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Paper Title: Concept Maps, Vee Diagrams and Rhetorical Argumentation Analysis (RAA) : Three Educational Theory-based Tools to Facilitate Meaningful Learning

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Concept Maps, Vee Diagrams and Rhetorical Argumentation Analysis (RAA) : Three Educational Theory-based Tools to Facilitate Meaningful Learning

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Abstract

There are many different graphic knowledge representation techniques which are called concept maps. These and similar techniques are scrutinized and a comparison table with eight categories is suggested. The first dimension with four categories is conceptual and propositional explicitness. The second dimension with two categories is whether or not pictures are utilized. Criteria for good concept maps are discussed. A quick way to teach concept mapping is presented. Examples of concept maps are analyzed. Structure of Vee diagrams is discussed and possible improvements are suggested. When we read concept maps and Vee diagrams, we understand them proposition by proposition. Most of these propositions, if not all of them, are claims about the world. It is often unclear if these claims have any evidence, any theoretical or empirical grounds, any specific justification or any general backing. Rhetorical argumentation analysis (RAA) is presented and discussed. A suggestion is made to interview those subjects who make concept maps and Vee diagrams and to analyze their accounts by RAA.

1. Introduction: a short overview and background of the main ideas of this paper

In this paper I will first present an analysis of concept maps and similar graphic knowledge representation techniques. As Ducker (1993, 210- 218), I believe that "in the knowledge society where we are moving, individuals are central....Knowledge is always embodied in a person; created, augmented, or improved by a person; applied by a person; taught and passed on by a person..." I have used concept maps since 1984, when I read Novak and Gowin's (1984) <u>Learning how to learn</u>. I have found concept mapping a very flexible and creative tool. I have tried with my students to test both conceptually and empirically ideas presented by Novak and Gowin (1984). Together with my research group in Finland, I have also tried to develop concept maps and Vee diagrams and to apply rhetorical argumentation analysis (RAA) to construct argumentation structures which are involved in concept mapping and in Vee diagramming. I will present some findings of our studies. I will also reflect on value questions concerning all research and educational efforts, as well as the implications for the use of Vee diagrams.

In both concept maps and in Vee diagrams there are many propositions (claims). Often there are very few, if any, explicit grounds or justifications for these claims. That is why I will present a metacognitive tool which can be used always when we are interested in argumentation and rhetoric of some text or discourse (writing or talking). It is a nature of good map that only the most important features are shown. There is always a tension between concisness and explicitness. So mainly conclusions are presented both in concept maps and Vee diagrams. Vee diagrams and value questions ought to be pondered always before any research and other important activity. Concept maps are an excellent tool to depict conceptual structures, but to construct argumentation and reasoning structures we need a tool like rhetorical argumentation analysis (RAA).

2. Concept maps and other similar graphic knowledge representation techniques and their underpinnings scrutinized in order to understand them more deeply and to use them more wisely

I have made in Finnish two reviews of concept maps and other similar graphic knowledge representation tools (Ahlberg 1989a;1990b). I found two earlier classificatory systems of graphic knowledge representation systems, but they were not satisfactory. The first is by Fry (1981a and 1981b). He does not mention concept maps. The semantics (a study of meaning, reference and denotation) in his article is very naive: no proper distinctions between concepts (conceptual) and words (verbal) are made. As an example of conceptual graphs TRUTH, BEAUTY AND JUSTICE are presented as sides of a triangle. And as an example of a verbal graph, a branching graph is presented, in which 1) BLACK CAT, 2) ATE, 3) FISH and 4) DINNER are the four elements used. However it is certain that 'truth', justice' and ' beaty' are words as well as 'black', 'cat', 'ate', 'fish' and ' dinner'. According to scientific semantics those words span in brain abstract concepts of TRUTH, JUSTICE AND BEAUTY and concrete concepts of BLACK, CAT, EAT IN IMPERFECT, FISH and DINNER. The second earlier category system is by Jones et al. (1989). They neither mention Fry (1981a, 1981b) nor concept maps. They have only the "network tree" in schematic form in which neither concepts nor links are named.

In Table 1, I present an improved version of my suggestion to a classificatory system of graphic knowledge representation techniques (GKRT) which uses concepts as basic elements. I have found that very different techniques are called "concept maps": 1) Novak and Gowin (1984, 2): concepts and links flexibly named, 2) Entwistle (1978, 255 - 263 and 1981, 212): concepts and unnamed links, 3) Matthews et al. 1984, 173): concepts are symbolized by numbers which are connected by unnamed links, 4) Peresich et al. (1990, 426 - 427): concepts and unnamed links, 5) The Journal of Experiential Education (1992. 15(2), cover picture): concepts mentioned, but some of them have been connected by a short phrase which does not link together concepts in any comprehensible proposition. I have been able to categorize these and many other examples by using two dimensions and eight categories or types of conceptual graphic knowledge representation tools (CGKRT) (Table 1.)

	No Pictures	Pictures
Only Concepts and Practically No Links	TYPE 1: Hanf 1971: *mapping;* Schaefer 1979, 91; The Journal of Experiental Education 1992. 15(2) cover picture: *concept maps*; Wandersee 1987: *concept circles*	TYPE 2: Buzan 1974 - 1989: *brain patterns (1974), mind maps (later on)* Russell 1979: *mind maps*
Concepts and Unnamed Links	TYPE 3: Collins and Quillian 1969: *illustration of hypothetical memory structure;* Rico 1983: *clustering;* Heimlich and Pittelman1986: *semantic mapping;* Grice and Skinner 1993, 110: *visual brainstorming;* Tillema 1983, 324: *network of concepts*	TYPE 4: Glass, Holoyak and Santa 1979; Glass and Holoyak 1986, 158: *conceptual network*
Concepts and Rigidly Named Links *(Lambiotte and al. 1989, 335: "canonical")*	TYPE 5: Fridja 1972, 4; Dansereau & al. 1979: *network* ; Anderson 1985: *network of concepts* ; Aditjondro 1989; Wiegman and al. 1992: *knowledge mapping*	TYPE 6: Greeno 1976: *network of propositions*
Concepts and Flexibly Named Links *(Lambiotte and al. 1989, 335: "idiosyncratic"*	TYPE 7: Novak and Gowin 1984: *concept maps*; Ahlberg 1989a and 1989b: *concept maps;* Fisher 1990: *semantic networking*	TYPE 8: Ahlberg 1988b: *concept maps* Fuata'i 1985, 90: *concept maps* Heinze-Fry 1987, 263: *concept maps*

TABLE 1. Comparison of different conceptual graphic knowledge representation tools (CGKRT) in which conceptual level is prominent. Excluded are those techniques that use mainly propositions or questions, e.g. Vee diagrams or pictures, or some combinations of them. The result: Eight basic types of CGKRT. *In cells above here are some examples of language used in these kinds of CGKRT. Other writers use also many other labels.*

The first dimension is conceptual explicitness: from mere concepts to flexibly named links and clear propositions in concept maps The second dimension in the classification system I am suggesting is whether there are pictures or not. Lambiotte, Dansereau, Cross and Reynolds (1989, 335) in their otherwise excellent article call rigidly (inflexibly) named links "canonical" links. I wonder what is canonical in them. Lambiotte & al. (1989, 335) call flexibly named links "idiosyncratic". I agree that when we name links flexibly we get an idiographic external representation of our thoughts and some of our ideas might well be sometimes idiosyncratic. I think this is a misnomer because most educated persons' ideas are rather similar according to my many years experience with hundreds of students' concept maps. Guba and Lincoln (1991) use term 'ideographic inquiry' in the similar sense.

After I had made the eight category system shown in Table 1, I found a mixed example. Nersessian (1989, 170 - 173) says that she uses concept maps, but only in part of her maps she utilises flexibly named links. Most links in her maps are rigidly labelled: 'K' for kind links, 'PR' for property links and 'R' for relation links. It is left open what kind relations 'R's are. Now I think that human beings are so creative that any kind of mixed version can be made and found. However the categories of CGKRT still highlight main features of different techniques.

Ahlberg (1990b) compared these and many other graphic knowledge representation techniques and concluded that the most practical, flexible and accurate description of individual's knowledge system is possible by using concept maps. Ahlberg (1991a) explicitly presents it as an important tool for qualitative research. A good concept map is an accurate external representation of an individual's internal representation of the world, or more often part of it. In Finland my research group has used methodological triangulation, a multimethod approach to test this claim. Alvarez and Risko (1993) have used a similar strategy in their work. In Finland my students and their pupils have written essays and we have interviewed them before and/or after they have made concept maps. As in an ordinary map, only the most important aspects and connections of the world are depicted on a concept map. If one tries to put too much knowledge about the world onto one map, the map becomes too crowded and messy, and difficult to read and understand.

In Novak and Gowin (1984, 2) there is a concept map in which it is claimed that concepts may undergo extinction. They have taken evolution as an analogy and to date they have made too strong a conclusion. Real living species of organisms can undergo extinction. They never come back alive when they have all died, this is the evidence today. But concepts can come back. They do not undergo extinction forever and permanently. For instance, when we read about phlogiston theory, we reconstruct the concept PHLOGISTON in our brains. This example shows how there are two different kinds of existence: real existence like that of real organisms and conceptual existence, like all our thoughts, concepts, propositions and theories.

Conceptual objects exist only as long as somebody thinks them. We can again and again reconstruct ancient concepts when we read or hear enough of them. They become "alive" again. They do not change in the way all objects change, which have real existence. Concepts are also real in a sense, but they have a constructed reality and they change only through our brain processes (thinking). This explains why thinking takes time and why it takes time to learn something. This type of critical realist constructivistic (and systemistic, emergentistic, materialistic) position is presented in Bunge (1979 - 1983b) and in Ahlberg (1988a- 1993b).

By critical realist constructivism I mean here such a version of constructivism which admits that there are no concepts ready-made in nature. Human beings must themselves construct all concepts and conceptual systems, like propositions and theories. Scientific realistic constructivism agrees with social constructionism in the importance of culture and social context. But according to modern scientific evidence they are constructed in nervous systems of living human beings. There is no brainless mind.

By systemism I mean scientific ontology according to which all elements in the world are somehow connected (Fig. 1). In this sense they form the biggest system known: the universe. If there were something in the world that is not connected to other elements of the universe, there is no way that we ever could get any knowledge about it. Scientific systemism is an ontology from which I claim that because there is only one common world which has both qualities and quantities, there is no incommensurability between qualitative and quantitative research. There is nothing wrong in synthetizing different theories, at least those parts of them which are not contradictory. Guba (1993, X) claims that " the naturalistic paradigm is incommensurable with the conventional paradigm...The naturalistic paradigm is incommensurable with positivism in the same way as flat earth and round earth are conceptually incommensurable." From the scientific systemistic viewpoint there is always a possibility to construct a new conceptual system in which both earlier and newer conceptual systems are parts. It is common knowledge that the earth appears to be flat, but when we have enough scientifically tested knowledge we know that the earth is approximately round. We can understand those who have not enough tested knowledge.

By emergentism I mean here that in the world there are systems which have different level of complexity. Each systemic level has properties of its own which are not reducible to the lower level properties. From the viewpoint of biochemistry human beings are biochemical systems. However a human being has many properties and processes which we cannot reduce to biochemistry, like thinking, feeling and acting: e.g. writing a paper in order to enchance a higher quality of human life.

By scientific materialism I mean here the view based on modern science that there is no brainless mind. All human thinking is events in human brain.

Novak (1990, 29) has defined a concept "as a perceived regularity in events or objects, designated by a label". A concept is then something that refers to both perceptions and to understanding. According to The Advanced Learner's Dictionary of Current English (1963): "perceive ... become aware of, esp. through the eyes or the mind." And "perception ... process by which we become aware of changes (through the senses of sight, hearing etc.); act or power of perceiving." In Ausubel, Novak and Hanesian (1978, 61 - 62) there is text about "cognition versus perception in meaningful verbal learning" and it is clearly said: "We both perceive verbal messages and cognitively learn their meaning as a result of interpreting them in the light of existing knowledge. The difference between two processes is one of immediacy and complexity."

If we define concepts as perceived regularities, then we have problems when we try to say something about imagined objects, for instance centaurs (half man and half horse). They are very difficult to be taken as perceived regularities. In which sense can they be perceived? And what about irregularities? We do have a concept of IRREGULARITY. We also have concepts (ideas) of individually unique objects (like the famous McGraw Tower at Cornell University) or concepts of individual unique events (like the Declaration of Independence of the USA on a certain day at a certain time and in a certain place). In which sense are they regularities? And what about plans, or visions or strategic intents? In what sense are they perceived regularities?

After writing this part of my paper I had an opportunity to hear Bob Gowin present his ideas behind Vee diagrams (August 3, 1993). I guess he would say that the events used to get answers about McGraw Tower would be to go there and see it, to touch it, read about it, and its regularities are that it is there and it has its history, properties and uses. So we also could perhaps explain unique dates. There must be some evidence left and the idea of regularity concerns the evidence and inferences made from them. Imagined objects like centaurs could also be explained in this way by thinking about events that can be read or heard about them. This usage of word 'regularity' in the definition of the concept of CONCEPT is a little bit unusual, and I still wonder if it is the best definition.

I suggest that we simply define concepts as basic elements of thinking and admit that other basic elements of thinking are different "images" (memories of visual objects and events, sound memories, taste memories, smell memories) which are difficult to explain verbally and conceptually. Paivio (1986) has presented this kind of system. Also Novak (1986, 8) says "The core of my beliefs is 'concepts are what we think with." My theory is based on this and Paivio's (1986) and Bunge's (1983a and 1983b) ideas.

According to Bunge (1983a and 1983b) many animals make perceptual maps of their surroundings. Only higher animals like humans also make conceptual maps of the world in their brain. Using science, humans have constructed concepts and knowledge about deep unobservable regularities of the world. (In this context deep unobservable regularities have been inferred from all relevant knowledge we have constructed and they are tested continuously both conceptually and empirically.) No perceptual map can include such knowledge. Using abstract concepts, and conceptual maps and models of the world, we can manage much better than by using only perceptual maps of our environment. A conceptual map is an internal representation of the world or part of it. When we make a concept map using words and lines, we make an external representation of our internal conceptual map.

In the world where an enormous amount of books, journals, articles, papers, etc., are published all the time, and where from newspapers, TV and radio we get all kinds of new information, there is an urgent need to make sense of it. For survival of humankind there is no alternative but more meaningful learning (Novak 1986, 11 and Ahlberg 1988, 66 - 67).

I (Ahlberg 1988a-1993b) find it extremely important to make distinctions between atomism, holism and systemism, which Bunge (e.g. 1979, 1983a and 1983b) has earlier suggested. Rote learning is atomistic: meanings have not been arranged into coherent hierarchical wholes and important connections between concepts are lacking. In nowadays very popular unscientific holism there is plenty of talk about intuitionistic wholes. But because concepts (basic elements of thinking) are not clearly presented and connections between main concepts are not clearly shown, we are left in situations where there is no way to decide which of many different intuitionistic wholes is best. For sure intuition is important in creative activities, but in science we test products of intuition for their truthfulness and in technology and services we test products of intuition for their effectiveness and efficiency. In systemism the basic elements of thinking and the main connections between them are presented as accurately as possible. Accurateness can be both qualitative and quantitative. Then we have knowledge about both the elements and the whole. This is the way modern science and technologies proceed. In concept maps we have a tool to present accurately systemistic ideas. So we are able to test every part of our conceptual map. But we test it part by part, never all at one time. We must assume other parts to be truthful enough. Even presuppositions can be tested conceptually one by one.

There are concrete systems like the Universe that includes part systems like physical systems, chemical systems, biological systems, sosiosystems and technological systems. Each of them has their own real and emergent properties. In our conceptual systems of the world we try to make sense of these different kinds of real systems and relations between them (Figure 1.)

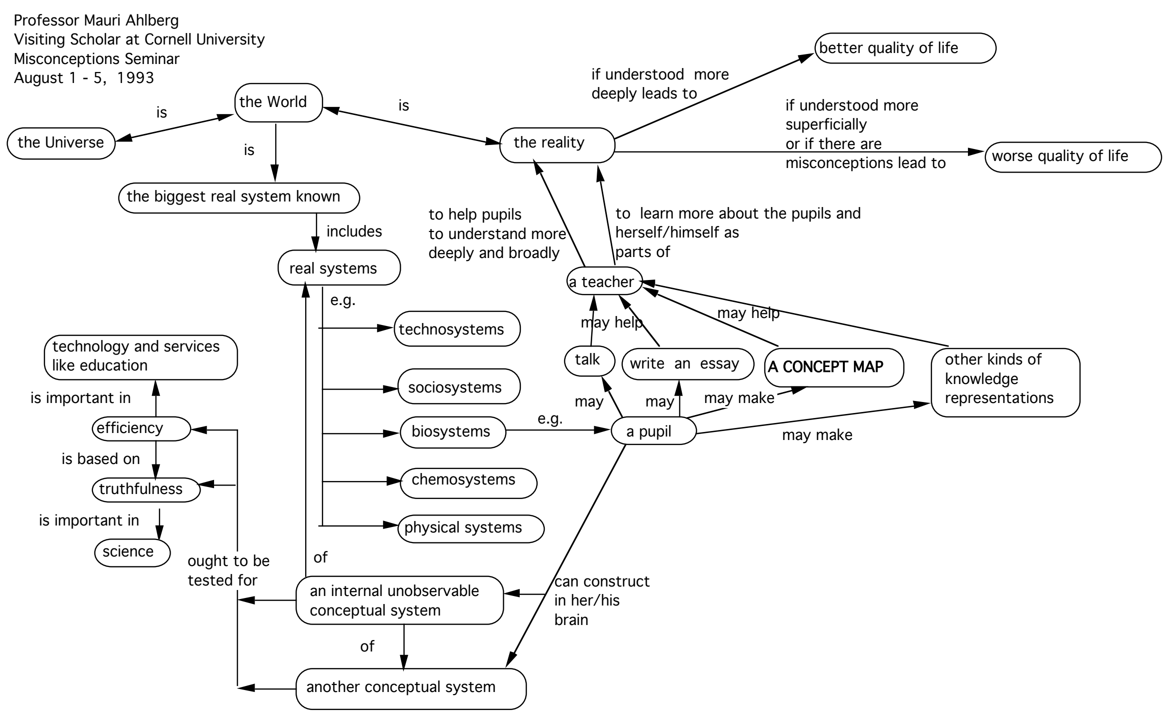

FIGURE 1. Concept mapping in relation to what is essential in the world according to systemistic ontology which is coherent with modern sciences (Based on Ahlberg (1988a - 1993b) which are partly based on Bunge's (e.g. 1979 - 1983b) scientific systemistic philosophy of science.)

Figure 1. Concept Mapping in relation to systemic ontology.

Today there are many threats to life in general and human life in particular. So it is more important than ever before to make wise systemistic overviews of what is most important to do for long term survival and better quality of human life. I think Novak (1992, Chapter 1, 4) is right when he asserts that we need meaningful learning and only by this can we get constructive integration of thinking, feeling and acting. But why do we need meaningful learning and constructive integration of thinking, feeling and acting. They can be understood as contentless, empty labels. That is why I would like to add the viewpoint of the axiology which is coherent with modern science and technology (e.g. Ahlberg 1988a, 1989c and Bunge 1979 and 1989). According to it the most central values are the survival of life (human life included) and a high quality of human life. All values imply both rights and duties. E.g. we have a right to live a meaningful life and we have a duty to do it, and a duty to enhance and protect this value for ourselves and other people.

3. History of graphic knowledge representation tools and some basic theoretical underpinnings and definitions in order to better understand, value and use them

I think those people are right who say that if history is not important for the present then what we do today means nothing for future. It often helps enormously to understand the history of issues related to your research, and what you are trying to develop further (to improve, to make still more truthful, efficient and empowering). That is why some short historical landmarks in graphic knowledge presentation tools will be introduced.

The oldest known example of branching knowledge representation tools is the famous Porphyry's tree (AD 232 - 304) (e.g. Machlup 1982, 23 and Reese 1980, 449). Only a relatively small amount of graphic knowledge representation techniques are found before Collins and Quillian (1969). But in the 1970's and 1980's many different techniques were developed. There are some in which only pictures have been connected to other pictures or only propositions have been connected to other propositions (e.g. Kintsch & van Dijk 1978 and Graesser & Clark 1985, 49). These have not been included in the previous category system presented in Table 1. They may be useful for some purposes but not for depicting relations among concepts and conceptual structures.

This article focuses on graphic knowledge representation tools from the conceptual level to propositional level. Concepts are here defined as basic elements of thinking. Thinking is considered here as events in the human central nervous system. This type of scientific contructivism is expressed in the writings of Novak (1977, 75; 1983, 609; Novak 1993, 180-181), Novak and Gowin (1984, 17), Bunge (1979; 1983a; 1983b), Ahlberg (e.g. 1988 and 1990b) and Wittrock (1992). We cannot observe directly internal thinking events, only external indicators of thinking like talking, writing and making diagrams, e.g. concept maps.

Concepts form kind a knowledge web or map in our mind. Webs and maps are examples of spatial analogies used to describe thinking and our internal representations of the world. Other spatial and visual analogies are hierarchies and world pictures. We make internal conceptual models of the world in our brains and we are constantly testing them both in scientific research and in everyday practice. In science we do not talk figuratively. In education it is sometimes useful to talk figuratively. In science we try to say as truthfully as possible what kind the world really is like. For sure our knowledge and value claims are only tentative. They are based on evidence that we have gathered. In front of new evidence and inferences we can change our internal models.

There are clear differences between positivism, post-positivism, social constructivism (which Gergen 1985 calls social constructionism) and scientific realistic constructivism (e.g. Boyd 1992; Bunge 1979 - 1983b; Ahlberg 1990b). The main differences between scientific contructivism (e.g. Inhelder and Piaget 1958, 337; Piaget 1929; Piaget 1954, 3, 351; Piaget 1969, XV, XXIII, XXVIII, 364 - 366, Piaget 1971, 7, 72, 116 - 119, Piaget 1972, 145; Piaget 1976, 1, 333, 350 - 353; Piaget and Inhelder 1969, VII, 13, 109; Novak 1977 - 1993; Wittrock 1977 - 1992; Anderson 1992; Bunge 1979 - 1989; Ahlberg 1988a - 1993b) and unscientific social constructivism (Guba and Lincoln 1989): are answers to qestions: 1) Is there one common world or not 2) Do we call different conceptions of this common world as different "realities" or not, and 3) Do we construct concepts and conceptual structures in our brains or only in immaterial minds and/or only in culture and/or only in society? Also according to scientific constructivism almost all human activities (learning, teaching, research etc.) are social and cultural, or better biopsychosocial. Strike (1987) has noticed that some writers use only two labels: constructivism and positivism. And all who are constructivists seem to be right and all who are blamed to be positivists seem to be wrong, as if they were "bad guys". I do not want to say that social constructivists are "bad guys" and all what they write is nonsense. There are many good ideas in their texts which have enriched educational research, e.g. ideas of trustworthiness and credibility and how they can be checked. The space does not allow me to discuss the issue more deeply.

There are many varieties of unscientific constructivism. von Glasersfeld (e.g. 1989) has presented a version of it which which he calls radical constructivism. For von Glasersfeld (1989, 124) radical constructivism is a form of pragmatism. He refers to "Rorty (1982, p. XVII)" and claims that "modern science does not enable us to cope because it corresponds, it just enables us to cope." However in his references there is no Rorty (1982). von Glasersfeld (1992, 384) repeats: "truths are replaced by viable models." Critical scientific realist constructivists do not believe in miracles: modern science enables us to cope, because its theories truthfully enough correspond reality. Bruner (e.g. 1991) refers to his version of contructivism as the narrative construction of reality. He makes no difference between reality and stories of reality. He stresses importance of culture and cultural tools, importance of which nobody denies.

The biopsychological aspect of human activity means that the human central nervous system is always involved. The social aspect of human activity means that all human activity happens in some social and cultural context. In educational research the main proponents of social constructionism are Guba and Lincoln (e.g. 1989). Social constructionism is unscientific in the sense that its proponens say that there is no common world (e.g. Guba and Lincoln 1989, 64). One of the main underpinnings of modern science is that there is one common world and different tentative conceptions of it. It is misleading to call different conceptions of the common world as different worlds, different realities. Hoyningen-Huene (1993, 31 - 63) scrutinizes Thomas Kuhn's texts and shows that Kuhn has used the concept of WORLD in two different senses: 1) the real world, the world as the object of science, the world-in-itself, and 2) the phenomenal worlds, perceived worlds, lived worlds. Futhermore from viewpoint of the critical scientific realistic constructivism, it is clear that Kuhn does not make a proper distinctions between the world and the nature. In the real world there are two part-worlds: the original nature (physis) and the inorganic and organic nature which man has transformed and made cultural artefacts out of them (artephysis) (Bunge 1979; Ahlberg 1989b).

By continuous conceptual and empirical testing we may get tentative conceptions from our best guesses about what kind our only and common world probably is. It may well be that all human beings can ever have is partial truths, but truths anyhow. Some theories and mental models can be shown to be more truthful than others. Critical scientific realist philosopher Mario Bunge (1983b, 261) says it clearly: " Of course we construct all our concepts and propositions: these are not found ready made in nature; but we construct models of the world not the world itself." So concept maps show individual's or collective conceptual models of the world or more often of part of the world.

Novak ((1983, 103) attacks empirism and **true** knowledge and ultimate truths. Later on Novak (1990b, 31) attacks "positivistic (truth-falsity proving) epistemologies". I think that there is an important difference between reality testing (truthfulness and efficiency testing) and truth-falsity proving. I agree that in science we do not try to prove anything finally. And I agree that in science we do not expect to find out any ultimate truths. At least we can never be sure that now we have the ultimate truth in some issue. In science we just try to invent possible improved models and explanations of the world and to evaluate (by constant checking and testing) how truthful they seem to be. In technology and in different services, as in education (helping others to learn what can be rationally justified to be the most worthwhile to learn in those circumstances), it is efficiency that we are most interested in. But pragmatic efficiency is based on truthfulness. The more truthful models of the world we have, the more efficient can our practical activities be.

As Paivio (1986, 57 - 67) presents in the human internal representation system there are both concepts (and verbal labels for them) and related images (visual, auditorial, haptic, taste and smell memories). In every proposition there are at least two concepts connected. A proposition is a claim about the world. A proposition can be true or untrue, probable or improbable, plausible or unplausible etc. For sure pictures alone may be external representations of some concepts, but they need verbal labels to be explicit.

Novak (1983, 104 and 1990a, 937 - 942) presents a history of the Cornell style of concept mapping. He starts his history from 1971. During 1974 - 1978 an evaluation strategy was developed which was called concept mapping. An important year is also 1977, when Novak's theory of education was published. In Novak (1977, 91 - 92) diagrams have links without labels and they are called conceptual hierarchies. In Novak (1979, 470) the only concept map is without named links. Even in Novak & Gowin (1984, 21) there is one concept map with almost no named links.

Clarke (1990) has written a book about different graphic knowledge presentation techniques. He suggests that different techniques might have different uses, different strengths and weaknesses. In a later article (Clarke 1991) he continues this discussion. I realized this also in 1990 and I tried to organize an international researcher network for those who are interested to make research and develop these tools. Now I think it would be best if an international research group, or Special Interest Group (SIG) is organized in the American Educational

Research Association (AERA) and in the European Association for learning and Instruction (EARLI).

4. Scrutinizing variations of concept maps in order to better use them flexibly and creatively to make better conceptual maps of world or of part of it for survival of mankind and for better quality of human life

Hierarchy or web or both?

Novak (1990, 30) and Novak and Gowin (1984, 14) suggest that concept maps should be hierarchical and they ought to be read from top to bottom. Earlier Symington and Novak (1982, 14 - 15) present a series of four concept maps which are horizontal, not vertical. They are as clear as vertical hierarchies. Bousquet (1982) compared effects of three different ways to make concept maps. He called them 1) Hierarchical-Propositional Concept Mapping, 2) Hierarchical Concept Mapping and 3) Propositional Concept Mapping. Bousquet (1982, 68) presents a comparison table of these concept mapping procedures. In all of them concepts are identified, related concepts are grouped and related concepts are linked by lines. Propositional concept mapping procedure differs from the two other procedures having no explicit intention to make general-to-specific organization. Bousquet's hierarchical concept mapping differs from two other concept mapping procedures by having no named links, only lines between concepts. Bousquet found no statistically significant differences in achievement between groups who used these three different procedures. There were however, observations of more favorable attitudes from the hierarchical-prepositional concept maps. By looking at Bousquet's (1982, 211, 214, 223, 226, 235 and 238) instructions, and what different groups used, it is understandable. The initial examples for hierarchical-propositional concept mappers are evidently the clearest.

Novak and Gowin (1984) suggest that hierarchical concept maps ought to be read mainly from top to bottom. Those links which are read from top to bottom can be without arrowheads. However in Novak and Gowin (1984, 176) there is an example in which it is clearly seen how an arrowhead would make a concept map clearer. Many authors have come to the conclusion that concept maps are clearer with arrowheads (directed lines) than without arrowheads (e.g. Nussbaum 1983, Ahlberg 1989a - 1993b, McAdams 1992). Also Tamir (1991, 333) presents a concept map which he says is from Novak and Gowin (1984, 122). In Tamir's concept map there are arrowheads but not in the original book! Some of Novak's students have also started to use arrows as links: Ben-Amar Baranga (1990), Griffiths (1991) and Abrams (1993). Brody is one of the best of Novak's former students. In his dissertation (Brody 1985) he used lines as links. Still in articles (Brody, Chipman and Marion1989 and Brody and Koch 1990), he used lines as links and concept maps were hierarchical. However Brody (1991) uses arrows as links and the concept map is clearly a web! In some published textbooks of science, arrows are allway in links (Towle 1991, e.g. 1B, 3B, 5B). Some textbooks do make concept maps almost exactly as Novak and Gowin (1984) suggest (e.g. McLaren, Rotundo and 'Laine Gurley-Dilger 1991, TG17).

In hierarchical concept maps the most general concepts ought to be put on top and the most specific concepts to the bottom (Novak and Gowin 1984, 14).

However even in their example concept map where the instruction is given, the most general concept is not on top. If all that is in the world are included in EVENTS and OBJECTS, then these concepts ought to be on top. The same can be seen in "rubber maps" (Novak and Gowin 1984, 16 - 18). In none of those three maps is STATE(S) the top most concept. Although from my view of the scientific ontology, every real object is in some state or other. So STATE(S) is really the broadest of these concepts.

I think that because the top most concept is actually like a title of text, it could as well be a center of text. We can then think the top most concept as a top of a pyramid seen from above or a trunk of a tree seen from above. In my experience most econominical and powerful concept maps have been mostly hierarchical, but sometimes webs are best. I think that it is best to be liberal, tolerant, flexible and creative. To make a good concept map demands to remake it about seven times, sometimes more.

Links: lines or arrows or both and how?

In Novak and staff (1981, e.g. V-1 and V-2) we can see clearly that first the research group did not use arrows at all, only lines. In Novak and Gowin (1984) arrows are suggested to be used when a link is read either sideways or upwards. The same instruction can be read from the concept map of concept mapping in Novak (1990, 30). In Novak and Gowin (1984, 102) there is a concept map where all links are arrows; however, it is described as: " A good concept map..." I suggest that it is best to always show by arrows how your thinking was going on when you made the concept map. It is the simplest way to do it and in the same time most powerful way to present exactly what you are thinking about the issue.

There is still another detail in instructions on how to make concept maps which I think is not well founded. This is how to show examples in a concept map. Examples are a very important part in thinking. From the viewpoint of argumentation, they are evidence (grounds) for an implicit claim that there is really such a concept (set of instances). In Novak and Gowin (1984) and in Novak (1990) it is suggested that examples are marked differently than other concepts. Other concepts are in ovals but examples are not in ovals. This suggestion has no grounds and I think that there is no need for such a complicated usage. Earlier in Novak and staff (1981, e.g. V-2) examples are in boxes like other concepts. My suggestion is that all concepts ought to be in ovals or in boxes. For sure links almost always contain concepts, but they are concepts which are used only for connecting main concepts to each other. If some concept in a link becomes important, I have drawn a line round it and used it as another main concepts in a concept map.

In an otherwise excellent article Wandersee (1990, 933) presents in a concept map his conception of graphic conventions in concept mapping. He uses both ordinary lines and broken lines. Examples are ovalled by broken lines. In the article no reasons are given fort these representations. In the workshop on concept mapping August 5, 1993, Wandersee said that he found it useful that examples are marked differently than other concepts. He is interested in students own examples and when they are clearly marked he can analyze them quickly. Lines to the left are broken lined and they only have arrowheads. Horizontal lines to right (e.g. PENCIL LEAD which is a BAKED CERAMIC ROD) have no arrowheads . No reasons are given in the article. In his workshop Wandersee explained that horizontal connections may indicate new creative ideas of students and that is why they are marked differently.

I have made my own, and read hundreds of concept maps which other people have done. I think that in a good concept map as on a good geographical map the same "place" or concept is only shown once. (Wandersee 1990 has discussed in more detail this analogy.) In e.g. Cullen's (1990, 1068) concept map, which according to him is made on basis of Zoller's scheme 10, both IODIDE and BROMIDE appears two times on the same map. I think that Cullen's (1990, 1068) concept map would be clearer if IODIDE and BROMIDE appeared only once on the map. I have suggested in 1989 (Ahlberg 1989b, 285) that by counting the direct links to each concept we can estimate how essential or central each concept is in the concept map. The more links to and from a concept, the greater would the damage be if that particular concept would be cut away from the concept map (conceptual network, conceptual web). By this way counting we can estimate that in Cullen's concept map the following three concepts are of equal importance: NUCLEOPHILE, POLARIZABILITY, and IODIDE. They all have five links. The top-most concept in the map is LEWIS BASE. It is a kind of title to the whole conceptual hierarchy. It could be the most important concept in the whole concept map. In this case however the hint was not right, because in Zoller's (1990, 1063) original scheme 10 the most important concept seems to be NUCLEOPHILE. (This conclusion is based on the fact that Zoller (1990, 1063) says in the explaining text of his scheme 10: "Nucleophilic strength of anionic nucleophiles versus their usefulness as leaving groups.")

There are concept maps which are not called 'concept maps' and there are "concept maps" which are not concept maps in any accurate sense

In Great Britain Checkland (1981, e.g. 8) and Checkland and Sholes (1990, e.g. 3) have developed a similar graphic representation technique which they call conceptual models and soft systems methodology. However they very rarely name links between concepts. Often they use some kind of propositional maps.

Al-Kunifed and Wandersee (1990) have made a bibliography of one hundred references related to concept mapping. In their bibliography the definition of concept map is liberal. E.g., Boschhuizen (1988) is included although he does not name links at all. But the definition of concept map is however not so liberal that Matthews et al. (1984) would be included, although they use also concept and unnamed links. Boschhuizen (1988) uses hierarchy, and Matthews et al. (1984) do not use hierarchy.

Candy (1991, 323) suggests that "concept maps (by a variety of names) have proved useful". He does not mention Novak and Gowin (1984). He mentions only Buzan (1978) and Hampden-Turner (1982). In both sources there are conceptual diagrams in which there are no named links like in concept maps. In Hampden-Turner (1982) "maps" are mostly different kinds of pictures. In fact, Candy (1991) presented only a claim and two references which can be interpreted as warrants in argumentation. When we evaluate his warrants we come to the conclusion that he is not an expert in this area. In Candy's examples

concepts are in some way mapped onto two dimensional space, on paper, but the term 'concept map' has already a long history, which Candy should have known.
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5. Criteria of good concept maps: how to teach concept mapping quickly and efficiently

Novak and Gowin (1984) present some hints as to how to teach concept mapping from first grade to adults. I started to make concept maps after having read Novak and Gowin (1984). From the beginning for me concept mapping was a very natural way to structure my ideas. I tried to teach it to my university students and I soon found that instructions have to be as simple as possible. So I started to use arrows as links and always to place in an oval a concept which I wanted to highlight in a concept map. I first translated to Finnish Novak and Gowin's (1984, 24 - 34) detailed instructions. And we tried to act according to instructions flexibly and meaningfully. We got concept maps from children in grades 2 to 7 (ages 8 to 14) years. But often children left links unnamed and then concept maps are not so revealing and powerful. During years 1984 - 1988 it was only from 6th grade (or 13 year old pupils) upwards that we got good concept maps, in which all links were named. If the links are unnamed then you must as a teacher and as a researcher guess too much about what children really think and how their learning is proceeding. At that time I was a lecturer in the Department of Teacher Education at University of Helsinki.

But then in 1989 I got a job as an acting professor and then as a tenured professor at University of Joensuu, Savonlinna Department of Teacher Education. There I met brilliant and flexible students who were eager to develop and adapt instructions with me to be suitable for Finnish pupils. We first got good concept maps where all links were almost always flexibly named, that is using a wide variety of accurate words, from 4th grade (11 years old) pupils. (Kolari and Malmivuo 1990). In 1991 one of my university students (Kammonen 1991) got very good concept maps in the Spring term from 1st grade students (about eight years old). All links were almost always flexibly named.

Kammonen and I planned new startegies to teach children concept mapping. It took about fifteen minutes for children to learn concept mapping in this way and they made good concept maps from the beginning. The children kept the habit to name all links also in later lessons. In Helsinki a doctoral student of mine, who at the same time taught 1st grade pupils (about 8 year old) concept mapping according to original Novak and Gowin (1984) instruction, required weeks to introduce children to concepts and concept mapping and she did not get results as good we got in Savonlinna. Later on I tried the method used with Kammonen to introduce concept mapping to my new university students and it has always worked very well.

Our annotated suggestions to instruct how to make good concept maps are as follows:

1. Show to your students a good example of a simple and interesting concept map. We have almost always used a modified version of the concept map from Novak and Gowin (1984, 176). It is presented in Figure 2. We have modified it so that our links are always arrows which show how thinking is

proceeding. We have also from the beginning wanted to show how each concept appears only once in a good concept map and so we have drawn an extra link from PETALS to RED. So RED has two links: one from LEAVES and one from PETALS. This map is amusing and suitable for both children and adults. Many pleasant associations come to mind while reading it. We show our map by overhead projector to the class and we ask a student to read a proposition (a claim) from it. Then another student reads another proposition from it and so on. We stop when all possible claims are read. In this way we show to students that it is as easy to read a good concept map as it is read ordinary text. But by concept mapping we can see how central each concept is in text. The higher in a concept map a concept is the more important it probably is. And the more links to each concept, the more important a concept probably is.

2. Then we have presented a list of four concepts to first graders (7 - 8 year old) and a list of six concepts to adult university students. Our shorter list have been: BIRCH, BIRD, CATERPILLAR, and TREE. (Longer list for university students has included also concepts of SPRUCE and CROW.) We present our concepts in alphabetical order so that we do not give any unnecessary hints as to what kind of a concept map we are expecting for. Then we ask a student to take a concept from the list. Then another student is asked to pick a concept from the list. Then we ask how these concepts are related. And we say that concepts are like islands and you can go from one island to another only by linking them by an arrow and then naming the bridge. This analogical model works well with both children and adults. Then we ask a fourth student to pick third concept. The fifth student is asked to say to which concept it is linked. The sixth student says how these two concepts are linked so that when we start our reading from the source concept, we read the link and we extend to some concept in a way that it makes an intelligent claim about the world. This is the way we have proceeded. When all necessary connections between concepts have been made we stop and ask students themselves to make a new concept map from a given subject under study. Only one concept, the theme of study is given to pupils. Then each pupil makes her/his own concept map and is free to get help if needed from the teacher or from other students. All pupils have been able to do their first map. And they really own it because they have themselves done it. Later on they together or alone can make many kinds of concept maps both cooperatively and alone.

3. Almost always it is good to remind your students that if links are not named you cannot go from one concept to another, from one island to another. The bridge between concepts is ready only when it is named.

4. The above method should work for you as well as it has worked for us. From time to time we remind our students that nobody else can do learning for them. They themselves must do it. And a teacher can only help them if the teacher knows as accurately as possible what they think and how their learning is proceeding.

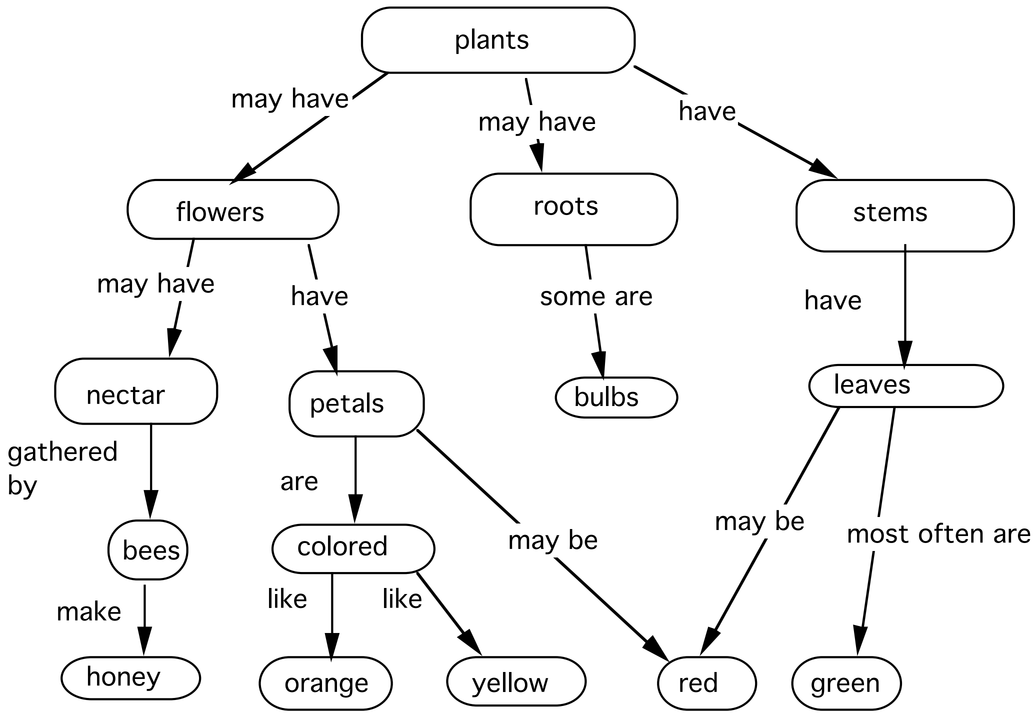

FIGURE 2. This kind of concept map has used successfully to teach both children and adults how to make good, creative concept maps. The theme of the map is amusing to both children and adults. Link labels are varied. There are promts to be as accurate as possible in use of link labels. All propositions make sense. Every concept is only once on the map. There are possibilities to improve the map, e.g. by adding arrows from colored to red and to green. The map is modified from Novak and Gowin (1984, 176).
Figure 2. Teaching people how to make creative concept maps.

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6. What is a misconception and what is not? Different aspects of conceptions about the one and only common world and some validity, reliability and value questions

When people don't see a difference between different graphic knowledge representation tools I think that it is fair to say that they have misconceptions of these tools. An expert in this area knows differences between different tools and she or he can use them appropriately.

Novak and Gowin (1984) think that an essential aspect of a concept map is that it is hierarchical. However e.g. Ahlberg (1990b), Brody (1991, 28), Nussbaum (1983, 280) and White and Gunstone (1992, 41) have come to the conclusion that a concept map can be also like a web. Then we can think of the most central concept (the concept which has the most links to other concepts) is kind of top of a pyramid seen from above. The most abstract or inclusive concept can also be in the center of a concept web. The best representation for knowledge may be a multidimensional network. This is the conclusion to which I have come when I have tried to make concept maps of some complex issues. It was often difficult to draw a concept map onto the two-dimensional space of paper. But if we limit the number of concepts from 10 to 30 it is often easy to make a concept map on an ordinary sheet of paper.

I take two examples of 11- to 12- year-old pupil's concept maps in which there is at least one misconception. Kolari and Malmivuo (1990) present two concept maps. The first is done by a good pupil and the second is done by a less able pupil. Both have read the same textbook. In textbooks it is said that bacteria and viruses cause some diseases like influenza. According to the textbook, viruses and bacteria differ in that there is medicine (antibiotic) against bacteria, but none against viruses. The good pupil draws a concept map in which this is clearly depicted. But the less able pupil claims that bacteria and viruses are the same and so implicitly suggests that there is a medicine against viruses.

Nowadays we know that we have medicines for some viruses (e.g. interferons) (Towle 1991, 676). It may well be when the Finnish textbook was written no medicine was known against viruses. But our example shows that when science develops, the "external validity" of concept maps may change. So it may sometimes happen that what once was a misconception can later become a valid conception and what was a valid conception may sometimes become a misconception.

Ahlberg (1989b, 281 and 1990, 54 and 1991, 127 - 128) has explored issues of validity of concept maps. There are at least three different phases of validity evaluation in the use of concept maps: 1) How accurately does a concept map correspond to what a pupil really thinks about the issue 2) How accurately does a concept map correspond to what really is said in the textbook and 3) How accurately does a concept map correspond to the situation according to modern science. These phases of validity estimation are at level of describing and testing conceptual structures. It corresponds to "test validity" evaluation in quantitative research. The decision to use concept maps is connected to a decision of research design or general methodological approach. The validity of this step ought to be pondered (Ahlberg 1992, 78). It corresponds "validity of research design" in quantitative research.

Think for instance if we want to do research on how meaningfully our students learn. Then if we would use only concept maps, we may get only one aspect of meaningful learning. There are other verbal and nonverbal messages and associated meanings included and the whole social context. Posner (1983, 56) has presented a similar view. Also reliability issues or their qualitative counterparts ought to be pondered (Ahlberg 1991b, 128 - 131 and Hoz 1983). Guba and Lincoln (1982) have presented an interesting comparison of four basic aspects of validity and reliability issues in quantitative and qualitative evaluation. For instance internal validity of quantitative research design would correspond credibility in qualitative research. Reliability of quantitative research would correspond "auditability" in qualitative research etc. Guba and Lincoln (1985 and 1989) use a little bit diffrent terminology. Erlandson & al. (1993) use concepts like quality criteria and trustworthiness and recommend e.g. triangulation and thick description.

There is also a curricular question as to why 11- to 12-year old pupils ought to know about viruses. Could the issue be left to upper classes when electron microscope pictures (photos and drawings) could be looked at? This is the basic question of what is worthwhile learning, that is learning which can be rationally justified to be the most valuable in a given social context.

7. Vee-diagrams: a suggestion is to say clearly why we are doing the inquiry, what we are planning to do, and to express clearly the value basis of our acting

Novak and Gowin (1984, 56) present "Gowin's knowledge Vee". Gowin invented the Vee diagram in 1977 (Novak & Gowin 1984, 5). First Gowin (1981, e.g. 107) called it "a **V**". In Novak and staff (1981) it is called ""Gowin's "V" mapping". In Ault, Novak and Gowin (1984) it is called " a Vee map". In Gowin (1987, 235) it is called " a Vee Heuristic". Gowin (1991, 54) calls it among other names a " Vee diagram" and I think this is a good international name for it. Gowin (1981, 107, 127 and 157) has a Vee diagram for curriculum, learning and governance, but not for teaching. I have used Vee diagrams also when I have planned my teaching.

I think that whatever a person does, she/he often constructs options from which to choose. Some people are able to construct or to see more options and some less. In choices people make we can see their values in practice. Also, according to Novak (1992, 12): "The mere decision to enter a certain field is already a value decision". We trust deeds more than words. Some people think that one cannot infer from knowledge of the world what is valuable and what is not valuable. This is an old doctrine of David Hume (1739), but this does not make it true. I think that on the basis of what we know about human life, its preconditions and human needs, we can infer what is valuable for us in the long run. For sure it is always tentative. It is not valid in the strict sense of the formal logic (e.g. Strike and Soltis 1992, 7 - 8), but I think it is a valid argument in the ordinary language sense of 'valid' (Ennis 1969, 8). My world view-in-use is such a version of scientific humanism which takes both science and other best achievements of humankind seriously and tries to foster life and its preconditions for a good quality of human life.

From my two year experience trying to teach Vee diagrams to University students, I have found that the part of Vee diagram called 'the world view' is difficult for many university students. I have taught them what I understood to be the best description of the world view in Vee diagrams (e.g. Novak 1990, 34): "The general belief system motivating and guiding the inquiry". Also Novak (1993, 188) has come to similar conclusion: world view questions are difficult for students. Novak (1989, 14) presents a clear and interesting example of what a world view can be: "the world view that most of the ills in the world can only be solved through better education and empowering people to take charge of their own meaning making is ultimately the fundamental challenge of modern civilization". I accept the basic ideas and values of this statement, but it is not a world view in the sense of the scientific humanism or the Judeo-Christian World view, the theology of Christianity, the ideology of Marxism etc. (Kekes 1980, 59 and Moore 1993, 59 - 76). Adapting Kekes (1980, 3) we say that a world view combines our conceptual model of the nature of reality and our system of values which give meaning and purpose to life. In a workshop which Bob Gowin gave in the Misconception Conference (August 3, 1993) he answered to a question about the meaning of world views that for him, world view means issues like optimism, or pessimism and similar things. He said he is not so interested in exact definitions.

In Novak and staff (1981, VI-1) the Vee diagram is introduced in a form in which there is no focus question. On the conceptual side are: 1) World view, 2) Philosophy, 3) Theory, 4) Telling questions, 5) Conceptual system, and 6) Concepts. Beneath the sharp end of Vee there are written in this order: "events/objects". On the methodological side there are: 1) Records, 2) Transformations, 3) Generalizations, 4) Value claims and 5) Knowledge claims. Later on Novak and staff thought that it is best for seventh year pupils is to present the Vee diagram in such a mode that on the conceptual or thinking side there are: 1) Theory, 2) Principles and 3) Concepts. Now in the middle of the Vee 'Focus Question' has been invented. Beneath the sharp end of the Vee there are again: "events/objects". On the methodological or doing side there are only: 1) Records, 2) Transformations, and 3) Knowledge Claims. In this rudimental form of the Vee diagram, no value questions were explicit.

In Novak and Gowin (1984, 56) the Vee diagram is presented in an expanded version. Focus questions are there in the middle of the Vee. On the conceptual side there are eight categories: 1) World views (in plural!), 2) Philosophies (in plural!), 3) Theories (which are also in plural but it is more usual), 4) Principles, 5) Constructs, 6) Conceptual Structures, 7) Statements of Regularities or Concept Definitions and 8) Concepts. On methodological side there are seven categories: 1) Records of Events or Objects, 2) Facts (which is defined as follows "The judgment, based on trust in method, that records of events or objects are valid", 3) Transformation, 4) Results, 5) Interpretations, Explanations & Generalizations, 6) Knowledge Claims and 7) Value Claims.

I started to work seriously with Vee diagrams after I got from Novak his manuscript for A Theory of Education, second edition (1990c) and I heard him explaining it. I understood that it might be a very useful tool. It is worth trying and testing in practice. I have made Vee diagrams for my own purposes and I have written an article in which they are used together with concept maps and rhetorical argumentation analysis and presented as some of the main tools for teachers who want to do research on and develop their own work (Ahlberg 1993b).

In Novak (1990c) on the conceptual/theoretical/thinking side there are five categories: 1) World View (in singular, as is customary), 2) Philosophy (in singular, as is customary), 3) Theory, 4) Principles and 5) Concepts. On the methodological/doing side there are four categories: 1) Records, 2) Transformations, 3) Knowledge Claims and 4) Value Claims. This is the version I first tried both myself and together with my university students. The world view is here defined very clearly: "The general belief system motivating and guiding the inquiry". My world view after years of thinking is scientific humanism, a version of scientific world views. Implicit in my world view is the belief that most important value is life, because without it we would not have any other values or activities.

For my students it was very difficult to express what is their world view or what is "the general belief system guiding their inquiry". However it was easier for them to say why it is important (valuable) to make research on the chosen subject. And I think that it is enough if we ask our students to show for themselves and their teachers what is the value basis of the activity they have chosen, how it can be rationally justified as a valuable use of time and resources. Also Principles (Statements of relationships between concepts that explain how events or objects can be expected to appear or behave) was very difficult. I think that it is enough if university students can name one or more theories and concepts. Principles are then handled in the text. On the methodological/doing side the difference between knowledge and value claims was hard for them. This difference is, however, very essential. We may in principle have very similar knowledge claims, but because of differences in broader and deeper knowledge and perhaps also in values, we may infer different value claims. It is very important to think about what, if anything, follows from knowledge claims to the worth or value of inquiry.

On the basis of the above discussion I suggest that for all levels of education, a value basis which explains why you are starting some kind of activity (learning, helping others learn, making research on something etc.), would be useful to express clearly for the common benefit of researcher and other people who are in one way or other involved. Life is short and it is not meaningful to spend it in futile activities which you yourself cannot rationally justify to be valuable in the long run.

My experience is that philosophical questions are difficult for ordinary pupils and university students. Philosophy is defined in Novak (1990c, Chapter 3.4) very narrowly: "The beliefs of the nature of knowledge and knowing guiding the inquiry". This is the part of philosophy which is technically known a epistemology. Other important parts of basic philosophy are semantics, ontology (or what is in the world), axiology (questions of value and ethics). I think semantical and ontological questions might be handled in Theories. Value questions are handled in the first question concerning value basis of the project. Epistemological and methodological questions are best handled when we plan what kind of records we will need and make and how we will transform them.

In conclusion, I suggest that an international research project ought to be organized to make coherent research on Vee diagramming. I think that it is best to be as liberal as possible and let participants themselves decide what they think is valuable and useful information for their students, for them as teachers and for general research purposes. Smith (1989 and 1992) has used Vee diagrams creatively in teaching basic nursing skills. She names the left side 'theory'. My choice would be 'planning'. She names the right side of the Vee 'practice'. In my context it is 'writing and evaluating'. She has nine elements in the Vee, In 'philosophy' she mentions values. I have stressed values already in the title: 'value basis'. My choice of basic elements of Vee diagram are shown in Figure 3. There are the epistemological elements that I regard as essential for understanding how humans make sense out of their world.

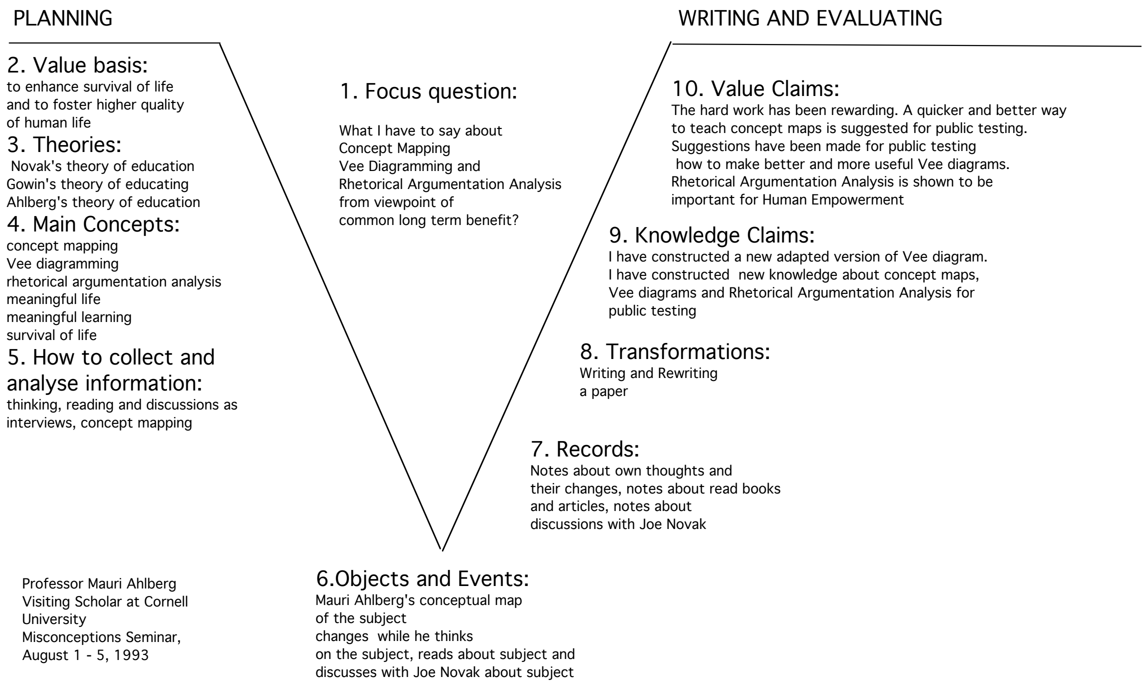

FIGURE 3. An example of and a suggestion what kind of Vee diagram is useful in teacher education and in writing reports and theses

Figure 3. An example of a Vee Diagram.

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8. Rhetorical argumentation analysis (RAA) as a new metacognitive tool which is theory-based and compatible to concept maps and Vee diagrams

Rational argumentation is the basis of both science and democracy. That is why we as educators and researchers on education ought to be interested in what kind of argumentation is in textbooks and in discourse, e. g. in science and mathematics classes. In many countries there are only claims in large parts of textbooks., no grounds, no justifications, no warrants, no backings, no rebuttals, no qualifiers.

Novak (1977 and 1986, 47) borrows Toulmin's (1972, X) famous words: "A man demonstrates his rationality, not by a commitment to fixed ideas, stereotyped procedures, or immutable concepts, but <u>by a manner by which, and the occasions on which, he changes those ideas, procedures and concepts</u>." I have underlined the parts of text where it is clearly said that not any change of ideas which happens to be popular or in fashion shows rationality. There must be critical judgments of evidence, rational justifications before a rational person changes her/his ideas.

In concept maps and in Vee diagrams there are mostly claims about the world. It is a very rare occasion indeed when grounds (evidence) or justifications are presented. This may be one reason why an expert thinks that "linkages here, the verbs, whatever, don't have a lot of capability to make conditional statements and giving enough information on the linkages" (Griffiths 1991, 24). The same opinion was expressed many times in the session of the Misconception Seminar (August 4, 1993) where issues of biology teaching were discussed. Those people have probably taught and used concept maps unimaginatively. If concepts maps are made flexibly and creatively, conditional statements and long links can also be used (Figures 1 and 5). Some participants in the session of the Misconceptions Seminar (August 4, 1993) where issues of biology teaching were discussed said that according to their experience with concept maps, you cannot always be sure whether a pupil understands the issue or not. It is a common recognition that by using different methods you get different data. My research group has used concept mapping mainly together with other well-thought-educational-theory-based methods. Our ideal has been all the time some kind of educational theory based multi-method approach, on methodological triangulation.

We have analyzed also textbooks using concept maps. An elementary school textbook was the first textbook for which I tried argumentation analysis (Ahlberg 1990c).

To learn deeply and meaningfully we need to construct rational reasoning. This demands use of constructive critical thinking, finding theoretical and empirical grounds, constructing claims, rational justifications for inferences and claims, discovering if there are any known rebuttals, constructing and testing new rebuttals, explicating probability qualifiers if they are needed etc. (Ahlberg 1992, 58, 171 -173; Entwistle and Ramsden 1983, 23).

In my first attempts (1988 - 89) I used Toulmin's (1958) argumentation analysis in a modified version. This is because I knew that some of Toulmin's original categories and examples were not clear enough. Other scholars have come to similar conclusions (Ahlberg 1991b, 121 - 124; Govier 1987, 16 - 18; van Eemeren and al. 1987, 199 - 207; Weinstein 1990). I also used in my development work the books of Toulmin, Rieke and Janik (1984) and Bromley (1986). Also, articles of Voss (1983 - 1991) and Weinstein(1990) and a book written by Kuhn (1991) were helpful. However little by little our research group became more experienced and now we have a system sufficiently different from Toulmin's original argumentation analysis that I decided to name it Rhetorical Argumentation Analysis (RAA) (Ahlberg 1993a, 1993b). I named it **rhetorical** because I found in Aristotle's Rhetoric many of the same ways of influencing people we are still using to day: rhetorical questions, proper questions, emotional expressions and instructions to do something.

My research group's last version of Rhetorical Argumentation Analysis (RAA) categories is as follows (Table 2 and Figure 3):

CATEGORY DESCRIPTION	LOGICAL FUNCTION
C = claim	states claim or conclusion
G = grounds	offers grounds or evidence for the claim

W = warrant	warrants or justifies either a claim (C) or the connection between a ground (G) and a claim (C) by appealing to a model, a picture, an article, a book. an analogy, a diagram, a document etc. Something that you can in principle touch. Something that you can in principle check yourself. Warrant (W) is more concrete or exact than backing (B).
B = backing	backs up, justifies or otherwise supports either a claim (C) directly or inference of the sort IF G THEN C. Most often backing was originally supposed to back up warrant (W). But we have found it useful to connect backing directly to a claim, if we have interpreted reasoning in that way. Backing may be a theory, a value, a common practice, a common knowledge etc.
Q = qualifier	qualifies a claim (C) by expressing degrees of confidence, probability and likelihood
R = rebuttal	rebuts a claim by stating the conditions under which it does not hold; or introduces reservation showing the limits within which the claim (C) is valid

Rhetorical categories are:

rq= rhetorical question	This is a question where no answer is expected. (Sometimes a rhetorical question is functionally a claim. This can be marked rq/C.
pq = proper question	An answer is expected when the question is put.
i = instruction, orders, commands	e.g. "Answer following questions..."
h = clearly expressed hope	e.g. "Let us hope that human life survives on Earth"
e = emotional expression	e. g. "Good heavens!"
a = analogy m = metaphor	in both analogy and metaphor some item is compared to something else and similarity is claimed to be in some respects. The category of analogy is used if it is clearly expressed that an analogy is used. Otherwise the category of metaphor is used.

Table 2. Basic categories of Rhetorical Argumentation Analysis (RAA). The original system presented in Ahlberg (1993a) is broader and is being continuously improved because it is used in research and developed in practice.

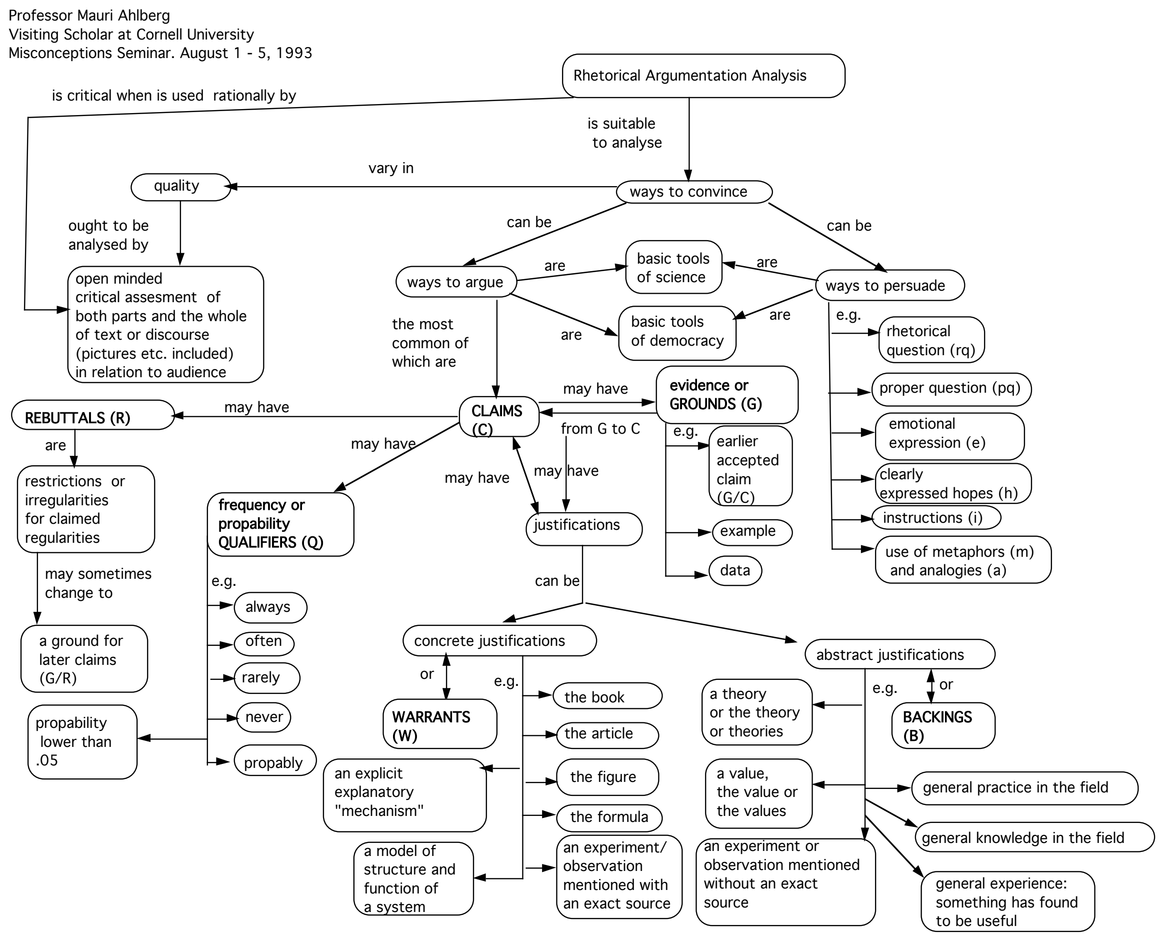

FIGURE 4. Basic elements and connections of Rhetorical Argumentation analysis as presented in this paper and in Ahlberg (1993a and 1993b).

Figure 4. Basic elements and connections of Rhetorical Argumentation Analysis.

When we have analyzed texts and videotapes by RAA we have found that sometimes there is argumentation at both the micro level and macro level. A longer part of a text can function as a macro ground (MG) for some micro claim (C). The first one was found by Nevalainen (1990). We have found examples of following macro level categories: macro ground (MG), macro warrant (MW) and macro backing (MG). However in each of these macro elements there was a different microstucture of itself. The Finnish examples are from history and social studies textbooks.

Some words of warning: Often, but not always, warrants and justifications show good reasoning. There is a difference between form and content. Sometimes we have seen formally good reasoning in the sense that there are grounds and justifications for claims but the quality of the grounds and justifications has not been good. So we conclude that it is not possible "mechanically" to analyze the quality of reasoning and persuasion. We are always in situation where we must from all we know about the world to infer, interpret and evaluate how good reasoning and persuasion are.

9. Conclusions

On basis of above results my suggestion is that those who are making concept maps and Vee diagrams are at times interviewed in order to find out what kind of reasoning process is underneath their claims in concept maps and Vee diagrams. Those interviews might well be analyzed by RAA. In Ahlberg (1992, 1993a and 1993b) there are more detailed instructions how to do it.

If we believe that the scientific way of thinking and acting is the only known self-correcting way to construct knowledge, then also educating ought to be created by a scientific way of constructing and testing educational models, "creating education through research" (Bassey 1992 has presented some interesting ideas about this, but see also Duckworth 1987, 134 - 140). Then teachers and students would become researchers and developers of their own learning and thinking about the world, and because they themselves are a part of this world, they can make research on themselves and their relation to other systems of the world. This differs clearly from phenomenography, which makes research only of conceptions and only of those conceptions which are "of the world around us" (e.g. Marton 1981) .

In their efforts to learn more meaningfully and to understand more deeply the world, teachers and pupils would probably benefit if they try to test in their practice, what I regard as some of the most promising theories in the field: the theory of educating (Gowin 1981), and the theory of education (Novak 1977, 1992). I think that it is good for all of us to try to construct and test our own theory of education and/or educating. We all have some kind of theory-in-use in practice while educating. If we try to make it explicit, for instance by concept mapping, it is easier to test and improve.

In this paper I have described our efforts to construct and develop and test a part of my own theory of education and educating (Figures 1 - 6). I stress importance and interdependence of democracy, enlightenment and wisdom, e.g. Stenberg (ed.) (1990), love and caring (e.g. Noddings 1984; Shaver, Hazan and Brandshaw 1988, 88; Stenberg & Barnes (ed.) 1988), creativity (e.g. Miller 1987), excellent quality management and healthy economy. I think that Bunge (1980, 208) is right when he asserts that "The good society is based on sharing of economic, political and cultural tasks and goods. Replace participation with greed or exclusiveness, and you get the corresponding social consequencies: poverty, oppression and ignorance - the hallmarks of evil society." There are clear examples from the former Soviet Union and from the Third World, e.g. South America. In my theory making I have used best sources what I and my research group have found in English, Finnish, Swedish and German. There are language barriers in the world and we know practically nothing about work which has published only in French, Spanish, Italian, Greek, Dutsch, Russian, Japan, Chinese etc. But I do know that the only way to get your ideas spread and tested is in English and using the best American channels. The Third Seminar on Misconceptions in Science and Mathematics was this kind of channel. The Proceedings of the Seminar will have lasting value.

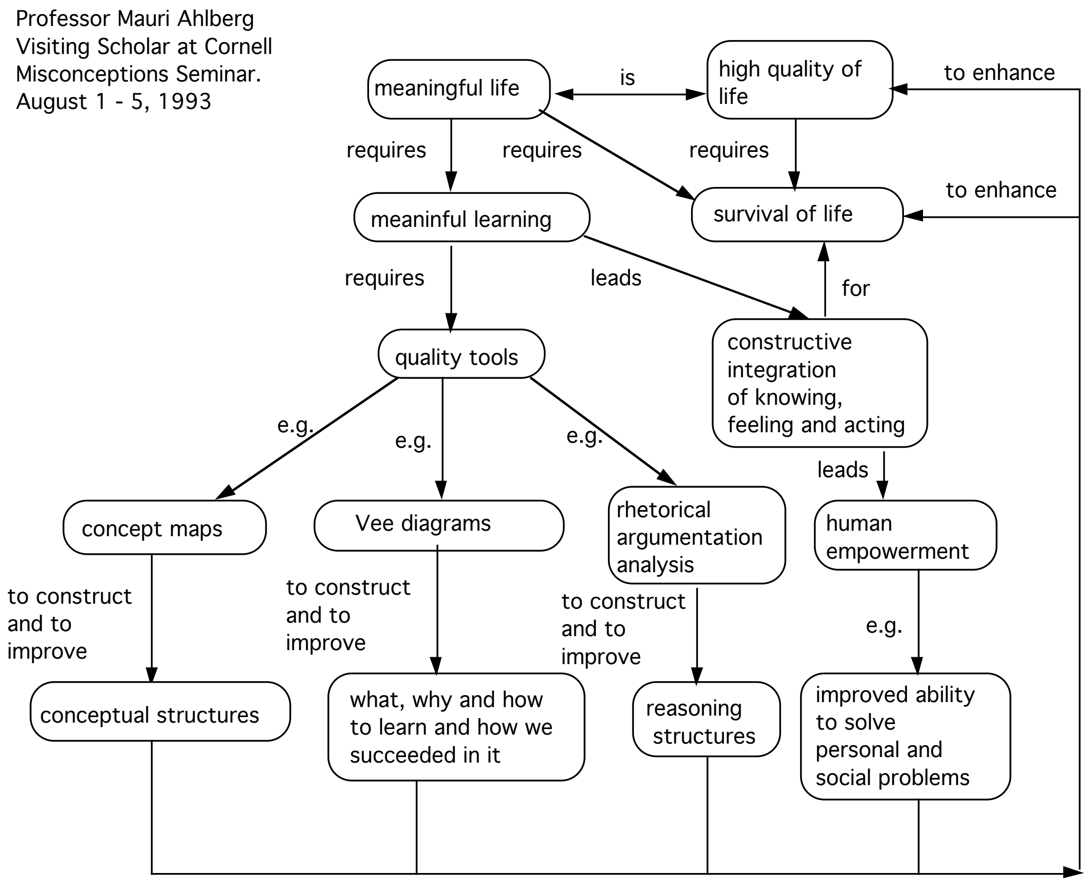

FIGURE 5. Basic tools to foster meaningful learning as presented in this paper with some essential links

Figures 5. Basic tools to foster meaningful learning.

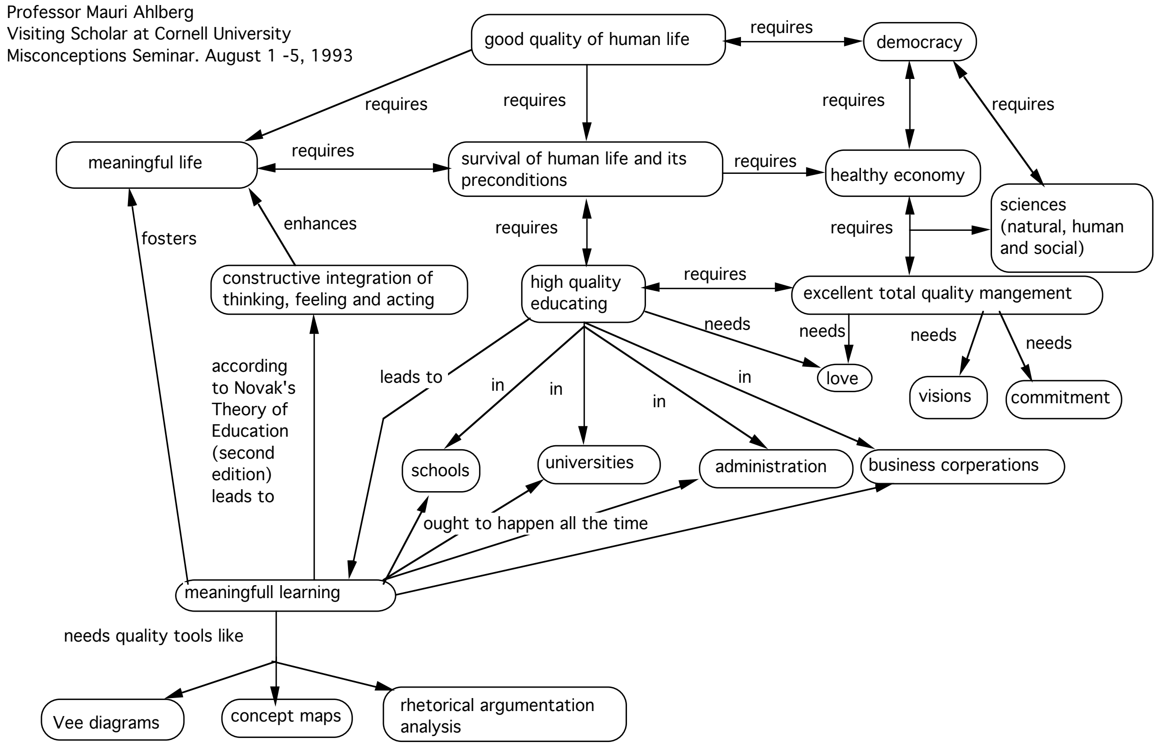

FIGURE 6. Some basic elements of Ahlberg's theory of quality educating
(Based partly on ideas of Gowin 1981 and Novak 1977 and 1992a)

Figure 6. Basic elements of Ahlberg's theory of quality educating.

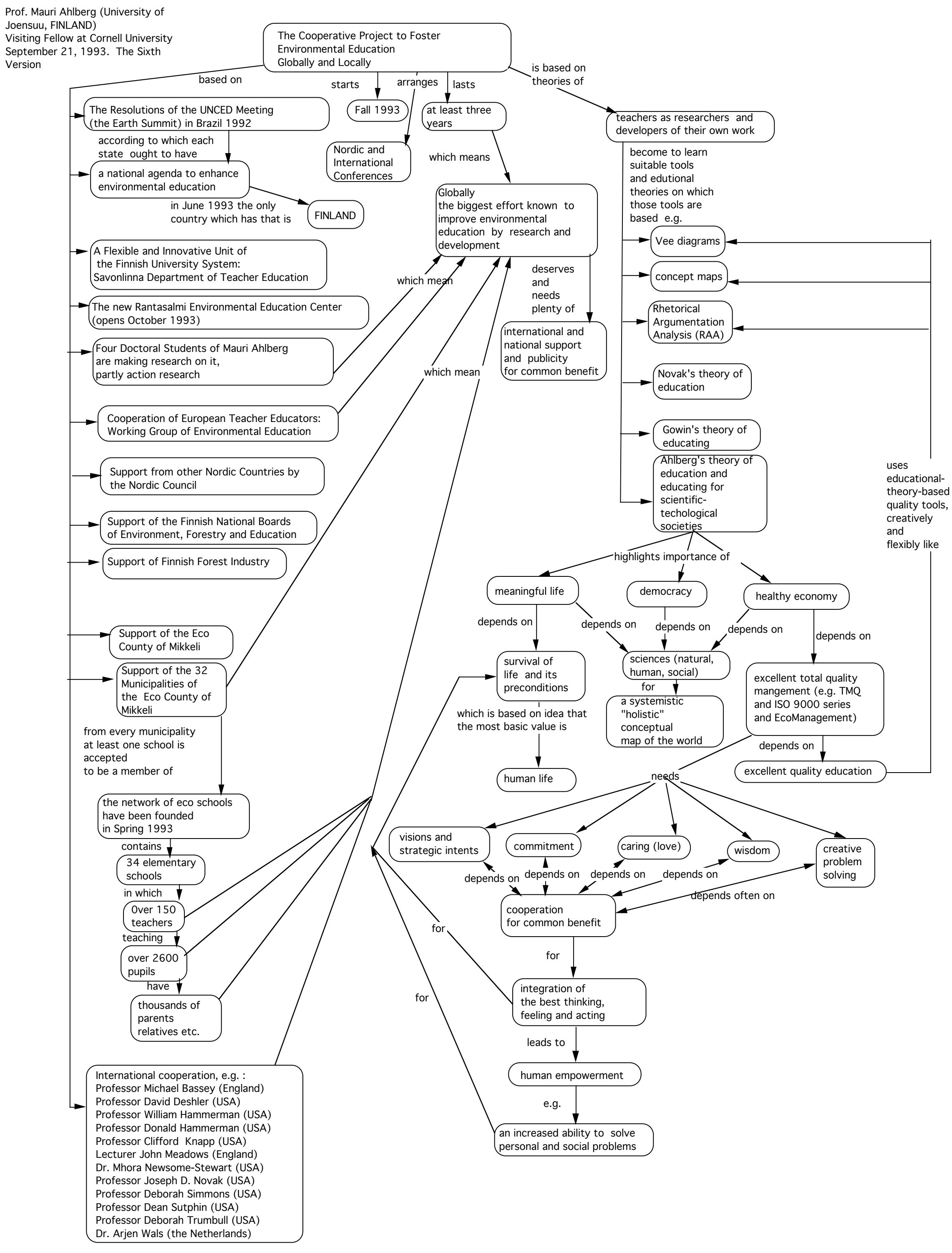

FIGURE 7. An example of a reseach and development project in which theories and tools presented in this paper are tested in practice

Figure 7. An example of a research and development project in which theories and tools presented in this paper are tested in practice.

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