. Each concept map proceeds from top to bottom in the same sequence as the essay from which it is drawn. Thus, it is easy to see the order in which a student dealt with different topics. The relations between the concepts, such as interdependence or causal relationships, were marked with lines and arrows and specified with words. Boxes in the maps enclose the themes that a student had discussed together.

The column in which each concept or proposition was placed depended on the *function* that a student had given to it rather than on its position in the original model of learning constructed by Biggs (1987). Generally the propositions were placed in the same category as in the original model, but not always. For example, in Biggs' theoretical model "evaluation of learning" is in the product column,

but a student may have presented it only as a presage factor directing learning, in which case it was placed in the presage column. Similarly, if "prior knowledge" was described as "prior knowledge affects learning" then it was placed in the presage column. However, if a student wrote that "learning takes place when new information is anchored to prior knowledge structures", then the concept "prior knowledge" was placed in the process column. Likewise, the concept of "motives" belongs to the process column in the original model, but the students often presented it merely as a presage factor.

Examples of concept maps are presented in Appendices 1 and 2. These concept maps are constructed from two essays written by the same student at the beginning (App. 1) and at the end of the course (App. 2). To analyse conceptual change the two concept maps derived from each student's essays were examined side by side to catch any structural and thematic differences between the maps. Furthermore, the original essay texts were also used to confirm the interpretations.

3) Phenomenographic Analysis

In addition to a classification of the theoretical viewpoints and preparation and interpration of concept maps, the study also involved a phenomenographic analysis of those passages in the essays that described the learning *process*. The idea was to find out how learning takes place in the students' view. For this purpose the extracts from the essays that described the learning process (i.e. the extracts which were placed in the process column in the concept maps) were analysed by the phenomenographic procedures as earlier described. The categories of description resulting from the analysis are the main result of phenomenographic research (Marton, 1988). In this study, an additional aim was to compare how students' conceptions develop during an educational psychology course in a constructivist and a traditional learning environment. For this purpose, the categories of description were tabulated by group and by the phase of the course (at the beginning / at the end).

Analysis of Traditional Examination Answers

The traditional examination answers were analysed by two methods, by an epistemic categorisation and by the SOLO Taxonomy.

1) Epistemic Categorisation

The epistemic categorisation used was based on earlier studies of learning declarative knowledge (Leiwo et al., 1987; Ohlsson, 1996). The categories were: 1) classification, 2) description, 3) comparison, 4) evaluation, assessment or criticism, and 5) generalisation. The analytic unit was a thematic sequence, consisting of one or more sentences related to each other by topic. Very often the length of a thematic sequence equalled a paragraph but not necessarily. The categorisation was carried out simply by giving each thematic sequence a code representing the appropriate category.

2) The SOLO Taxonomy

The answers as a whole were evaluated by using the SOLO-Taxonomy (the Structure of the Observed Learning Outcome) (Biggs & Collis, 1982; Biggs, 1996). The levels of the SOLO-Taxonomy are as follows (Biggs, 1996):

1. Prestructural. The task is not attacked appropriately; the student has not understood the point.
2. Unistructural. One or a few aspects of the task are picked up and used (understanding as nominal).
3. Multistructural. Several aspects of the task are learned but are treated separately (understanding as knowing about).
4. Relational. The components are integrated into a coherent whole, with each part contributing to the overall meaning (understanding as appreciating relationships).
5. Extended abstract. The integrated whole at the relational level is reconceptualised at a higher level of abstraction, which

enables generalisation to a new topic or area, or is turned reflexively on oneself (understanding as far transfer, and as involving metacognition).

When appropriate, the statistical significance of the differences between the groups were tested with the chi square test and the t-test and checked with the Mann-Whitney test (the Wilcoxon rank-sum test). The non-parametric tests were carried out by using the SPSS Monte Carlo method because it produces reliable results even from limited data (Mehta & Patel, 1996), which made it appropriate for the present study.

The research problems, the data collected and the analytic methods are summarised in Table 2.

Table 2. A summary of the research problems, data and analytic methods of the study

RESEARCH PROBLEM	DATA	ANALYTIC METHODS
1) What were the students' subjective learning experiences like?	a) Answers to the open interview question: "What do you feel you have learned during the course? b) Answers to the self-assessment of learning form	Phenomenographic analysis + Cross-tabulation Cross-tabulation
2) How did the students' conceptions of learning develop during the course?	Short essays written at the beginning and at the end of the course	a) Abductive analysis of theoretical viewpoints b) Concept mapping c) Phenomenographic analysis
3) What were the students' learning outcomes like as assessed by traditional examination questions?	Answers to a) a reproductive comparison question and b) an overall view question	a) Epistemic categorisation of the answers b) The SOLO Taxonomy

Chapter 4

RESULTS

The Students' Subjective Learning Experiences

Part of the results of this sub-study have been published earlier by the author in two related papers (Tynjälä, 1996, 1998a).

What Did the Students Think That They Had Learned During the Course?

In answering the interview question "*What do you feel that you have learned during the course*?" the students described their learning in the following qualitatively different terms:

1. as the accumulation and organisation of their knowledge;
2. as the ability to apply knowledge;
3. as changes in their thinking or conceptions;
4. as gaining an increasingly critical perspective;
5. as moving from epistemological dualism towards relativism;
6. as learning English;
7. as the acquisition of study skills;
8. as the acquisition of communication and co-operation skills.

These eight categories of description can be further reduced to three main categories:

I Acquisition and application of knowledge (categories 1 and 2)
II Development of thinking (categories 3 to 5)
III Acquisition of skills (categories 6 to 8).

Examples of interview answers belonging to each category of description are presented below.

I ACQUISITION AND APPLICATION OF KNOWLEDGE

1. Accumulation and organisation of knowledge

> 37: "Now I know a much broader range of different theories and theorists, and their names and their views. For example, I knew earlier that there was someone called Locke, but I had not the faintest idea of what he thought. And I knew that there was a book called *Emile* by Rousseau, but I did not know the basic ideas set out in it. So I feel that I got a general view of developmental and educational psychology ... And of course I knew something very well earlier, such as Kohlberg, Freud and Piaget, but there was much that I did not know. And there were new ideas concerning the things that I was already familiar with."

2. Ability to apply knowledge

> 12: " All the time I reflected on our workplace with the result that I made a plan for the pedagogical development of our school."

> 9: "As regards my own learning, Entwistle's book was good because it gave me ideas for developing my own learning and studying. In my opinion, the theories studied and the whole course on educational psychology were useful from the viewpoint of one's own development. On the other hand, I have realised that theory and practice do not always go hand in hand."

II CHANGES IN THINKING

3. Changes in thinking or conceptions

4: "I realised, as Entwistle's book emphasised, that I am transforming knowledge into a conception of my own. The fact that the assignments required producing and thinking about ideas led to reflection."

12: "... the most surprising thing was that, on the basis of only a couple of books, it [the course] changed my thinking so much."

16: "I learned to look at things also from other people's perspective ... I learned to think about knowledge in an entirely different way."

4. Gaining an increasingly critical perspective

5: "I learned that you cannot accept everything at face value but you must be critical, like the assignments were, that we also have to search for those sides of things that we cannot take for granted."

9: "I noticed that when I begin a new book I cannot form a general picture, or I do not read it critically. I think that during the course I developed a more critical attitude towards reading."

5. Moving from epistemological dualism towards relativism

1: "Because of the comparisons that we had to make, I noticed the differences between the theories. And – as we spoke during the course – in the upper secondary school I thought that there is only one right theory, but especially now I realised that one should not believe everything that is printed in books and that one must be critical towards everything."

32: "I understood that there are many different theories and that not all of them are very reasonable."

16: "And then I realised – although I had already realised it earlier, too – that one should not take all those theories literally, and that they can be interpreted

in many different ways. During my university studies I have learned that although many theories are good, they also have their weak sides. It was very good that we had to discover the pros and cons of the theories."

III ACQUISITION OF SKILLS

6. Learning English

28: "I have learned to read textbooks in foreign languages."

21: "And then I learned that I need not be afraid of English textbooks."

30: "At first I read the text in too great detail and translated it into Finnish word by word... But then I developed a routine to understand the essentials rather than translating every word."

7. Acquisition of study skills

10: "I noticed that during the course I aimed at optimal learning, in which emphasis is on the most important things, not on rote learning ... I started to acquire and deal with information more holistically – I do not mean superficially – I mean that I learned to get to the gist of the matter.

13: "Well, I learned rather a lot about myself as a learner. I had to reflect on my strong and weak points and think how I could develop my learning. I learned to work more deeply and to think about things from my own viewpoint and relate previous knowledge to new knowledge."

8. Acquisition of communication and co-operation skills

5: "And then there was working in a group. I learned to express myself although I was scared at the beginning. At first it was difficult and I was nervous. But it was very educational because you had to commit yourself and analyse your thinking. It was a very educational situation."

12: "This course also taught me how to analyse things through writing. I mean that if I plan something I feel it very easy to write it down quickly

> and make a summary. This skill developed along with other things ... Although it may not have been the aim of the course, I think that what I have especially learned is that now I dare open my mouth. If I know something I do not keep it to myself but I share it with other people."

The prevalence of the three main categories in the constructivist and the traditional group is shown in Table 3 and the prevalence of the more specific categories in Table 4. Table 3 reveals that all students in both groups described their learning in terms of knowledge acquisition. However, there is a striking difference between the groups as regards the other two main categories. While 80 per cent of the constructivist group students emphasised that the course had developed their thinking, only 15 per cent of the traditional group students felt the same. Skills acquisition was also mentioned more often by the constructuvist group students.

Further, the students in the constructivist group described their learning in a greater variety of ways than did the students in the traditional group (Table 4). The traditional group students characterised their learning mainly in terms of knowledge accumulation and organisation and learning the English language. (The students were Finnish and the textbooks were in English). In contrast, most constructivist group students also emphasised the acquisition of an ability to apply knowledge, gaining a more critical perspective, changing their conceptions of the topics studied and moving from epistemological dualism towards a more relativistic view of knowledge. Furthermore, over half of the constructivist group students mentioned that they had acquired communication and co-operation skills, such as teamwork and writing skills, while not a single one of the traditional group students mentioned these skills as their learning outcomes.

Table 3. The prevalence of the main categories of learning experience in the constructivist group and the traditional group

		Constructivist group (N=15)		Traditional group (N=13)		Chi-square test
		n	%	n	%	significance
I	Acquisition of knowledge	15	100	13	100	
II	Development of thinking	12	80	2	15	.002
III	Acquisition of skills	11	73	7	54	ns

Table 4. The prevalence of the narrower categories of learning experience in the constructivist group and the traditional group

	Constructivist group (N=15)		Traditional group (N=13)		Chi-square test
Category of description	n	%	n	%	significance
1. Accumulating/organising one's knowledge	12	80	13	100	ns
2. Applying knowledge	10	67	1	8	.005
3. Changes in one's thinking or conceptions	5	33	-	-	.042
4. Gaining a critical perspective	9	60	1	8	.001
5. Moving from dualism towards relativism	8	53	1	8	.016
6. Learning English	4	27	6	46	ns
7. Acquiring study skills	6	40	1	8	ns
8. Acquiring communication and co-operation skills	8	53	-	-	.003

How Well Did the Students Learn in Their Own Opinion?

In the interview the students were also asked to assess their learning by filling in a form that consisted of nine items with a five-point scale. The items and the frequencies and percentages of each item in the two groups are presented in Table 5. Because of the low frequencies, the two extreme point values at each end of the scale were combined. Consequently, the results are presented as classified on a three-point scale.

Table 5 shows that the constructivist group students gave a more positive assessment of their own learning on almost all items, although the differences between the groups are small. The most striking contrast appears in the students' assessments of the development of their

thinking and of changes in their conceptions during the course. While 93 per cent of the constructivist group students felt that their thinking had developed a great deal, only 46 per cent of the traditional group students felt the same. Similarly, over half of the students in the constructivist group felt that their conceptions of the topics studied had changed considerably, while only 23 per cent of the traditional group students gave the same answer.

Table 5. Students' assessments of their own learning in the constructivist and the traditional group

	Constructivist group (N=15)		Traditional group (N=13)	
Assessment item	f	%	f	%
1. Surface vs. deep learning				
Mostly surface learning	-	-	-	-
Intermediate	2	13	4	31
Mostly deep learning	13	87	9	69
2. Detailed vs. holistic learning				
Mostly detailed learning	-	-	-	-
Intermediate	1	7	2	15
Mostly holistic	14	93	11	85
3.Rote learning vs. understanding				
Mostly rote learning	-	-	-	-
Intermediate	-	-	1	8
Mostly understanding	15	100	12	92
4. Book learning vs. applicable knowledge				
Mostly book learning	1	7	4	31
Intermediate	1	53	6	46
Mostly applicable knowledge	8	40	3	23
5. Rapid forgetting vs. long-term retention				
Mostly rapid forgetting	1	7	-	-
Intermediate	3	20	5	38
Mostly long-term retention	11	73	8	62
6. Development of a student's own thinking				
Little development of thinking	-	-	1	8
Intermediate	1	7	6	46
Considerable development of thinking	14	93	6	46
7. Fun vs. dull				
Mostly dull	1	7	-	-
Intermediate	2	13	2	15
Mostly fun	12	80	11	85
8. Changes in a student's conceptions of the topics studied				
Few changes	4	27	8	62
Intermediate	3	20	2	15
Many changes	8	53	3	23
9. Externally vs. internally motivated				
Mostly externally motivated	1	7	1	8
Intermediate	4	27	6	46
Mostly internally motivated	10	67	6	46

Development of the Students' Conceptions of Learning

Part of the results of this sub-study have been published earlier by the author in two related papers (Tynjälä, 1997, 1998b).

In the following sections the students' learning conceptions will be described from three perspectives. First, we shall examine which theoretical viewpoints the students' conceptions of learning represent. In other words, the focus of the analysis is the compatibility of the students' conceptions with or their resemblance to the learning theories or schools of thought of the scientific community. Second, the students' different descriptions of the learning process will be examined, and, third, the nature of changes that took place in the students' conceptions during the course will be analysed.

The Theoretical Viewpoints

As stated earlier, the categories of theoretical approaches were not strictly defined beforehand although some main categories were expected to appear in the students' essays. As a result of the analysis, ten theoretical viewpoints could be identified:

1. Sociological approach
2. Physiological psychology
3. Personality psychology
4. Interactionism
5. Behaviourism
6. Humanistic psychology
7. Lifelong learning
8. Experiential learning
9. Cognitive theory of learning
10. Constructivist view of learning.

In addition to these approaches, a category called "metaconception" was also identified. That is, those expressions which indicated that a student was aware of different theoretical or scientific conceptions of learning were classified as metaconceptions. Such expressions included references to behaviourist, cognitive and humanistic views of learning. No student mentioned the constructivist view. It is important to note here that the contents of the course did not include any straightforward categorising of learning theories as "behaviourist" or "constructivist" or the like. Therefore, the students who explicitly described, for example, "a cognitive conception of learning" have appropriated these categories from other sources than the course under study. Furthermore, metaconceptions also included the illustrations with which the students expressed the source of their own conception of learning. Two examples of meta-conceptions are presented below. (Letters B and E indicate whether the subject presented the statement in question before the course (B) or at the end of the course (E), while the numbers are used to identify each student).

> B13: "My conception of learning is based partly on my own experiences of learning, partly on knowledge acquired during my studies. However, I am going to discuss the topic mainly on the grounds of my own experiences."

> B24: "There are many schools of learning. These include, for example, the behaviourist, the cognitive and the humanistic lines of thought."

Examples of each theoretical viewpoint are presented below.

1 Sociological approach

Although the students generally discussed learning from a psychological perspective, some students also brought up sociological aspects of learning, for example:

B28: "The social class background affects learning in the sense that middle-class students educate themselves further than working-class students. It depends very much on how important the parents consider education and studying."

E6: "However, the learning process is not only a micro-level process. Instead, it should be seen from a broader perspective, from those social frames where teaching takes place. Laws, regulations, curricula and budgets among other things affect the length, quality and timing of teaching. And these things can be seen clearly in classrooms and in learning. Lack of study materials resulting from a shortage of money can impair learning because we need visual information, too. However, this time of economic depression should be seen as a challenge to and an opportunity for new teaching methods."

2 Physiological psychology

Physiological perspectives on learning were briefly discussed in some essays. The following extracts are typical examples of physiopsychological viewpoints:

B9: "Furthermore, physiological factors make a difference, too. If one is tired then one's mental activation level is low, and low blood sugar level causes exhaustion, etc."

B34: "Learning is affected by many factors. Physical factors that enhance learning are, for example, being active, healthy and feeling good."

3 Personality psychology

Especially in their final essays many students described how personality factors may influence learning. These descriptions were sometimes taken straight from the textbook:

E11: "What we learn or how we learn is also affected by a learner's and a teacher's personality. A teacher who is encouraging, ready to discuss things, sincere, and competent is considered a good teacher. Teachers may be formal or informal. Formal teachers follow the rules and are precise, impersonal.

Informal teachers allow their students freedom, change the rules and the topics. The basic distinction among students is whether they are extroverts or introverts. The introverts usually succeed better in formal instruction. The basics are also learned better this way. Instead, restless and low-ability students learn better in informal instruction."

E20: "Heath paid more attention to students' personality and identified three personality types and an ideal type: non-committers, hustlers, plungers, and the reasonable adventurer as an ideal type. Everyone developed in the direction of the ideal type as their studies advanced. The reasonable adventurers are intelligent, sociable, have high tolerance to frustration and a sense of humour. They are both curious and critical in their studies. The students who were close to the ideal type at the end of their studies received the best grades."

4 Interactionism

Particularly at the end of the course, several students described learning as a phenomenon that could be best understood in terms of the interaction between an individual and his or her environment. Such descriptions were defined as interactionist views.

E2: "I put more emphasis on an individual's natural, genetic factors now. The harmonious interaction between them and environment is the alpha and omega of everything!"

E17:"The learning process is not only a teacher-student process. Instead, there are many other factors. Learning is interaction between several factors."

5 Behaviourism

The expressions which stressed external stimuli and environment as a basis of learning or described conditioning or modelling were classified as behaviourist statements. For example:

B17:"All people do not learn same way. This is due to many factors. The

amount of the content to be learned is important. If a person receives too much or too little stimuli, his or her interest will diminish."

B1: "Learning may be, for example, modelling when we learn through observation by imitating others. Learning can also be affected by conditioning like what Pavlov did in his dog experiments. Conditioning may take place, for example, through instrumental conditioning when rewards and punishments are used to enhance or weaken learning."

6 Humanistic psychology

The viewpoint of humanistic psychology includes those expressions that stress the need of self-actualisation and the growth of personality and self-esteem.

B11: "Why should we learn new things? The first thing which came into my mind is doing well in life. But this is not enough. I would also consider it is important that one is able to satisfy one's needs. And I don't mean what are called basic needs but our need for self-actualisation and personality development."

B12: "Learning is a continuous process in which a person's self-esteem and self-image develop, too. Teaching should lead to holistic learning, to the development of emotional life and a positive self-image."

7 Lifelong learning

Ideas linked with lifelong learning appeared quite often in the students' essays, for example:

B24: "I think that learning takes place through the whole life span. Adulthood and old age are often considered a time when there is not very much learning taking place. I think that adults and old people can also learn and that they have all that is needed for learning. In modern society you must engage in continuous learning and keep abreast of the times."

E21: "In youth learning is flexible and discovery-like. In older age learning is more 'crystallised', the learner has more experiences, and the experience that people have gained in their life marks their learning too. Learning is not necessarily easy because knowledge structures and attitudes are already so well established. However, learning in older age has been underestimated needlessly. Learning continues throughout one's life if an individual stays responsive."

8 Experiential learning

Those descriptions of learning that resembled the ideas of learning by doing or the experiential learning theory were placed in this category, for example:

B4: "I think that learning in practical situations and learning by doing is an efficient way to learn because a person may form mental pictures about the things to be learned, and they will be remembered better, too."

E6: "Many factors affect how well the content that has been learned is recalled. Generally, the important thing is that one has understood the content and could have applied it in some concrete situation in mind or in practice. Personal experience is important – it makes it easier to learn things"

9 *Cognitive theory of learning*

This category consist of descriptions that characterise learning either in terms of *the information processing* theory or from the viewpoint of studies of *student approaches to learning,* which emphasise learning styles and strategies. Although accounting for learning in terms of the information processing theory or in terms of learning styles or strategies are not very similar positions, both represent descriptions of the cognitive processes involved in learning, and therefore these two approaches have been combined into the same category.

E28: "Learning depends on memory. At first a stimulus initiates a perception when the senses are alerted. After this, knowledge goes into sensory

memory, then into working memory and through analogical thinking, for example, into long-term memory, into either its episodic or semantic component."

E6: "Learners have different learning styles. Some people may act in a holistic way and concentrate first on the whole and afterwards on the details. Other people are serialists, working their way through the details to the whole. Some may engage in surface learning, others in deep learning. Surface learners tend just to pass exams while deep learners strive for understanding, as Marton puts it. Of course, the task also affects how it is handled. Some tasks require a surface approach. The best way from the viewpoint of learning would be a versatile style of learning where the surface or the deep approach are used depending on the task."

This is a very typical extract from the students' final essays. The cognitive learning theory was the main content of the coursebook dealing with learning. It is therefore no wonder that this conception of learning was also the most common view at the end of the course.

10 Constructivist view of learning

Strictly speaking, what we usually call the constructivist view of learning can be defined as a view that includes ingredients of all of the following: 1) constructivist epistemology; 2) the cognitive theory of learning; and 3) pedagogical implications of the former two. Thus, the above-mentioned viewpoint category, the cognitive theory of learning, is embedded in the constructivist view. When a student paid attention only to cognitive processes, his or her statement was classified into the category of the cognitive learning theory. If the student additionally emphasised either the constructivist epistemology or the pedagogical implications of constructivism, such as learner activity or study methods in which learning is not seen as passive reception of information but as active knowledge construction, his or her statement was judged to be a constructivist account of learning. The mere mention of student activity was not a

sufficient criterion for a constructivist view because many views – even behaviourist ones – may include the activities of the student as an important element of learning. The constructivist views that appeared in the data were either theoretical descriptions of the learning process or pedagogical considerations emphasising the role of active knowledge construction in learning. It is important to note that the course itself did not deal with constructivism although the cognitive theory of learning was its main focus. For this reason, no student explicitly used the terms "constructivism" or "constructive learning", and constructivist epistemology was usually an implicit ingredient of a student's descriptions of cognitive activities or of his or her pedagogical statements.

> E12: "Learning is the result of a learner's active information processing. It is a subjective event in which a learner processes information with the help of his or her previous knowledge, experiences and thinking. Environment, instruction and education may stimulate, direct and guide learning, but the final cognitive change takes place in the individual who is learning."

> B12: "I have good experiences of essays from the viewpoint of learning. When writing an essay one feels that one is doing something on one's own, processing information in a totally different way from when reading for an exam. It is a more meaningful way of familiarising oneself with the material, one can also choose the themes that interest one and they will be handled more thoroughly. When producing an essay one feels that one is creating something and the experience of learning is enhanced. At the same time, the process of producing and finishing the essay gives you a kind of satisfaction that is totally different from mere reading."

Changes in Theoretical Viewpoints

As described earlier, the categories of theoretical viewpoints were coded for paragraphs or sentences or other extracts from the students' essays. Each essay contained one or more different categories appearing once or several times. Consequently, a variety

of combinations of different viewpoints were identified at the individual level. An individual essay could include, for example, only behaviourist viewpoints, both behaviourist and cognitivist viewpoints, or behaviourist, cognitivist, humanistic and interactionist viewpoints. At the individual level, the initial essays incorporated one to three and the final essays one to six viewpoints. Table 6 shows the theoretical viewpoints that emerged in each group.

Table 6. Theoretical viewpoints at the beginning and at the end of the course in the constructivist learning group and in the traditional studying group: The number of students expressing each viewpoint

	Constructivist group (N=14)		Traditional group (N=17)	
	Beginning	End	Beginning	End
Sociological approach	1 (7%)	1 (7%)	1 (6%)	– (-)
Physiological psychology	2 (14%)	– (-)	3 (18%)	1 (6%)
Personality psychology	1 (7%)	3 (21%)	1 (6%)	7 (41%)
Interactionism	0 (0%)	6 (43%)	0 (0%)	4 (24%)
Behaviourism	5 (36%)	4 (29%)	14 (82%)	9 (53%)
Humanism	2 (14%)	2 (14%)	2 (12%)	1 (6%)
Lifelong learning	4 (29%)	5 (36%)	4 (24%)	6 (35%)
Experiential learning	4 (29%)	4 (29%)	(6%)	0 (0%)
Cognitivism	9 (64%)	13 (93%)	9 (53%)	17 (100%)
Constructivism	7 (50%)	8 (57%)	3 (18%)	2 (12%)

Table 6 shows that the cognitivist approach became more prevalent and the behaviourist approach lost favour in both groups during the course. We can see that constructivist statements were more common in the constructivist group at the end of the course, but they were more common at the beginning of the course, too. For

this reason we cannot conclude that it was the constructivist learning environment that influenced the prevalence of constructivism.

As described earlier, various combinations of viewpoints were identified at the individual level. However, Table 6 does not present individual changes, i.e. how individual students' viewpoint profiles changed during the course. For example, does a student who holds behaviourist-cognitivist views at the beginning of the course retain them at the end of the course or has he or she adopted any new viewpoints? Due to the small number of subjects and the great number of different combinations of viewpoints, a statistical analysis of the changes in theoretical approaches was not possible. However, three different types of individual viewpoint change could be identified:

A) The viewpoints were exactly the same at the beginning and at the end of the course.

B) The earlier viewpoints or at least some of them were still present in the essays written at the end of the course, at the same time as new viewpoints were also expressed.

C) The viewpoints expressed at the beginning and at the end of the course were entirely different, that is, only new viewpoints appeared in the final essay.

In Vosniadou's (1994) terms, type B could be characterised as representing *enrichment* of conceptions and type C *revision* while type A stands for *no change*. An enrichment-type student is the one who described learning at the end of the course partly from the same viewpoints as at the beginning of the course but had also acquired some new theoretical perspectives. Revision-type students described learning from completely different perspectives in their initial and final essays. However, this does not necessarily mean that they had totally rejected their earlier views because it is possible that they only did not express them. Thus, the term "revision" does not mean here the "objective" revision of framework theories in the sense that Vosniadou uses the term.

Most of the students in both groups were type B (9 out of 14, i.e. 64 per cent in the constructivist group and 12 out of 17, i.e. 70 per cent in the traditional group). Three students in both groups were type C and two students in both groups type A. Thus, studying in any of the two groups seemed to generate mainly learning that increased the students' knowledge within their existing "framework theory" and additionally provided them with some new ideas. Table 7 shows what these additional viewpoints were. That is, it displays the number of the students who had not expressed a certain viewpoint at the beginning but who did express it at the end of the course. The table shows that the behaviourist and humanistic views as well as physiological psychology and sociological accounts were the standpoints least often adopted during the course as new views. For example, no student in the constructivist group and only one student in the traditional group presented behaviourist notions as novel approaches to them at the end of the course. Cognitive standpoints, as well as views linked with lifelong learning, personality psychology and interaction approaches became more prevalent in both groups. The most interesting feature from the point of view of the present study is that the constructivist and the experiential learning approach increased only in the constructivist group. This fact supports a hypothesis that a constructivist learning environment may influence the emergence of constructivist views even when constructivism is not explicitly taught. Furthermore, a constructivist learning environment also seems to stimulate ideas linked with experiential learning. Another interesting point is that cognitivism and views derived from personality psychology, that were emphasised in one of the textbooks, became more general especially in the traditional group. A probable explanation for this is the fact that the traditional group students had to pass an examination and therefore paid more attention to reproducing the descriptions of the textbook.

Table 7. The number of students, for each theoretical viewpoint, who expressed the viewpoint as novel to them at the end of the course

	Constructivist group (N=14)		Traditional group (N=17)	
	n	%	n	%
Sociological approach	1	7	-	-
Physiological psychology	-	-	1	6
Personality psychology	2	14	7	41
Interactionism	6	43	4	24
Behaviourism	-	-	1	6
Humanism	1	7	-	-
Lifelong learning	3	21	3	18
Experiential learning	4	29	-	-
Cognitivism	3	21	7	41
Constructivism	4	29	-	-

The Students' Conceptions of the Learning Process

This section describes the findings of the analysis of those parts of the students' essays which dealt with the learning *process,* that is, the students' explicit accounts of *how learning takes place.* In other words, the data of the analysis were those passages which were placed in the process column in the conceptual maps drawn from the essays. As a result of the phenomenographic analysis, seven different categories of description were identified:

1 Learning as an externally determined event/process
2 Learning as a developmental process
3 Learning as student activity
4 Learning as strategies/styles/approaches
5 Learning as information processing
6 Learning as an interactive process
7 Learning as a creative process

According to Marton (1994), the categories of description generated in a phenomenographic study form a hierarchical system. A certain kind of hierarchy may be seen in the list of categories above, but the hierarchical nature of the categories should not be taken strictly.

For example, we cannot exactly determine whether describing learning in terms of information processing is at a higher or a lower level than explaining learning as styles or approaches.

It is important to notice that these categories concern the students' descriptions of the learning process, not their discussions of the products of learning or of definitions of learning. This explains the absence of categories such as "increasing one's knowledge", "memorising and reproducing", "understanding" etc., which were documented by Säljö (1979) and by Marton and others (1993). Descriptions of this kind were identified also in this study, but in most cases they were judged to be part of *product* descriptions, not process descriptions. Furthermore, when they were included in process descriptions, they were parts of broader categories. For example, "understanding" was generally described by the students as an essential feature of "the deep approach" to learning (category 4) and "memorising", by the same token, was a part of the "surface approach".

Another important point is that these categories, like categories in phenomenographic research in general, do not represent types of individuals. Instead, they are forms of understanding a certain phenomenon that individuals express in their speech, or in this case, in their writing. Consequently, the categories do not exclude each other at an individual level so that an individual may express more than one conception. In fact, this is the usual case in this data. Examples of each category are presented next.

1 Learning as an externally determined event/process

These descriptions stressed that the learning process is brought about by stimuli coming from outside the individual. In these cases the students often mentioned classical conditioning, observational learning and modelling. One student wrote about a "behaviourist way of learning". The following examples are quite typical cases:

B31: "Situational factors influence students' readiness to receive stimuli. Friday afternoon between two and four is not the best time to learn scientific Swedish vocabulary. A classroom climate also influences how individuals receive stimuli."

B21: "Learning by modelling is very important especially in the learning of skills. Somebody just shows somebody else how to do a thing."

(The examples given of the behaviourist viewpoint also represent this category of describing the learning process.)

2 Learning as a developmental process

This category includes two subcategories: learning as lifelong development (2A) and learning as cognitive development (2B). Common to both is seeing learning as an unintentional and inevitable process. Furthermore, this conception does not accept the division between development and learning: according to this view, learning *is* development. In the following example of conception 2A the account of learning as a lifelong process is related to the conception of learning as an externally determined process.

B2: "Learning takes place throughout an individual's life. At first, learning is related to a baby's gradual separation from his or her carer and its development into a mobile, talking and conscious individual. Something absolutely new seems to happen every day and learning takes place very fast. Challenges and models of stimulating environment influence learning."

While the above student associated lifelong development (2A) with external forces, conceptions of learning as cognitive development (2B) often implicitly or explicitly emphasise the internal determination of development, especially when they refer to Piaget's theory:

E13: "Cognitive models, such as Piaget's developmental description of how thinking moves from a sensorimotor to an abstract level, emphasise cognitive processes going on inside a person."

In some final essays the students referred to Perry's research which was discussed in one of the coursebooks (Entwistle, 1981):

E20 "Perry investigated students' intellectual development and how the structure of their knowledge changed. At first knowledge was seen in terms of a strict right-wrong dichotomy and the right knowledge always came from an authority (a teacher). Gradually students begin to see knowledge as more relative and in the last phase all knowledge is contextual and relative."

3 Learning as student/learner activity

These conceptions stressed the active role of a learner in the learning process. Notions of learner activity varied in the nature of the activity that they described. Six different types of activity description could be identified:

3A Regarding learning as an intentional/unintentional activity

Some students presented a division between intentional and unintentional learning while some others explicitly emphasised the intentional nature of learning.

B16: "Learning is usually directed towards some goal but it can be unconscious, too."

E28: "I think that the three types of students as well as the ideal type identified by Heath indicate very clearly that learning is always intentional."

3B Simple mention of experience as the basis of the learning process.

The conceptions belonging to this subcategory were almost all expressed word by word as in the following example:

E22: ”Learning is a rather permanent change in behaviour caused by experience.”

This definition-like statement was usually the first sentence of the essay and was probably learned by rote from the teacher’s presentation. The statement defined the product of learning (change of behaviour) without much describing the process of learning. However, the last words ”caused by experience” implied that learning takes place when a learner has undertaken – intentionally or unintentionally – an act of ”experiencing”. No matter how experiences are initiated – by the learner himself or by an external force – they are always the actions of the individual who is experiencing something. That is why these descriptions are defined as a subcategory of the student activity although the activity point is only implicit.

3C General notions about activity-passivity.

When the students paid explicit attention to the activity-passivity dimension in the learning process, they usually criticised school learning for lacking in activity:

B23: ”Learning at school is often such that a teacher ladles out information in front of a class into passive pupils, expecting them to learn. If the pupils could be a part of the process, not just passive receivers, learning outcomes would surely be better and the pupils would be more motivated to learn.”

3D Study activities.

One way of describing learner activity was depicting different studying activities:

B19: ”Learning may come about in different ways. We learn by reading, looking, listening etc.”

B1: "Repeating, rehearsal and practising promote learning and enhance the level of the learning outcome."

Common to these descriptions of learning is the assumption that learning takes place when a student actively studies by some method.

3E Learning by doing / Experiential learning

This subcategory includes conceptions which concern applying the knowledge to be learned either mentally or in real-life situations, or practising and reflecting on one's own experiences in a learning situation. These descriptions of the learning process resemble Dewey's "learning by doing" and Kolb's "experiential learning" theories. One student also mentioned Dewey by name:

E14: "If learning is to be useful and joyful, you should be able to apply it in practice. Furthermore, by practising we learn things that we would not learn otherwise. I think that Dewey's idea about learning by doing is good."

3F Thinking activities

According to this view, an essential feature of the learning process is thinking. The emphasis on thinking is expressed in different ways, for example as critical thinking, problem-solving, reasoning or analytical thinking. Furthermore, such ideas about the importance of thinking in learning are often linked with the concepts of metacognition or learning to learn. In the following example view 3F is related to view 3C, that is activity-passivity:

E1: "When we are learning and studying new things, we should be critical about those new things. A critical attitude makes it easier to analyse one's own thoughts and to bring out existing knowledge about the topic. A critical attitude generates reasoning and speculation, and understanding will be more efficient. Learning should not be only passive receiving or being a passive

object. Instead, effective learning requires active participation, a critical attitude and a subjective approach that influences the learning situation."

4 Learning as strategies/styles/approaches

Referring to learning styles, strategies or approaches was the most usual way of describing the learning process both at the beginning and at the end of the course. In general, in their initial essays the students did not make any conceptual distinction between styles, strategies or approaches. They simply used some of these terms or did not use them at all but instead wrote generally about "surface learning vs. deep learning". In the final essays many students still employed styles, strategies and approaches as synonyms but some students could make a conceptual difference between the three terms. However, terminological accuracy is not the main concern from the viewpoint of conceptions of learning process. All the three terms – styles, strategies and approaches – referred to the way in which a learner acts during the learning process. Very often the students mentioned the names of Pask, Marton, Ausubel and so on in their descriptions. However, the following student referred to research in general without mentioning any authors.

E21: "Research has revealed differences in students' studying styles. They may approach a task using either surface or deep approaches. Learners using a deep approach aim to understand the content to be learned, they work on it in their mind and also in other ways. They are interested in the topic and want to know about it. Thus the efforts put into studying do not feel too hard. The learner draws inferences and tries to integrate individual elements into each other to form a whole with the aim of achieving better learning outcomes. A student adopting a surface approach tends to use rote learning aiming to memorise sentences as such. He or she may be thinking of a coming test situation. Learning is not understanding, so the outcomes are not good, either. The students may retain the knowledge in their mind until the test but after the examination they will forget it. Instead, when one has understood the knowledge, it has acquired meaning and has been placed in knowledge structures as a reasonable whole, and the learning outcomes are good."

5 Learning as information processing

The information processing view of learning was also a very common perspective on the learning process, and we shall see later that like the above "approaches view" it became more common during the course. This is explained by the fact that one of the textbooks used on the course emphasised these ideas of learning. Information processing was considered either in terms of schemata and the formation of knowledge structures (5A) or discussed as pure memory processes without reference to schemata (5B). In the following example the student's description of assimilation and accommodation is not accurate but she is clearly striving for an understanding of information processing (5A):

> E22: "Schemata also influence learning. They activate a knowledge structure in the memory and learning is based on it. New information will be assimilated to old information, and old information will be accommodated. The more numerous and the more exact the schemata in a person's mind map are, the better are the possibilities of learning."

The following example stresses the role of memory in the learning process (5B). It is highly probable that the student had memorised the next description of the functioning of the memory.

> E31: "Learning is change in the structure of the brain. To understand learning it is important to understand brain functioning. The brain goes through the following operations in the learning process: a) senses bring in internal and external impulses; b) the sensory memory (1 sec) recognises the impulse on the basis of the information stored in long-term memory (LTM); c) working memory or short-term memory (STM) handles the impulse and tries to understand its meaning. STM is limited and an individual can handle only a certain amount of information at the same time. In STM the new information (impulses etc) is analysed and sent on to the next functions; d) the impulses are stored in LTM according to the directions of STM. LTM is divided in episodic and semantic components. Episodic or situational structures and knowledge learned by rote are stored

in episodic memory. Meanings are stored in semantic memory. Episodic and semantic memory work in interaction; e) the structures of STM have to be reinforced by rehearsal. The linking of a new impulse to a strong emotional reaction, for example, may make storage easier; f) when all the above phases have been gone through, the reaction caused by the impulse may be seen in behaviour. Learning has taken place."

6 Learning as an interactive process

This category includes the conceptions which involved describing learning as an interactive process between people, usually a student and a teacher.

> B15: "I think that the most important factors in a learning event are a learner and a teacher. The interaction between these two persons and the matching of a teaching style and a learning style is quite significant."

In the following case the interactional view is linked with the information processing view and the idea that learning involves thinking activity:

> E14: "An essential part of learning takes place in interaction. Thus, it is not enough that one structures his or her own old and new knowledge into a united 'net'. One's own knowledge increases with the help of the knowledge and experiences of others, and one acquires new points of view and may find it necessary to rethink his or her knowledge and to be critical. This also promotes understanding of others."

7 Learning as a creative process

This was not a common view of learning. Two students at the beginning of the course and one student at the end of course described learning in terms of creativity. The following description of learning is compatible with the constructivist view of learning, which sees learning as a process where learners continuously construct and re-construct their views of the world on the basis of

their existing thoughts and knowledge. This constructive process is, indeed, creative in nature.

> B28: "I see learning as a complicated process that is influenced by several factors. It is difficult to analyse learning as a separate event because it is, in my opinion, a creative activity guided by individual thinking and operational models."

While the student above depicted the learning process itself as a creative activity, the following example stresses creativity as a means of enhancing learning:

> E1: "I have understood the meaning of a critical attitude, imagination and the use of images as new factors influencing learning ... Creativity, imagination and images enrich learning."

Changes in the Students' Conceptions in the Constructivist and the Traditional Group

As mentioned earlier, the individual students' essays usually incorporated more than one of the various conceptions of the learning process both at the beginning and at the end of the educational psychology course. The prevalence of each category of description in the constructivist and the traditional group is shown in Table 8.

Table 8. The number of students who expressed each category of description at the beginning and at the end of the course

Category of description: learning as	Constructivist group (N=14) Beginning f	%	End f	%	Traditional group (N=17) Beginning f	%	End f	%
1 An externally determined process	4	29	2	14	10	59	6	35
2 A developmental process	1	7	3	21	6	35	7	41
3 Student activity	9	64	13	93	14	82	13	76
4 Strategies/styles/approaches	9	64	13	93	10	59	17	100
5 Information processing	4	29	8	57	6	35	12	70
6 An interactive process	-	-	2	14	2	12	3	17
7 A creative process	1	7	1	7	1	6	-	-

From Table 8 we can see that at the beginning of the course most of the students described the learning process in terms of student activity and learning strategies/styles/approaches. In the traditional group, over half of the students considered that learning is also an externally determined process. Generally, the students' conceptions changed similarly in both groups: descriptions of approaches to learning as well as references to the information processing view increased while discussions of learning as an externally determined process decreased in both groups. Such changes are not surprising because the contents of the course emphasised approaches to learning and information processing. The only difference between the groups seems to appear in descriptions of student activities. While this category became more common in the constructivist group, it decreased slightly in the traditional group. The changes that took place in the subcategories of Student activities are presented in Table 9. The figures indicate that the difference between the groups in this category derives mainly from the striking divergence apparent in the subcategory of Thinking activities. At the beginning of the course, four students in both groups mentioned thinking as an essential feature of the learning process. At the end of the course, eleven students (79%) belonging to the constructivist group emphasised thinking while in the traditional group only four students (24%) did the same.

Table 9. The number of students who expressed each subcategory of the main category of Learning as Student Activity at the beginning and at the end of the course

	Constructivist group (N=14)				Traditional group (N=17)			
	Beginning		End		Beginning		End	
Subcategory: learning as	f	%	f	%	f	%	f	%
1 Intentional / unintentional activity	3	21	1	7	5	29	6	35
2 Change in behaviour caused by experience	-	-	-	-	1	6	3	17
3 Activity/passivity in general	4	29	4	29	2	12	5	29
4 Study activities	3	21	2	14	5	29	3	17
5 Learning by doing/ experiential learning	3	21	3	21	5	29	1	6
6 Thinking activities	4	29	11	79	4	24	4	24

The Nature of the Changes in the Students' Conceptions of Learning

In addition to identifying the theoretical viewpoints on which the students based their ideas of learning and their conceptions of the learning process, the study aimed to examine the general features of conceptual change as far as conceptions of learning are concerned. For this purpose, the concept maps constructed from the students' written products were analyzed side by side with the original texts. As described earlier, abductive reasoning was the main principle in the analysis. That is, while the procedure remained open to new empirical findings, earlier theories of learning and conceptual change were used as heuristic tools in the analysis. The most profound theoretical influences were derived from Vosniadou's (1991, 1992a, 1994) research and from other findings on conceptual learning (e.g. Carey, 1991; Hewson & Hewson, 1992; Chi et al., 1994) on the one hand and from applications of neo-Piagetian theories of cognitive development such as the SOLO taxonomy by Biggs and Collis (1982; Biggs, 1992) on the other.

As a result of the analysis of the concept maps and of the previously described analysis of theoretical viewpoints, the following types of change could be identified in the students' conceptions of learning:

1) Adding concepts
2) Redefining, specifying or particularising concepts
3) Linking specific aspects of the conceptions with each other
4) Moving a concept from one category of explanation to another
5) Adding theoretical viewpoints
6) Replacing one theoretical viewpoint with another
7) Forming an explanatory framework

This categorisation of different types of conceptional change is profoundly data-driven. In other words, the categories were not

defined beforehand but were established as a result of the analysis of the students' essays. However, the final category system has many similarities with the theories mentioned above. For example, categories 1 to 5 can be seen as representing a type of change called enrichment and categories 6 and 7 as representing revision (Vosniadou, 1994). Category 3, linking specific aspects of the conceptions with each other, is an important element in the SOLO taxonomy (Biggs & Collis, 1982; Biggs, 1992), while category 4, moving a concept from one category of explanation to another, bears some resemblance to the idea of conceptual development as change in the ontological categorisation of concepts (Chi et al., 1994). Thus the category system, although created by the author on the basis of this particular data, may be understood as a synthesis of earlier work in conceptual change theory. A close examination of the category system also provides us with material for answering the question that Dykstra (1992) has called the most fundamental issue in research on conceptual change: *what* changes when conceptual change occurs? The categories identified in this study suggest that change takes place on at least four levels: A) on the semantic level, involving the meaning of individual concepts; B) on the level of the relationships between the concepts; C) on the level of shifts between ontological categories and D) on the level of a background theory or framework theory.

On the first level (change categories 1 and 2), the contents of the concepts that students use to describe a phenomenon become more accurate and students also acquire new concepts. On the second level (category 3), students become aware of connections between the concepts and different aspects of the phenomenon in question. On the third level (category 4), the contents of the concept not only become more accurate but also change ontologically, moving from one ontological category to another. Finally, on the fourth level (categories 5 to 7), framework theories underpinning a conception may change. New theories may be acquired alongside the old ones or existing theories may be replaced by a new theory.

An important point here is that although new ideas may be adopted, old ideas do not necessarily disappear but may be retained side by side with the new ones.

A more detailed description of each of the seven types of change in the students' conceptions is presented in the following.

1) Adding concepts

Adding concepts involves the adoption of new concepts that the student did not know (or at least did not express) earlier. For example, the following student did not mention "learning styles" in her initial essay, but in her final essay she described them as follows:

> E12: "Our learning styles – ways of learning – differ greatly. We may approach a subject holistically when we create an overall picture of the content to be learned. Or we may be serialist learners when learning takes place in a logical order, step by step."

2) Redefining, specifying or particularising concepts

Generally speaking, change of this kind meant that an everyday sense of a concept was replaced by a more theoretical definition. Furthermore, theoretical terms were adopted to describe everyday phenomena. For example, in her initial essay the following student uses the concept of motivation in a general and everyday sense as a synonym for personal interest. The student also describes extrinsic motivation without having a concept for it:

> B23: "Motivation is important in learning. When a learner is motivated he or she will achieve better results. Motivation will be enhanced if a learner feels that the content to be learned is important and useful. If learning does not produce any reward, the learner's interest in learning may disappear. Evaluation may increase motivation. If a learner knows that his or her learning will not be evaluated, he or she may not make such an effort as when it will be evaluated."

In the student's final essay the concept of motivation is more specific. The student is now familiar with the concepts of "intrinsic" and "extrinsic" motivation. It seems that everyday perceptions have gained names and explanations:

> E23: "Motivation, too, affects learning. When a learner perceives a new thing as interesting and is eager to learn, learning is guided by intrinsic motivation. When learning is internally motivated, learning outcomes will be better than when learning is externally motivated. When motivation is extrinsic, a learner considers learning as an instrument for achieving other goals. Hope for success or fear of failure may also act as a form of motivation."

3) Linking specific aspects of the conceptions

This type of learning means establishing *relations* between the concepts or phenomena that the students had previously described as separate entities. These changes are similar to those involved in moving from the "multistructural" to the "relational" stage in the SOLO taxonomy (Biggs & Collis, 1982). In the following example, a student writes in her initial essay that there are different "learning styles", referring to "holistic" and "analytic" learners. Furthermore, she describes the deep approach to learning.

> B37: "People have different learning styles, some want to construct an overall picture – they are holistic learners, some want to process information analytically, piece by piece ... One learns better when one tries to understand what one is learning and when one modifies information with the help of intrinsic models and links it to prior or changing structures. In other words, when one has read a text to be learned it is useful to think it over using one's own words and thoughts."

In her final essay the student again concentrates on learning styles, strategies and approaches but now she discusses them in greater detail and also describes contextual factors that influence approaches to learning:

E37: ... "Swedish researchers found that examination questions influence how students learn. Questions emphasising facts lead to a surface approach while questions emphasising meanings lead to a deep approach. However, the students who had usually adopted the surface approach had difficulties in adopting the deep approach. Anxiety (stress) and information overload produce surface learning, too. Furthermore, different styles between teacher and student may also lead to difficulties in learning. If the teacher and the student have very different styles of dealing with study materials, learning may become difficult, causing anxiety to both parties. Similarly, an information and knowledge processing style favoured by certain disciplines (e.g. the difference between the natural sciences and the humanities) may either match or contradict with the personal style of a learner. Personality differences lead people to different disciplines and to contexts where their own learning styles are more or less appropriate."

4) *Moving a concept from one category of explanation to another*

Generally speaking, this type of change means that individual elements that students described as *presage* factors in their initial essay were described as part of *process* of learning in their final essay. For example, in her initial essay the following student presents "prior knowledge" as an important presage factor influencing learning by simply stating that it makes learning easier:

P13: "Prior knowledge and experiences are very important for learning. It is easier to learn if one knows something about the subject and if those things are referred to during teaching. Things that are too new are much harder to adopt."

In her final essay the student is now able to explain *how* prior knowledge functions in the learning process:

E13: "If the subject is such that a learner is able to link it with his or her own experiences and prior knowledge structures and if teaching promotes this, learning will be more effective. It is possible to plan teaching so that the students are able to link new knowledge with their knowledge

structures, for example by using illustrations, anchoring ideas, analogies or concept maps."

In this case the concept "prior knowledge" was placed in the presage column in the concept map of the initial essay and in the process column in the concept map of the final essay. In conceptual development of this kind a student first knows that something affects or is related to something else and then gradually begins to understand why or how this relationship functions. In some cases the move from presage factors to process descriptions was comprehensive. For example, Appendices 3 and 4 present concept maps of the two essays by a student whose initial essay was almost entirely a description of presage factors while her final essay discussed chiefly the process of learning. This type of learning, where a student moves from one category of explanation to another, is analogous with the description by Chi and others (1994) of moving a concept from one ontological category to another in science learning. However, the changes described here do not seem to be as fundamental as ontological changes in science learning.

5) Adding a theoretical viewpoint

As described earlier, at the end of the course most of the students introduced new theoretical viewpoints that had not appeared in their essays at the beginning of the course. These students were defined as representing enrichment-type change. For example, a student who in her initial essay described learning from the behaviourist and cognitive perspectives had in her final essay discovered additional ways to conceptualise learning derived from interactionism and views linked with lifelong learning while still retaining her earlier views. In such cases, old ideas are thus not abandoned although new perspectives are adopted.

6) Replacing one theoretical viewpoint with another

Some students articulated at the beginning and at the end of the course entirely different viewpoints, that is, all the views presented in their final essays were new. The student whose essays are visualised in the concept maps given in Appendices 3 and 4 represents this kind of total shift from one theoretical viewpoint to another. In her initial essay she described learning mainly in terms of behaviourism and in some degree in terms of the ideas of lifelong learning. Furthermore, her description is close to everyday conceptions and language. The final essay by the same student reflects a number of different positions: interactionism, cognitivism, the experiential learning theory and the constructivist view of learning. Obviously, this student's conceptions of learning had undergone significant changes. (It is possible, of course, that the student did not abandon her old views either: she may have just refrained from expressing them in her essay. However that may be, the focus here is on expressed conceptions.)

7) Forming an explanatory framework

In their initial essays, the students started to describe their conceptions of learning *in medias res* without presenting any broader framework or holistic model of learning. By contrast, in their final essays some students first constructed a framework within which learning could be explained theoretically. Usually the framework presented the determining factors of learning:

> E1: "Learning is a broad concept. It depends on both internal and external forces, i.e. on internal maturation and external guidance."

> E 2: "My conception of learning includes a student, a teacher and a content to be learned. These factors influence each other, promoting learning or making it more difficult or, in the worst case, preventing it."

E18: "Learning is a very holistic process that produces a very permanent change in behaviour. It is a process with many components, of which the most important may be the source of information, information itself, and its receiver."

In all these examples the students have formed an explanatory model that they use to describe the details of learning. The models presented here ("internal-external forces", "student-teacher-content" and "source of information-information-receiver") are based on the source material of the course, being either individual models discussed in the textbooks or representing the overall structure of a textbook. Conceptual development of this kind, involving the construction of a component model of a phenomenon, resembles the descriptions of the development of "knowledge objects" put forward by Entwistle and Marton (1994; Entwistle, 1995).

Changes in the Constructivist and the Traditional Group

Table 10 shows the frequency of each type of conceptual change in the constructivist and the traditional group. It seems that there is no discernible difference between the groups in the prevalence of different types of change. In both groups, adding and specifying concepts, adding theoretical viewpoints and making links between different aspects of a given conception are the basic types of conceptual learning. Most students also constructed explanatory frameworks. Totally replacing one's prior theoretical viewpoints with new ones or moving from one category of explanation to another were rarer types of change in both groups.

Table 10. The number of students in each category of conceptual change

Category of conceptual change	Constructivist group (N=14)		Traditional group (N=17)	
	f	%	f	%
1 Adding concepts	14	100	17	100
2 Specifying concepts	11	79	15	88
3 Linking aspects of conceptions	12	86	11	65
4 Moving from one category of explanation to another	3	21	3	18
5 Adding theoretical viewpoints	12	86	15	88
6 Replacing one theoretical viewpoint with another	3	21	3	18
7 Forming an explanatory framework	10	71	9	53

Traditional Examination Assessment

The results of this sub-study have been published earlier by the author (Tynjälä, 1998c).

The first of the traditional examination questions required calling to mind certain developmental theories and comparing them. The question was: "Describe and compare briefly the theories of Havighurst, Levinson and Gould". This type of question represents, in pure form, the assessment procedures typically resulting from the knowledge transmitting paradigm. Although it involves certain higher-order thinking processes, comparing, the prerequisite of answering the question is a fairly exact recall of particular theories. The students were asked to describe the theories *briefly* so as to encourage them to concentrate on the main points and avoid long and detailed descriptions. The second examination question was: "Describe how psychological theories have described and explained human development". The purpose of this question was to elicit the students' overall view of developmental psychology.

The students' answers to both examination questions were longer in the traditional group than in the constructivist group. The average length of the answers to the reproductive comparison

question was 222 words in the constructivist group and 383 words in the traditional group (p=.009). Corresponding means in the answers to the overall view question were 300 words and 356 words (ns) respectively.

The thematic sequences of the students' answers to the two questions were classified into epistemic categories modified from those presented in earlier studies of learning declarative knowledge (Leiwo et al., 1987; Ohlsson, 1996). Tables 11 and 12 show the prevalence of the epistemic categories on the basis of the number of sentences belonging to each category. The significance of the differences between the groups was first calculated with the *t*-test and then confirmed with the non-parametric Mann-Whitney test (Wilcoxon rank-sum test). The results of both tests were similar: statistically significant differences between the groups were found in the use of classifications, descriptions, comparisons and generalisations. (The Mann-Whitney test is not grounded on means or medians but on the ranks of observations when the two samples to be compared are combined. However, the means and the medians are also presented in the tables because they show the average number of sentences in each category more concretely and in a more familiar way than the mean ranks.)

Table 11. Group differences in the average number of sentences belonging to each epistemic category in the answers to the reproductive comparison question: the means, the medians and the Mann-Whitney test results.

	Constructivist group (N=14)			Traditional group (N=18)			
	M	Mdn	Mann-Whitney mean rank	M	Mdn	Mann-Whitney mean rank	Mann-Whitney significance
Classification	-	-	-	-		-	-
Description	12.2	15.5	12.3	23.5	25.5	19.7	.024
Comparison	3.6	3.5	16.0	3.7	4.5	16.9	ns
Evaluation	4.4	5	18.9	2.9	1.5	14.6	ns
Generalisation	1.9	2	20.3	0.6	0	13.5	.029

Table 12. Group differences in the average number of sentences belonging to each epistemic category in the answers to the overall view question: the means, the medians and the Mann-Whitney test results.

	Constructivist group (N=14)			Traditional group (N=18)			
	M	Mdn	Mann-Whitney mean rank	M	Mdn	Mann-Whitney mean rank	Mann-Whitney significance
Classification	0.7	0.5	20.2	0.1	0	13.6	.012
Description	15.0	12	14.3	20.9	14.5	18.2	ns
Comparison	6.1	4	20.8	2.1	1.5	13.2	.022
Evaluation	1.5	0	16.8	1.2	0	16.2	ns
Generalisation	12.6	11	18.9	9.2	7.5	14.6	ns

In the answers to the reproductive comparison question, the average number of descriptions was higher in the traditional group while the number generalisations was higher in the constructivist group. The traditional group students, who took part in the examination to be graded, thus described the theories mentioned in the comparison question in greater detail, while the constructivist group students, who attended the examination only to produce material for the research, made more use of generalisations in their answers.

In the answers to the overall view question, comparisons and classifications were more common in the constructivist group. It is interesting that the number of comparisons did not differ between the groups in the comparative question but was higher in the constructivist group in the overall view question. The mean of classifications was very small in both groups because most of the students did not classify theories in any way. However, those classifications that were made were usually related to a coherent overall view of the subject as different theories were classified into broader schools of thought. In the answers to the overall view question, classifications were more common among the constructivist group students, half of whom used one or two sentences to classify theories, while only two students in the traditional group did the same.

The SOLO levels of the students' examination answers are presented in Table 13. In both groups over half of the students produced relational answers to both examination questions. Similarly, there were a few prestructural and unistructural answers in both groups. However, extended abstract answers appeared only in the constructivist group. Because of the low cell frequencies, the statistical differences between the groups could be calculated only when the three lowest categories of the taxonomy were re-coded into a single class. After re-coding the differences between the groups were non-significant for the overall view question but significant (p=.049) for the comparison question (Table 14). Thus, we can conclude that the general SOLO level of the students' examination answers was higher in the constructivist group, but only in their answers to the comparison question.

Table 13. The students' examination answers as evaluated with the SOLO Taxonomy

	Comparison question				Overall view question			
	Constructivist group (N=14)		Traditional group (N=18)		Constructivist group (N=14)		Traditional group (N=18)	
	n	%	n	%	n	%	n	%
Prestructural	2	14	2	11	-	-	1	6
Unistructural	-	-	1	6	-	-	1	6
Multistructural	1	7	5	28	4	29	5	28
Relational	7	50	10	56	8	57	11	61
Extended abstract	4	29	-	-	2	14	-	-

Table 14. The students' examination answers as evaluated with the SOLO Taxonomy re-coded into three levels

	Comparison question				Overall view question			
	Constructivist group (N=14)		Traditional group (N=18)		Constructivist group (N=14)		Traditional group (N=18)	
	n	%	n	%	n	%	n	%
Pre-Uni- or Multistructural	3	21	8	44	4	29	7	39
Relational	7	50	10	56	8	57	11	61
Extended abstract	4	29	-	-	2	14	-	-
	Chi-square significance .049				Chi-square ns			

Summary of the Results

The students' learning outcomes in the constructivist and the traditional group were investigated from three different viewpoints: 1) as the students' subjective learning experiences, 2) as changes in their conceptions of learning, and 3) as measured by traditional examination questions.

The clearest differences between the groups appeared in the students' subjective descriptions of their own learning. All students in both groups described their learning in terms of knowledge acquisition. However, most constructivist group students also emphasised gaining an ability to apply knowledge, the development of their critical thinking skills, changing their conceptions of the topics studied and moving from epistemological dualism towards a more relativistic view of knowledge. These types of description were rare among the traditional group students.

From the theoretical viewpoint, the most important results of the research project were the findings of the study of the students' learning conceptions. The study was carried out in a novel way, combining analytic methods from different traditions of research on conceptions. The phenomenographic analysis produced a description of how the students conceptualised the learning process, the analysis of theoretical viewpoints revealed the students' background theories of learning, and the concept map analyses generated an outline of the changes that occurred in their learning conceptions. The main finding was a category system of different types of changes, including: 1) adding new concepts; 2) re-defining, specifying or particularising concepts; 3) linking specific aspects of a given conception; 4) moving from one category of explanation to another; 5) adding a theoretical viewpoint; 6) replacing a theoretical viewpoint with another; and 7) forming an explanatory framework. These types of change suggest that changes in learning conceptions may take place on at least four levels: A) on the semantic level,

involving the meaning of individual concepts; B) on the level of the relationships between the concepts; C) on the level of shifts between ontological categories; and D) on the level of background theories or framework theories. The students' conceptions of learning appeared to change quite similarly in both groups. There were no differences between the groups in prevalence of different types of conceptual change.

Traditional examination assessment showed that the traditional group students, who took the examination to be graded, tended to write longer and more detailed answers than the constructivist group students, who answered the questions only to provide material for the research. However, the answers of the constructivist group students included more classifications, comparisons and generalisations and their SOLO level was slightly higher than in the traditional group.

Chapter 5

METHODOLOGICAL DISCUSSION

Study Design

The study was conducted using a quasi-experimental design which, however, includes certain critical points. First, it was intended that dividing students into a constructivist and a traditional learning group on the basis of the alphabetical order of their surnames would make the groups comparable as regards to their study preferences and conceptions of learning, for example. However, exchanges between the groups and moves from the constructivist to the traditional group were allowed because of the students' timetables. The fact that several students were permitted to change the group to which they were first assigned may have weakened the equivalence of the two groups. Thus, as the course started constructivist views of learning were already more prevalent in the constructivist group as were, correspondingly, behaviourist views in the traditional group. It is possible that some students used the clashing timetables only as an excuse, wanting to study in the traditional group because of their traditional (behaviourist) ideas of learning or in the constructivist group because of their constructivist ideas. If this is the case then the requirement of randomising the data in an experimental design has not been entirely

fulfilled, and some reservations for interpretation of statistical analyses and for generalisation of results have to be done. Even the use of statistical tests is questionable. Yet, in some cases, the statistical significance of the differences between the groups was reported in order to achieve a picture of the general scale of the differences. It must be emphasised, however, that fundamentally this study is based on qualitative analyses and its central findings describe the quality of learning in two different environments rather than statistical differences between the groups.

Another problem related to the research design concerns the data gathering of students' learning conceptions and the use of examination answers as indicators of learning. The "pre-test" and "post-test" situations of the learning conceptions differed from each other in that the students wrote the initial essays on their conceptions under free conditions, while the final essays were answers to an examination question. The difference between the situations as such may have affected the expression of various kinds of conceptions. Furthermore, the examination answers meant different things to the experimental and the control group: while the experimental group students wrote their answers only for the purposes of the research, the answers of the control group students were also used as a basis of their course grade. This may explain why the students in the control group tended to keep to the facts presented in the coursebooks, while the students in the experimental group seemed to have the courage to write more freely. This could be seen both in the students' descriptions of their learning conceptions and in their answers to more traditional examination questions. In the students' discussions of their learning conceptions, the role of critical thinking in learning was one particular aspect that was not directly stressed in the textbooks but which appeared in most of the essays in the experimental group, while it was missing from most essays in the control group. Although the difference in the data collection situation between the groups may have influenced this difference in expressed conceptions, it is also possible that the difference was caused by

different conditions in learning and studying in the two groups. In the experimental group, the writing assignments and the group discussions obliged the students to think critically and otherwise involve themselves actively, which may have promoted the development of conceptions where learning is seen as an active process requiring critical thinking. In answers to traditional examination questions the difference between the groups appeared in the length of the answers and in the number of details included in them. Many control group students wrote long and detailed answers, while most of the experimental group students, who were not to be graded, concentrated on generalisations instead of details. The present design does not allow us to draw any conclusion about whether this difference was stemmed from different learning conditions or whether it was, instead, basically due to the fact that the examination situation meant different things to the students in the two groups. For this reason it is advisable, in future comparative studies of student learning, to gather data in settings that are identical for both groups and that represent other than an examination situation.

The third problem related to the comparison of the two study groups was the fact that absenteeism from the interview as well as from the examination was more common in the control group than in the experimental group. As regards the interview, one possible explanation is that the experimental group students were more motivated to talk about their experiences of the course because it was something new to them. Studying in the control group, in contrast, represented a normal situation and therefore the students placed in this group may have found it a less interesting subject. The control group students' absenteeism from the examination might be explained by the fact that their course grade was based on the examination and some of them may have wished to have more time for preparation. Thus, they may have decided to sit a second examination few weeks later. (Different questions were used in the second examination, and participating students' answers to them were not included in the present study.)

Assessment of Learning

The purpose of the study was to compare students' learning outcomes in two different learning environments, in a constructivist environment built on cognitive learning theories and constructivist epistemology, and in a traditional environment that represented the knowledge transmitting paradigm of teaching and learning. A fundamental problem in this type of comparison is how to assess students' learning outcomes in a way that is compatible with both approaches. Traditional teaching is usually followed by traditional assessment, the kind which Biggs (1991, 1994) has called a quantitative outlook: a student is considered to have learned the better the more he or she is able to reproduce study contents. Traditional examinations are typical examples of this form of assessment. In contrast, the constructivist view of learning requires an entirely different approach to assessment, an approach that is qualitative in nature. Authentic assessment based on real-life tasks and performance assessment requiring students to complete certain learning assignments represent this type of assessment. The emphasis is on students' learning process and on their meaning making as much as (or even more than) on the final product.

The solution to this assessment dilemma was that the assessment procedures determining the students' course grade were different in the two groups: the students in the constructivist group were assessed on the basis of their general performance, the standard of their essays and other writing assignments and their contribution to the group discussions during the course, while the traditional group was assessed on the basis of a traditional examination. Course grades determined by these procedures were not considered as research material. Instead, for the purposes of the study the students' learning outcomes were evaluated by multiple methods representing different viewpoints on student learning, both qualitative and quantitative, although the emphasis was strongly on qualitative

assessment. Thus, the students' learning was studied from three perspectives: 1) as their subjective learning experiences, 2) as the development of their conceptions of learning (because learning theories were one main content of the course), and 3) as assessed by traditional examination questions that required the students to a) reproduce information studied and b) give an overall view of one of the main topics.

Earlier studies of student learning have often used only "objective" measures such as exams and tests in assessing learning. This approach has a major drawback. In its pursuit of objectivity it is forced to define the desired learning outcomes in precise detail beforehand, which usually leads to assessing how well students reproduce the factual information of the study material. Assessment procedures of this kind ignore the actual changes taking place in students' conceptions and knowledge as well as their subjective experiences. This study represents an alternative approach. The students' learning was examined basically from the viewpoint of conceptional change (Tynjälä, 1997, 1998b) and in terms of personal learning experiences (Tynjälä, 1998a, c). In fact, choosing the constructivist view of learning as the starting point of the study required that evaluation of learning does not follow the traditional lines (cf. Biggs 1996, Entwistle et al. 1993, p. 353).

However, traditional assessment methods, examination questions, were also used to find out whether different methods would produce different pictures of the students' learning outcomes (Tynjälä, 1998c). The findings indicate that this is indeed the case. Although the constructivist group students subjectively experienced more higher-order learning such as the development of their thinking skills, their examination answers were shorter and included less detailed descriptions than those produced by the control group students. If learning outcomes in the two groups had been measured solely on the basis of the amount of detail that the students presented in their answers, the result of this study would have been that it was the control group students who had learned better. However,

when the answers were analysed by the SOLO Taxonomy and the epistemic classification, it was found that the highest-level answers had been given by the students in the constructivist group. It is clear that if the teaching and learning environment is designed on the basis of constructivism, that is, involving students in active meaning making, assessment procedures should similarly concentrate on a learner's personal process of meaning construction. This means giving up traditional tests and exams and moving towards authentic or performance assessment in education (see, for example, Biggs, 1996; Dochy & Mcdowell, 1997; Dochy & Moerkerke, 1997). Correspondingly, in research we should use a broad range of methods in analysing student learning. In the present study, the quantitative and the qualitative procedures generated different pictures of the learning outcomes, but the findings gained by using different qualitative methods supported each other, thus suggesting that the approach adopted here is valid. For example, both in the investigation of the students' subjective learning experiences and in the analysis of their learning conceptions, critical thinking was found to be a prominent feature among the constructivist group students. If the students felt that their thinking had developed during the course, it is logical that they emphasised the role of critical thinking also in their conceptions of learning. Similarly, in the analysis of the students' examination answers, the findings from the epistemic categorisation and the SOLO Taxonomy bear a certain resemblance to one another: the higher number of comparisons and generalisations in the epistemic categories in the answers given by the constructivist group students is congruent with the answers' higher SOLO level.

The second difference from earlier studies concerns the scale of the study. While previous research has generally focused on a small number of limited tasks, the present study covered a complete university course lasting a full term. This was important because the purpose of the study was to examine student learning in natural situations and on a natural scale. In university studies, student

learning is evaluated on the course level, and therefore research on student learning should similarly focus on the course level (or even on longer-term learning). The kind of learning aimed at in university education involves understanding phenomena, forming a general view, and developing thinking more than merely reproducing factual information. These types of learning are more difficult to evaluate and are more likely to emerge in the long than in the short term.

Considerations Regarding Each Sub-Study and Particular Methods Used

The material of this investigation consisted of three different types of data: 1) the students' short essays on their conceptions of learning written at the beginning and at the end of the course; 2) examination answers to questions that involved a) reproducing and comparing information studied and b) giving an overall view of one main topic; and 3) students' answers to interview questions and a self-assessment form of students' own learning filled in during the interview after the course. The methods used to analyse this diverse data can be divided into three types of procedures: theory-driven, data-driven and approaches combining these both (Table 15).

When theory-driven methods are used, the categories into which the data will be classified are defined beforehand on the basis of a theory. Data-driven methods, in contrast, produce their classifications in the course of the analysis, and the classifications themselves are results of the study. (As a constructivist, I have to note that data-driven analysis can never be absolutely free from the researcher's expectations and theoretical thinking, because the researcher, like anyone else, cannot escape his or her previous knowledge and conceptions. In data-driven analysis the researcher, however, does not fix the forthcoming findings in categories determined before the analysis). In this investigation, the use of the

SOLO Taxonomy, the epistemic categorisation of the students' examination answers and the use of the questionnaire assessment of the students' own learning represented theory-driven approaches to analysis, whereas the phenomenographic study of the students' conceptions and experiences of learning and the use of the concept maps represented data-driven procedures. The classification of the theoretical viewpoints in students' written learning conceptions is located between these two approaches. Combining methods this way in the same study can be compared with conducting several separate studies each of which use different data and different methods but the same subjects in the same context and situation. A multiple-method approach of this kind is a laborious process to carry out, but it produces a more multi-faceted picture of learning than an examination only from a single perspective. In the following discussion, critical points of each sub study will be reviewed.

Table 15. The different types of methods used in the study

Theory-driven methods	*Data-driven methods*
- the SOLO Taxonomy - the epistemic categorisation of the students' examination answers - the questionnaire assessment of the students' own learning	- phenomenographic analysis of the students' essays on their conceptions of learning - the concept maps of the students' essays - phenomenographic analysis of the students' answers to an interview on their experiences of learning
- classification of theoretical viewpoints in the students' essays on their conceptions of learning	

A) The Study of the Students' Subjective Learning Experiences

This sub-study concentrated on the question of how the students themselves described their learning experiences and evaluated their learning outcomes. It combined what Marton (1994; Marton & Booth,

1997) has called research from the learner's point of view and recent developments in student assessment based on students' self-reflection and self-evaluation of their own learning (e.g. Boud, 1992). The students' subjective learning experiences were examined by means of a phenomenographic analysis of their answers to the open interview questions on the one hand, and on the basis of their answers to the self-assessment questionnaire on the other hand. Although both these methods focus on students' self-assessment of their learning, they represent entirely different approaches to analysing these personal and subjective data. When students are asked to answer open interview questions such as "What do you feel that you have learned during the course?", they are allowed to respond from their own perspectives, whatever they may be, instead of having to use some limited alternatives defined by others. On the other hand, a questionnaire focusing on certain aspects of the topic enables the researcher to make sure that all the relevant considerations that previous research has brought up will be taken into account. In the present study the questionnaire developed on the basis of previous research findings on student learning was given to the students at the end of the interview. Thus, answering it did not affect the students' responses to the open-ended questions.

Although the phenomenographic analysis and the questionnaire assessment approach students' learning experiences from different perspectives, there are some interesting similarities between the findings derived from the two methods. Both analyses indicated that the constructivist group and the control group differed from each other mainly in the extent to which the students paid attention the development of their thinking as their most important learning experience. While most of the constructivist group students emphasised the development of their thinking in their answers both to the open-ended questions and the questionnaire items, only a few of the control group students did the same. Thus, the findings gained with the two methods support each other.

B) The Study of the Students' Conceptions of Learning

This sub-study derives from two sources, the phenomenographic studies of how people understand different phenomena on the one hand, and cognitive study of conceptual change on the other hand. Consequently, the essays that the students wrote on their learning conceptions at the beginning and at the end of the course were analysed by using multiple methods. First, the structure and content of the whole essays were illustrated by drawing structured concept maps of them. Second, the essays were divided into epistemic units which were classified on the basis of the theoretical viewpoint that they represented. Third, those paragraphs in the essays that dealt with the learning process were analysed by the phenomenographic procedure. Finally, on the basis of the findings of the three analyses, different types of conceptual change were identified. Given the limited data of the study, these types of conceptual change can be seen only as hypothetical constructions for the time being, but it is nevertheless hoped that as such they will provide an important contribution to further research on the nature of conceptual change. It is also important to note that the essays the students wrote on their learning conceptions are not considered as representing any fixed or permanent mental structures. Rather, the essays are products created by the students in a specific context and situation. In other contexts and situations the products might have been different (cf. Shotter, 1995).

Earlier studies of conceptions of learning have generally relied on using a single method, ranging from phenomenographic analyses of interview answers to multiple-choice questionnaires (Marton et al., 1993; Marton & Booth, 1997; van Rossum & Schenk, 1984; Boulton-Lewis, 1994; Lonka et al., 1996). The use of written conceptions makes it possible to apply multiple methods in data analysis, thus allowing examinations from multi-level perspectives. For example, the classification of the theoretical viewpoints provided information on which scientific learning theories the students'

conceptions were embedded in, while the phenomenographic analysis of the students' descriptions of the learning process showed the different ways in which the students understood how learning takes place. While earlier studies of learning conceptions have mainly produced descriptions of how people *define* learning, the students' essays in the present study contained descriptions of learning that went beyond mere definitions. They dealt with a great variety of themes concerning learning. These themes could be categorised as: 1) definitions of learning; 2) descriptions of factors influencing learning; 3) descriptions of the learning process; 4) descriptions of learning outcomes and 5) metaconceptions. The descriptions of the learning process were subjected to further phenomenographic analysis because no other previous studies have focused on this specific topic.

The education students examined here expressed seven different conceptions of the learning process, ranging from considering learning as an externally determined process to regarding it as a creative process. To some extent the seven categories of description can be seen as hierarchically ordered, but the "outcome space" should not be regarded as a strict hierarchical system. In this respect, the results deviate slightly from phenomenographic principles (e.g. Marton, 1994). Furthermore, the categories do not exclude each other at the individual level. Instead, individual students may have articulated several conceptions in their essays. Phenomenography does not aim to discover types of individuals but forms of understanding phenomena or different conceptions that individuals express. In many phenomenographic studies, however, individuals are placed in only one category. Logically, this is possible when the categories do indeed constitute a strictly hierarchical system in which the highest category may include lower categories but not vice versa. For example, the learning conceptions identified by Marton and colleagues (1993) seem to follow this principle. However, the focus of the present study was the identification of conceptions of the learning *process*. Therefore it

differs ontologically from earlier studies of conceptions of learning. It is possible that ontologically different concepts and conceptions concerning them may appear differently (cf. Chi et al., 1994), which might explain the lack of strict hierarchy among the conceptions studied here.

A feature seldom studied in research on learning conceptions is how they change. The use of the structured conceptual maps proved an excellent method for the analysis of the change. The maps provided information both on the contents of the students' conceptions and on the structure of their answers at the same time. Combined with the findings achieved from the phenomenographic and epistemic analyses of the essay contents the conceptual maps produced findings about the nature of conceptual change that were not possible to get by using a single method.

From the theoretical point of view, the sub-study of changes in the students' learning conceptions yielded probably the most interesting findings of the whole investigation. Previous research on learning conceptions has produced rich descriptions of the different conceptions that people have of learning but it has not provided any theories of how such conceptions change. On the other hand, the tradition of research on conceptual change has focused on students' understanding of science concepts while other areas of conceptional development have been almost entirely neglected. This study integrated the two lines of research on conceptions of learning and on conceptual change to examine how university students' learning conceptions change during an educational psychology course.

As a result of the analysis of the essays, seven different types of changes in the students' conceptions were identified: 1) Adding new concepts; 2) Re-defining, specifying or particularizing concepts; 3) Linking specific aspects of a given conception; 4) Moving from one category of explanation to another; 5) Adding a theoretical viewpoint; 6) Replacing one theoretical viewpoint with another; and 7) Forming an explanatory framework. These various types of

change in learning conceptions may be seen as providing material for developing our understanding of what Dykstra and others (1992) have named the most fundamental issue in research on conceptual change: *what* changes when conceptual change occurs? Examining these seven categories of change reveals that changes in conceptions take place at least on four levels: A) on the semantic level concerning individual concepts related to the conceptions; B) on the level of the relationships between the concepts; C) on the level of shifts between ontological categories; and D) on the level of a background theory or a framework theory underlying a conception. On the first level, the contents of the concepts used by students to describe a phenomenon become more accurate or students may acquire new concepts. On the second level, students make connections between different concepts or different aspects of the phenomenon in question. On the third level, the contents of the concept change ontologically, moving from one ontological category, or category of explanation, to another. On the fourth level, framework theories underlying a conception may change. Previous theories may be replaced by a new theory or a new theory may be adopted alongside the old one. Thus, old ideas do not necessarily disappear when a new theory is learned but old and new ideas may, instead, live on side by side.

In this study, students' learning theories were called *theoretical viewpoints*. The idea was to find out which scientific theories the students' conceptions reflected. For this purpose, the students' essays on their conceptions of learning were analysed against the theoretical constructions of learning articulated in the scientific community. The classification of viewpoints was not strictly defined beforehand although certain views such as behaviourism and cognitivism were expected to appear in the essays. As a result of the qualitative analysis, ten different theoretical viewpoints were identified: the sociological approach, physiological psychology, personality psychology, interactionism, behaviourism, humanistic psychology, lifelong learning, experiential learning, cognitivism and construc-

tivism. In general, the students' essays included several of these theoretical standpoints both at the beginning and at the end of the course. Thus, an individual student usually described learning from different theoretical perspectives at the same time, expressing, for example, behaviourist, cognitivist and sociological ideas in the same essay. The students' conceptions of learning were thus characterised by eclectic conglomerations of different theoretical dispositions. Although most of the students adopted new theoretical viewpoints during the course, this did not necessarily lead them to give up their earlier views.

What does this all mean for conceptual change theory? First of all, the above system of categories of conceptual change, although created by the author on the basis of this particular data, may be understood as a synthesis of earlier work on conceptual change theory. As a synthetic creation of this kind, the category system provides general evidence of the validity of cognitive research on conceptual change. The types of conceptual change identified in this study have similarities with previously detected forms of change. For example, categories 1 to 5 can be seen as representing enrichment-type change, while categories 6 and 7 exemplify revision (Vosniadou, 1994). Category 3, linking specific aspects of conceptions with each other, is an important element in the SOLO Taxonomy (Biggs & Collis, 1982; Biggs, 1992) while category 4, moving a concept from one category of explanation to another, bears a certain resemblance to the view of conceptual development as involving change in the ontological categorisation of concepts (Chi et al., 1994). Further, the finding that the students' earlier ideas were not necessarily replaced by the new viewpoints supports Pozo's (1997) hypothesis about the coexistence of old and new models in students' minds. Moreover, such coexistence raises a number of further questions for future research. For example, how do students' coexisting theories relate to each other? Are they parallel or are they, rather, hierarchically ordered, as Pozo (1997) has suggested? Further, which theories may coexist and are some theories incompatible with

each other? May viewpoints that are often seen as opposites by the scientific community, such as behaviourist and constructivist views of learning, coexist in students' minds? Or are they incompatible also on the individual level? And should they be? Roth and Roychoudhury (1994) have found that some students may concurrently express constructivist views on the one hand and metaphors of learning that derive from an objectivist epistemology on the other hand. In contrast, the present material included not a single student who would have simultaneously expressed constructivist views and behaviourist ideas of learning. Does this indicate that if a student has acquired a constructivist conception of learning, a kind of scientific revolution (cf. Thagard, 1992a) or radical conceptual change (cf. Posner et al., 1982; Chi et al., 1994) has occurred in the student's mind? Or does it only suggest that this particular context and situation (educational psychology course) encouraged the students to take a stand for only certain theoretical positions?

The nature of the learning environment, whether a constructivist or a traditional one, seemed not to make a difference with regard to types of conceptual change. All change types seemed to appear equally often in both groups. It is possible that the time frame of a single course is too short to bring about group differences between the two learning environments. Longitudinal studies lasting several years might cast light on the question of whether different learning environments do produce different types of change in students' conceptual structures. Unfortunately, a longitudinal study of this kind would be very difficult to carry out.

Adding or specifying concepts and theoretical viewpoints and linking aspects of conceptions were the most common kinds of change in both groups. It seems that what is changing when conceptions of learning are developed through explicit teaching of learning involves, for the most part, adopting new concepts and theories and linking their different aspects with each other. Furthermore, most of the students in this material seemed to develop

a broader explanatory framework from which they discussed learning. The construction of frameworks identified here bears some resemblance to the development of the knowledge objects described by Entwistle and Marton (1994; Entwistle, 1995) and requires a more detailed further analysis.

Rarer types of change were moving from one category of explanation to another and totally replacing one theoretical viewpoint with another. Category shifts took place between the presage, process or product categories taken from the general model of learning (Biggs, 1987, pp. 9, 96; 1993, p. 75) that was used to analyze the structure of the students' learning conceptions. Moving from one category of explanation to another meant that a student presented a certain concept as a presage factor at the beginning of the course and as a process description at the end of the course. In some cases the students' category shifts were quite comprehensive, involving a switch from listing presage factors affecting learning to a detailed description of the learning process. Undoubtedly, gaining some such a deeper understanding of the learning process should be the main aim in teaching psychology of learning to education students.

Replacing one theoretical viewpoint with another meant that at the beginning and at the end of the course a student explained learning from totally different theoretical perspectives. For example, one student used only behaviourist terminology and the ideas of lifelong learning in her initial essay. In contrast, at the end of the course her essay contained not a single behaviourist or lifelong learning statement. Instead she described the cognitive characteristics of learning in terms of both information processing and students' approaches to learning. Furthermore, she expressed constructivist views on how learning situations should be arranged. Despite these fundamental changes, we cannot conclude that she had "revised" her framework theory of learning in the sense of Vosniadou's theory (1994). Such a conclusion would require further research focusing directly on the ontological and epistemological presuppositions of learning conceptions, and that is

beyond the scope of this study. However, the resemblance to Vosniadou's "revision of framework theories" is clear.

When the students' theoretical viewpoints were examined on the individual level, it was found that constructivist views appeared as novel views at the end of the course only in the constructivist group. This fact supports the idea that everyday experiences of a constructivist learning environment may influence students' conceptions of learning in the direction of constructivism even if constructivism is not explicitly taught (cf. Vermunt & van Rijswik, 1988).

Cognitive views and ideas stemming from lifelong learning and personality psychology became more common in both groups. These views were also dominant in the textbooks. Statements based on personality psychology seemed to become more frequent especially in the traditional group. This may be due to the fact that the final essay on conceptions of learning was one of the examination questions for the traditional group. Therefore these students may have been more concerned to reproduce detailed textbook descriptions than the students belonging to the constructivist learning group, who wrote their final essay only to provide material for the research. The context in which the material on learning conceptions was collected after the course was thus undoubtedly different in the two groups. Here we come to an important challenge to further research on learning conceptions: what kind of role does the context play in the way people express their conceptions? We may assume, for example, that students describe their learning conceptions differently in free conversation and in an examination situation, as was the case in the present study. Another interesting question concerns the relationship between students' expressed learning conception and their actual study practices. For example, do students holding the constructivist view of learning approach studying in a way different from students holding behaviourist views?

In sum, this sub-study has produced a preliminary model of changes in learning conceptions, a model that can be seen as a

synthesis of previous studies conducted in the domain of science learning. According to the model, conceptual change may take place on four levels: on the semantic level of individual concepts, on the relationships between the concepts, on the ontological level and on a framework theory. Constructivist and traditional learning environments seemed to produce the same types of change in the students' conceptions of learning. Generally speaking, the changes involved the extension of conceptual systems rather than their replacement with new ones. However, constructivist and traditional environments differed in the sense that constructivist views of learning increased only in the constructivist learning group. Further research in different contexts and domains is now needed to validate and elaborate this model of conceptual change and to elucidate the significance of contextual factors in students' conceptional development.

C) The Study of the Students' Examination Answers

This sub-study represents the kind of student assessment that has dominated educational practices and has also been widely used for research purposes, as examination marks are often used as indicators of learning in investigations. However, in the present study the traditional way of using examination marks as research material was not adopted, because traditional examinations conflict with constructivism, emphasising rather the knowledge transmitting view or a quantitative outlook on learning and teaching (Biggs, 1994). Studies of student learning have shown that examinations often distort students' efforts to achieve personal understanding and tend to encourage them to engage in trivial learning activities. Thus, providing constructivist instruction will have little effect on the quality of learning if conventional assessment methods are retained (Entwistle et al., 1993). Therefore the constructivist group students did not have to take an examination to determine their course grade.

Instead, their assessment was based on their learning tasks, group discussions and long essays. In an original research plan, it was intended that the constructivist group students would not need to answer the examination questions at all. However, in the end, they were asked to answer the questions to find out whether different assessment methods, such as an self-assessment questionnaire and examination questions, would produce different pictures of the students' learning outcomes. As the students were promised, their answers were not graded and they did not affect their course grades but were used only for research purposes. Thus, instead of using examination grades as indicators of learning, the intention was to analyse the answers with methods that previous studies have proved reliable means of assessing qualitative features of students' answers. The epistemic classification derived from earlier studies of learning declarative knowledge (Leiwo et al., 1987; Ohlsson, 1996) and the SOLO Taxonomy (Biggs & Collis, 1982; Biggs, 1992) were selected as they fulfilled these requirements. Both classifications are strongly theory-based and have proven their validity and reliability.

Length of examination answers has often been considered to represent an objective quantitative method for examining essay-type examination answers. Some earlier studies have suggested that the length of answers might also be in association with the quality of answers (Lonka & Mikkonen, 1989). On the other hand, some other studies suggest that long examination answers or other products do not necessarily imply a high quality of contents. For example, Schmidt, Norman and Boshuizen (1990) analysed medical students' protocols of the same case and found that sixth-year students might describe the case more accurately in significantly shorter protocols than forth-year students. The more advanced students had developed an ability to select the most important information and to use higher-level concepts. Biggs (1987, 1991, pp. 19–20) has also found that long and detailed answers may often be only multi-structural in their SOLO level, thus lacking descriptions of relationships between the different aspects of the answer. It was

similarly discovered in this study that long and detailed answers often typical of some control group students were in many cases no more than multistructural. These answers presented several aspects of the subject but treated them separately. Furthermore, the epistemological classification indicated that such long answers often included mainly descriptions of detailed information and lacked higher-order generalisations and evaluations. Thus, long answers did not always represent a high quality in sense of complexity, coherence, overall meaning and the level of abstraction of an answer. Altogether, the findings gained by means of the SOLO Taxonomy and the epistemic classification suggest that the length of an examination answer is not an adequate indicator of student learning. Instead, the SOLO Taxonomy and the epistemic classification can be recommended as tools for assessing qualitative features of students' learning outcomes.

Chapter 6

CONCLUSIONS: HOW TO FOSTER EXPERT KNOWLEDGE IN UNIVERSITY?

Constructivist Pedagogy and Generic Learning Outcomes

University instruction may be viewed at least from four perspectives: 1) from the disciplinary perspective, 2) from the angle of working life, 3) from the viewpoint of research on expertise, and 4) from the viewpoint of research on learning. The disciplinary considerations are related to the contents of each specific domain and concern questions such as what students should be taught and how the knowledge base of the domain should be organised. When teaching is looked at from the point of view of working life, central issues will probably be what is the need of workforce in different fields and what kind of learning outcomes education should produce or what kind of skills and knowledge future employees are expected to possess. From the viewpoint of research on expertise, basic considerations are related to the nature of expertise in specific fields and to the question whether there are general features that are common to experts independently of the domain they represent. Finally, from the perspective of research on learning, the questions related to university instruction involve the basic processes of how knowledge is acquired and how the learning process may be supported.

Educational and curricular planning in higher education are often based only on the first of these viewpoints, on the disciplinary aspects. However, it would be very important to pay attention to all these four perspectives in developing education for future experts. The main starting point of the present study was the perspective of research on learning and the constructivist view of knowledge acquisition. The findings of the study suggest that the learning outcomes produced in a constructivist environment are congruent with the requirements of working life. When discussing their own learning experiences, most constructivist group students did not only describe their learning as the accumulation of information but they also emphasised the acquisition of an ability to apply knowledge and the development of their thinking and communication skills. They felt that they had learned to write more fluently, act as members of a team and articulate their thoughts. They also thought that they had become more critical and more aware of different scientific approaches to explaining phenomena. Altogether, the learning experiences of the students interestingly match the requirements often given for expert work. The analysis of the students' written answers to the examination questions carried out using the SOLO Taxonomy and the epistemic categorisation also suggested that the knowledge base of the constructivist group students was more highly organised than that of the traditional group students.

Allan (1996) divides learning outcomes in higher education into subject-based, personal transferable, and generic academic outcomes. The learning outcomes measured by traditional examination questions belong to the first category, subject-based outcomes. These are the learning outcomes usually assessed in university courses. However, the personal transferable outcomes, including independent work, co-operation and communication skills, using information etc., as well as the generic academic outcomes, such as thinking critically and synthesising ideas and information, are learning outcomes that higher education is

supposed to produce along with the subject-based outcomes, although not much attention is paid on enhancing them, at least not in traditional instruction. In the present study, the students in the constructivist group often described their learning in terms of the personal transferable skills and the generic academic outcomes, while the students in the control group talked mainly about the subject-based learning outcomes. As we have seen, the subject-based outcomes were equal in both groups – or even at higher level in the constructivist group – while the transferable and generic academic outcomes were more often experienced by the constructivist group students. In sum, the constructivist learning environment proved successful in producing the type of learning outcomes that are congruent with the general aims of higher education. We have to remember, however, that learning outcomes were examined here on the conceptual level and that the study did not assess how successfully the students could have applied their knowledge in real-life situations. Despite this reservation, the findings give support to the idea often presented in recent literature that creating constructivist learning environments should be one of the main focuses in developing university pedagogy.

However, applying constructivist principles in teaching is not an easy task, and it requires a great deal of effort of teachers and students. In addition to strong knowledge base in their own domain, teachers also need knowledge about the processes of learning. Furthermore, they must have a plenty of time for planning instruction and designing learning tasks and for assessing their impact on students. Students, similarly, need time for meaning making and for constructing their own views of the central phenomena of their field of study. Instructional interventions have shown that students participating in activating instruction often advance more slowly in their studies than students taking part in traditional courses (Lonka, 1997; Lonka & Ahola, 1995). Furthermore, syllabi are often so over-loaded that they also lead to prolongation of study times. Therefore, it is important that instead of reforms

limited to individual courses, comprehensive reforms of whole curricula are carried out. What is also needed is education for university teachers. Constructivist learning theory and its applications should be an essential subject in staff development programmes in higher education.

From Cramming for a Test Towards Building Knowledge Products

Although the knowledge transmission paradigm and the behaviourist view of learning have been replaced by different constructivist approaches in research on learning, educational practices in general have been much slower to change. For example, traditional examinations on set literature are still very common in universities, at least in Finland. Students prepare to these examinations individually, often "swotting up" and using surface learning strategies. Thus, the aim of studying is to fill one's head with the course contents – at least until a test or an examination is passed. Bereiter (1994, 1997) and Bereiter and Scardamalia (1996) have paid attention to this point. Schooling has traditionally concentrated on what Popper (1972) has called "the Second World" – on the contents of individual students' minds. In contrast, scholarly disciplines are focussed on producing and improving what Popper has termed the objects of "the Third World", such as theories, explanations, historical accounts, problem formulations and solutions, proofs and disproofs. Science and scholarship also produce many derivatives of the Third World objects, such as syntheses, critiques and textbooks. Bereiter and Scardamalia (1993; Bereiter, 1997) have suggested that in order to produce real experts and to prepare students for knowledge society, schooling should be organised in a way similar to research groups and turn its focus on the activities on the Third World. This means guiding students to engage in knowledge building, that is,

producing knowledge objects – theories, theorylike conjectures, interpretations, historical accounts, problem statements, defences based on evidence, and so on. Instead of trying to improve their mind by filling it with new contents, students will focus their attention on improving the knowledge that is being collectively created.

I agree with Bereiter's view of shifting the focus of schooling from the contents of students' heads to students' knowledge building aims, but I have a complementary suggestion of where the products of students' knowledge building efforts should be stored. Scardamalia and Bereiter (1996) have developed a network-based system that students may use to construct a collective knowledge base for their knowledge objects. Creating a "collective memory" of this kind is inevitably a useful form of knowledge handling in information society, but I still think that students would also like to have something of their own. Therefore I suggest that the main practice in higher education should be that during their education students are encouraged to construct knowledge products for themselves (cf. Bruner, 1996, pp. 22–23). Instead of trying to cope with tests and exams, students could focus on building their own personal collection of useful packages of their domain knowledge. These knowledge products could be in the form of essays, term papers, project reports, research papers, videos, posters, slides, portfolios, or whatever products that students might create. In an ideal situation students could find these products so valuable that after their graduation they could serve them as useful resources in dealing with complicated real-life problems. Students' knowledge products would thus constitute a kind of personal library or portfolio. Personal libraries could, of course, be stored in a collective data base or Internet for collective use. Inevitably, the products themselves will eventually go out of date, but the processes of producing them will probably endure in lifelong transferable skills.

If the focus of studying could be turned from filling one's mind to producing what Bereiter (1994) calls knowledge objects or what I

discussed above as broader knowledge products, students would not need to concentrate on memorising and cramming for examinations. Instead, constructing different knowledge products would require them to engage in complicated processes of knowledge transforming. Knowledge work of this kind might enable students to work simultaneously on the abstract level of "non-situated" theoretical knowledge and on the level of situated practical knowledge. Furthermore, in creating, presenting and evaluating these products, different forms of collaboration, peer review and self-evaluation could be utilised so as to develop the kind of skills that working life expects of university graduates.

Integration of Theoretical, Practical and Self-Regulative Knowledge

From the viewpoint of expertise, a central question involved in the development of university instruction is the integration of theoretical, practical and self-regulative knowledge. The profound integration of these components of expert knowledge is of fundamental importance in expertise. However, in a traditional type of curriculum these different types of knowledge have been treated separately. There have been theoretical courses which introduce students to the basic concepts and theories of a domain, and there have been practical courses which involve students practising the special skills needed in a discipline or a profession. Furthermore, students may be offered courses on study skills in order to teach them effective and deep learning strategies and to enhance their meta-cognitive or self-regulative knowledge. These separate courses have usually been scheduled so that study skills courses and theoretical courses are placed at the initial phases of studies, while practical courses or practice periods have followed only at the final phase. On the basis of what we know today about transfer of

knowledge and the situated nature of learning, we can conclude that separating theory, practice and self-regulation in this way does not very effectively enhance the process of integrating the main components of expert knowledge in students. Therefore, one of the most important challenges to university pedagogy is developing curricula and teaching methods so that true integration of formal, theoretical knowledge and more informal practical knowledge as well as meta-cognitive and self-regulative knowledge may be achieved.

A promising approach to integrating different forms of knowledge seems to be problem-based learning (PBL) which has been applied in certain fields of professional education, such as in medical training, for several years (e.g. Boud & Feletti, 1991; Reynolds, 1997). The basic idea of PBL is that the starting point of learning and studying is a problem that needs to be solved. The courses are structured around problems or cases rather than subjects or disciplines, and practical experiences are integrated with theoretical material. Students are encouraged to apply their existing knowledge and to identify their further learning needs. Learning is student-centred and co-operative, with students working in a small group. Self- and peer assessment form an integral part of the learning process. Thus, PBL incorporates, in certain ways, some ideas of experiential learning (Kolb, 1984), reflective practicum (Schön, 1987) and an emphasis on supporting the learning process of an active learner, a main principle of constructivist pedagogy.

The educational psychology course that was investigated in the present study was purely theoretical in the sense that it did not include a practice period or practical experiments. However, one of its basic ideas was to the integrate theoretical knowledge presented in the coursebooks with the practical, experiential and often tacit knowledge that the students already had of the phenomena that were to be studied. Because everyone has experiences of learning and development, it was not difficult to use those experiences as components of the students' learning processes. Various writing

assignments and group discussions were used as tools for making those experiences and practical knowledge visible and tangible and thus accessible to theoretical reflection. As students' personal learning theories, beliefs and strategies were subjected to critical examination, their meta-cognitive and self-regulative skills developed during the process. Thus, in this experiment, the use of theoretical, practical and self-regulative knowledge were embedded in the learning tasks in an integrative way. Writing tasks and related group discussions proved useful tools for this purpose.

The impact of assessment procedures on student learning is a well-established fact in education. Students' perceptions of assessment requirements direct their approaches to learning and affect their learning outcomes. Therefore, it is very important that assessment is incorporated into the learning process instead of being kept as a separate phase at the end of a course. Making self-assessment and peer reviews an integral part of the learning process enhances students' meta-cognitive skills. Latham (1997) has described an interesting experiment of incorporating assessment in the learning process on a course in information systems (see also Tourunen, 1992, 1996). During the course, the students worked in simulated companies whose task was to visit a local secondary school in order to investigate the school's information technology facilities and to devise an information technology strategic plan for the school. The students were assessed on the basis of their completion of both individual and team-work assignments. Most of the theory was taught in the first weeks of the module, and at the same time the students wrote an essay which aimed to assess how they had understood the theory. Then each company produced a report and a presentation to the staff of the school. Each student received two marks for this assignment: a company mark, and an individual mark based on oral examinations, the student's commitment, the quality of his or her contribution, tutor observation and peer assessment. All students had to critically evaluate the way in which their company operated and to assess their own work as

well as their group members' work. Connecting different forms of assessment with the learning process in this way represents similar kind of performance assessment that was pursued also in the present study, although real-life tasks were not used. Moving from the knowledge transmitting paradigm of teaching towards the view of learning as active knowledge construction requires fundamental changes in assessment practices. In general, the direction will be from what Biggs (1994) has called the quantitative outlook towards what he called the qualitative outlook. Thus, the development of alternative assessment procedures is among the most important tasks of instructional design today.

Altogether, the findings of this study and recent research on learning provide several alternatives to enhance the development of expert knowledge during higher education studies. Common to most approaches seem to be the following principles:

- the emphasis is not on memorising and reproducing knowledge but on using and transforming it;
- acquiring and using knowledge are not separated as different phases of expert development, but knowledge is learnt by using it;
- knowledge is used especially to solve problems;
- stimulating students' thinking activities and enhancing their metacognitive and self-regulative skills are embedded in the study of content knowledge;
- social interaction has a central role in the learning process;
- assessment of learning is embedded in the learning process;
- students are themselves involved in the assessment of their learning.

On the basis of the present study and recent literature it can be concluded that constructivist pedagogy based on the above principles offers promising possibilities for training expert professionals for future working life. However, developing

prerequisites for professional expertise is not an easy job for teachers. Designing constructivist learning environments requires of the teacher much more than traditional teaching because the main emphasis shifts from the presentation of information to guiding students' learning process. This is a task where university teachers need education and support. Thus, the pedagogical training of higher education teachers is the question of the day.

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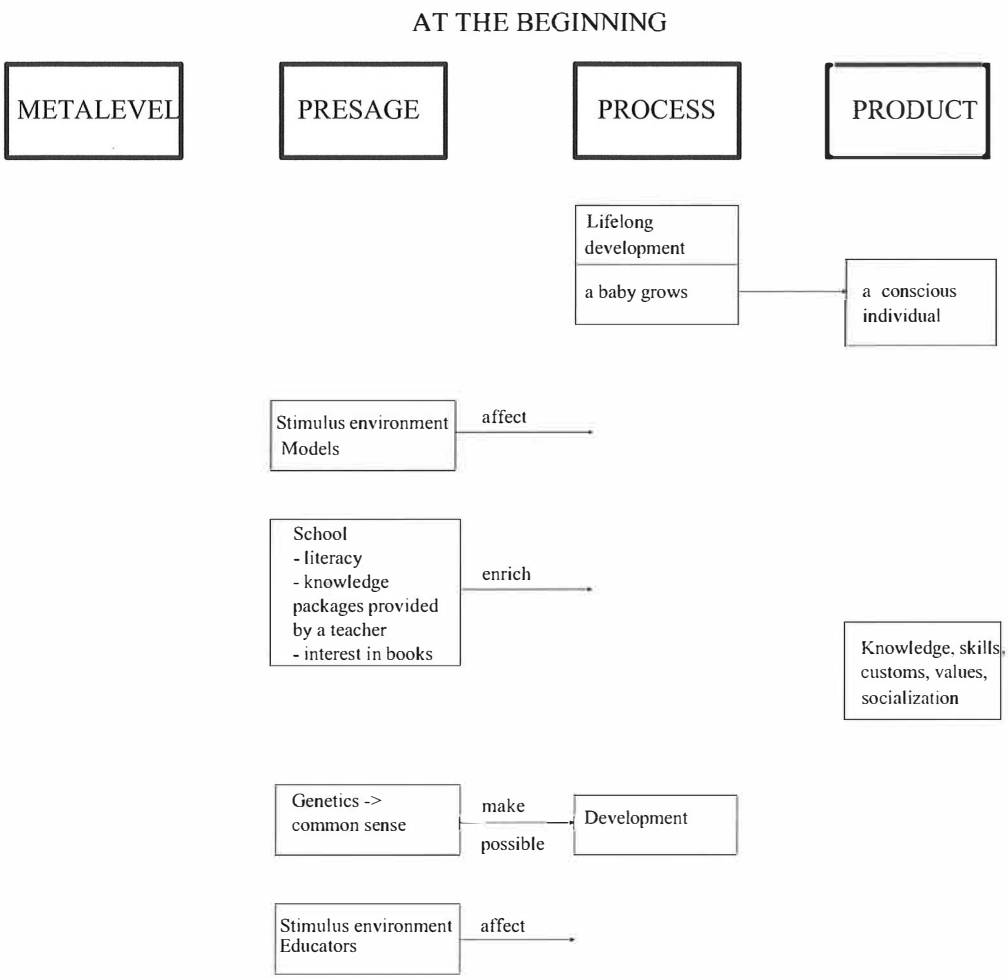
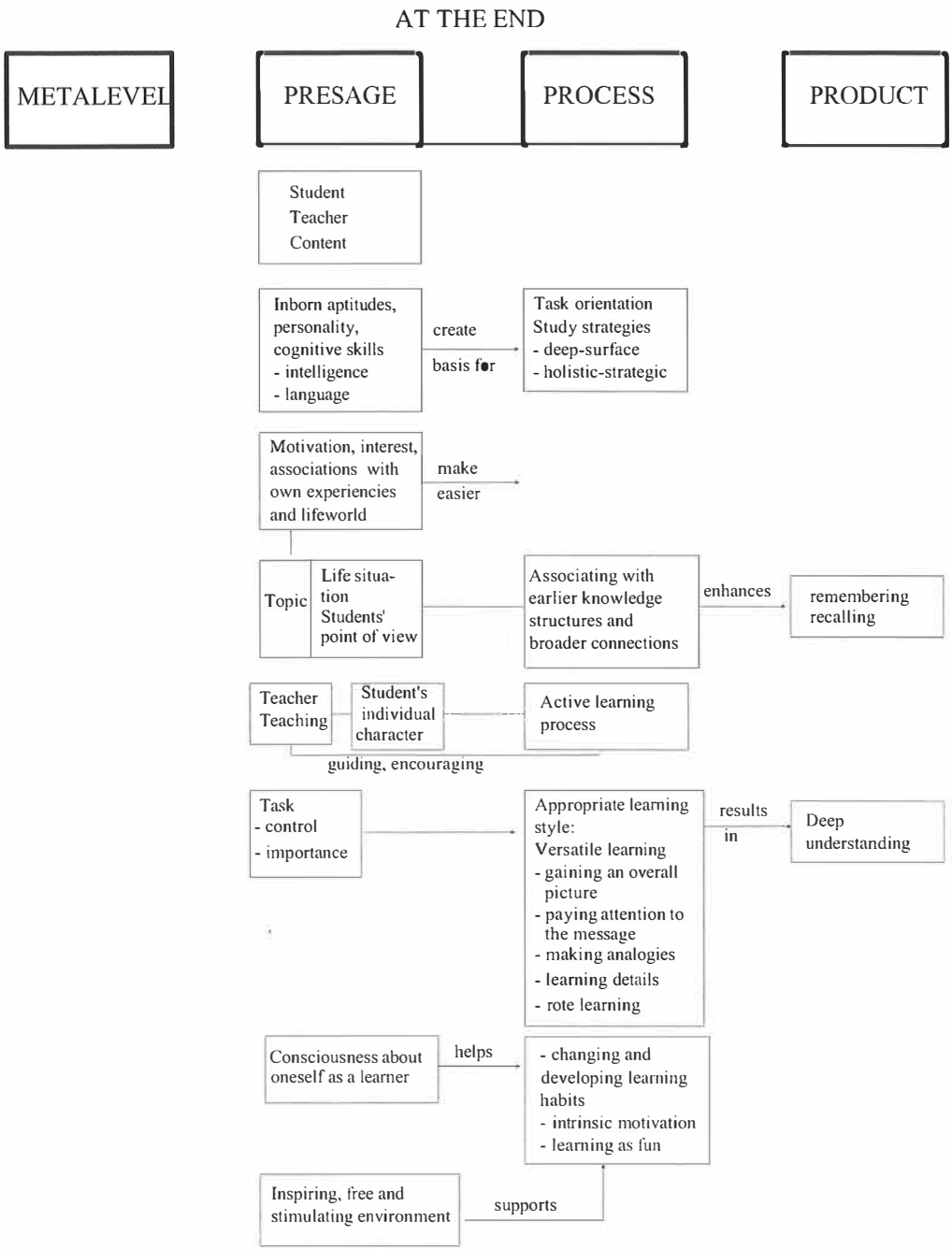
The prerequisites of working hard and doing research do not depend solely on the scientific community. An individual should also feel content and in harmony with the world to realise his or her talents, to cope with hard times and to deal with problems. Well-being of this kind is also socially constructed: it grows in relationships with other people. I wish to thank my friends and my family for providing me with such relationships, being there for me and standing by. My deepest thanks I want to address to my husband Jorma, my daughter Marjo and my son Jouni whose love is the source of my energy and the most important thing in my life.

APPENDICES

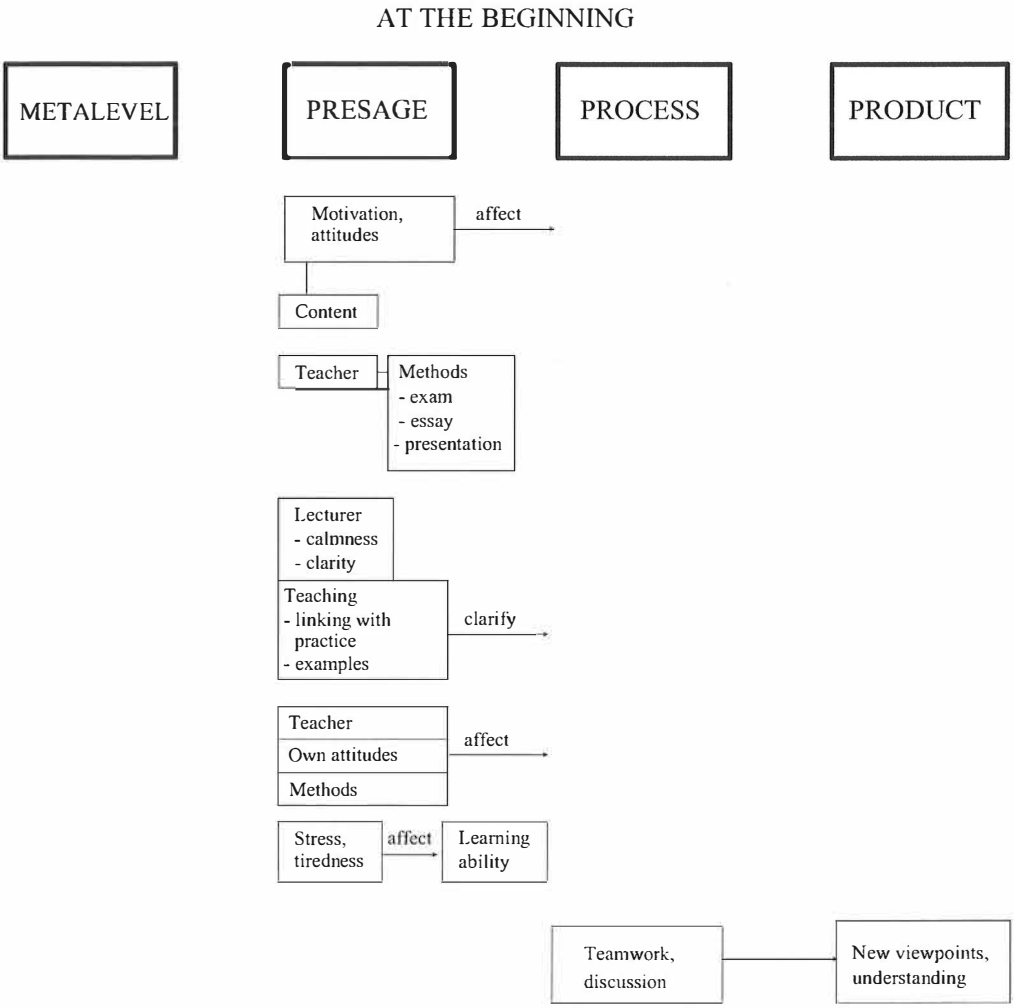
Appendix 1. An example of a structured concept map drawn from an essay written at the beginning of the course (student no 2)



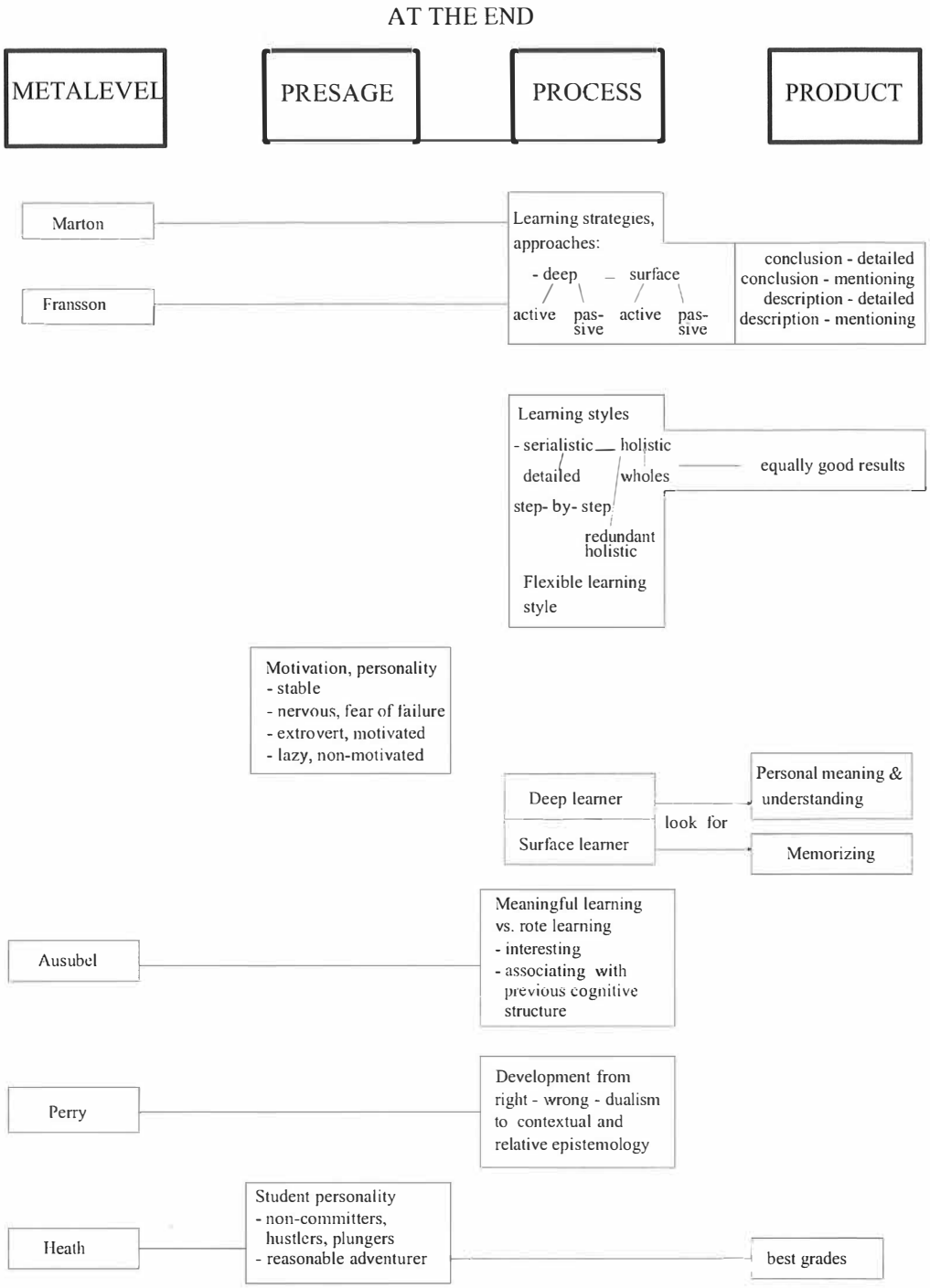
Appendix 2. An example of a structured concept map drawn from an essay written at the end of the cource (student no 2)



Appendix 3. A structured concept map drawn from an essay written at the beginning of the (student no 24)



Appendix 4. A structured concept map drawn from an essay written at the end of the course (student no 24)



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