CONCEPT MAPPING AS AN INNOVATION: DOCUMENTS, MEMORIES AND NOTES FROM FINLAND, SWEDEN, ESTONIA AND RUSSIA 1984 – 2008

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Abstract. Novakian type of concept mapping is studied as an innovation adapting Rogers' theory of communication and diffusion of innovations. The main data and conclusions are based on documents, memories and notes from Finland, but also from Sweden, Estonia and Russia 1984 – 2008. One of the main innovative uses of concept mapping in Finland has been its use and development as research method and quality tool. Concept mapping is compared to other graphic representation tools, in particular mind mapping and clustering. In the article the main features about history of concept mapping in Finland, Sweden, Estonia and Russia 1984 – 2008 is presented based on documents. Based on scattered evidence mind mapping is more spread and used than concept mapping in all these countries. In Finland concept mapping has stronger position than in Sweden, Estonia and Russia. More research is needed to reveal history and development of Novakian type of concept mapping both regionally and globally.

1 Introduction

Research on the diffusion of innovation is the study of how, why, and at what rate new ideas and technology spread through cultures. In this paper the innovation is Novakian type of concept mapping from 1980s. The history and spread of graphic knowledge representation tools in general are much longer and wider (Åhlberg 2007).

There is disagreement when proper concept maps were invented. Åhlberg (2004, 25) researched on this issue and came to conclusion:

> *"It is commonly known that concept mapping was developed at Cornell University. Stewart, Van Kirk, and Rowell (1979, p. 171) claim in The American Biology Teacher that they developed concept maps. However, in their concept maps the links were not named and no propositions were formed from concepts. In that same journal, Novak (1979, 1980) later published two articles in which he referred to Stewart, Van Kirk, and Rowell (1979). He also presented examples of concept maps, but the links were still unnamed. However, in Novak (1981, p. 14) the links were named, and meaningful propositions were created out of concepts. This is the form of Novakian concept maps that has been spread globally. In fact, Novak and Gowin (1984) were very influential in spreading it all over the world."*

I had seen the articles of concept mapping when they were published, but it was the book (Novak and Gowin 1984), which put me thinking: This is what my pre-service teacher education students really need. Too often they told me that they do not need studies of statistical methods or research methods in general. But the need for concept mapping ought to be self-evident. I soon realized that not all students were able to value this empowering tool. However, I myself was very convinced about its strong properties to express accurately everything that can be thought and expressed in verbal or written form. What was nice about concept mapping was that it revealed hidden core concepts, if you know how they can be counted from the number of links connecting concepts to other concepts. Concept mapping became to me a research method, as general as spoken or written language. For me it is an innovation to monitor and promote quality of learning and thinking. I have tried to spread this educational research innovation in all my teaching, research, seminars, conferences, that I have participated, and cities and countries where ever I have travelled since 1984. Next I discuss only three examples from North-Western Europe.

2 Concept mapping as research method

Åhlberg (1990b; 1993 and 2007) has published history and comparisons of main educational methods and techniques of knowledge representation. In theory of science, 'technique' is a narrower concept than 'method'. In 1980s, I regarded concept mapping as a technique for specific purposes, but later on I started to regard it as a very general method that can be applied for many different purposes. Mind maps developed and registered by Tony Buzan (1974; 2000) are often confused with concept maps, although these intellectual tools are very different. Åhlberg and Ahoranta (2002) and Åhlberg (2007) have compared these tools in detail. During 1989 – 2008 I have supervised tens of Master's theses (e.g. Malinen 1997; Mäkinen 1996) and many Doctoral Dissertations (e.g. Kankkunen 1999, Ahoranta 2004 and Salmio 2004) in which concept mapping has been used as a research method.

Primitive concept maps without link phrases are often misleadingly called concept maps. In Novak's research group in 1970s these kinds of primitive concept maps were used as documented in Novak and Gowin (1984). However from Novak (1981, p. 14) onwards all proper Novakian concept maps have used link phrases. Rico (1983 – 2008) has registered trademark for a technique called clustering which reminds of primitive concept maps: only concepts linked by lines, no linking phrases. Novak (1998) tried to register his original version of Novakian type of concept mapping (links mostly without arrowheads) but the application did not succeed.

Åhlberg (1990b and 1993a) presented in context of research on textbooks the idea of transforming a text proposition by proposition into concept maps. One of the main options in research use of concept mapping is transformation proposition by proposition from spoken and/or written text. This reveals hidden conceptual structures of text. E.g. key concepts can be objectively counted from number of links.

3 Finland

Since 1984 I have taught and developed concept mapping as a research method at University of Helsinki, first as lecturer, then as an adjunct professor (docent). During these years I published as far as I know the first concept maps in Finland (Åhlberg 1988 – 1989c). As Poom (1992, 58) reminds, Åhlberg (1987) had even before that distributed manuscripts in which there were concept maps in Finnish. During years 1989 – 2004 Åhlberg was Professor of Education at University of Savonlinna. In 1993 Åhlberg had a chance to visit Cornell University and Professor Joseph D. Novak. He learnt very much about concept maps and their history. Åhlberg developed a version of Novakian concept maps (improved concept maps), which uses always arrowheads with links to show in which direction concept map is to be read from concept to concept (Åhlberg 1987 – 2004). This type of Novakian concept mapping was used extensively later on in several doctoral dissertations, e.g. Kankkunen (1999), Ahoranta (2004) and Salmio (2004). Kankkunen (2001 and 2004) wrote also two papers based on the work I supervised using improved concept mapping.

In 1996 in Savonlinna Campus of University of Joensuu, a big international conference, Northern Call for Environment, was arranged. There Åhlberg taught concept mapping. One of the later on famous participants was Taina Kaivola, who used improved concept mapping in her doctoral dissertation (Kaivola 2000). Kaivola (2008) refers to history of concept mapping in Finland naming Åhlberg as an early adapter and active teacher of concept mapping. Åhlberg and Kaivola have used and promoted concept mapping as a research method (e.g. Åhlberg 1990a and 1990b; Åhlberg 1991a and 1991b; Kaivola & Åhlberg 2005; Åhlberg & Kaivola 2006a – 2006c). Little by little concept mapping spread among Finnish teachers and researchers. Nowadays concept mapping is well know in Finland and widely spread method of graphic representation of knowledge.

Physics teacher educators have developed a very special version of concept mapping from 1999 onwards (Väisänen & Kurkisuonio 1999, Niskanen 2007, Pehkonen 2007). Väisänen & Kurkisuonio (1999) refer to Åhlberg (1991). Åhlberg (1991) was published by Union of Mathematics, Chemistry and Physics Teachers of Finland. In that paper a Novakian concept map was used. Physics teacher educators use always arrowheads with links to show in which direction concept map is to be read from concept to concept like (Åhlberg 1987 – 2004). However the use on links in Väisänen & Kurkisuonio (1999), Niskanen (2007) and Pehkonen (2007) is very different from use of links in other fields of education and science. It is not ordinary language. It is not possible to read directly from one concept to another. They often use formulas as links. They admit that their use of concept maps is not Novakian. An explanation may be the following: Kurki-Suonio was a Professor of Physics who was interested in Physics Education. He used in Kurki-Suonio & Kurki-Suonio (1994, e.g. 159) graphic representations that used nouns as links between group of physical terms, that is an ordered association map. He seems never understood value of creating directly-read full propositions out of group of concepts. His main interest was in shared expert conceptual structure of Physics. They are often expressed as mathematical formulas.

On the other hand Lavonen (1996, 68 and 84) in his doctoral dissertation in Physics Education, uses concept map in the improved Novakian way that he had learnt in Åhlberg's courses during the end of 1980s. They both were members of a network for science education improvement called FINISTE (Finnish Innovations in the Science and Technology Education). Lavonen (1996) refers to Novak and Gowin (1984) and Åhlberg (1990). In the same FINISTE courses there were also teacher of physics Hannu Kuitunen from National Board of Education. He started to use improved Novakian concept maps developed by Åhlberg (1987 – 1989), e.g. Kuitunen (1993).

Even later on a PhD of Physics, Tuula Keinonen (2005) in her Doctoral Thesis in Science Education, used clearly improved Novakian concept mapping and improved Vee diagram developed by Åhlberg (1987 – 2004).

In 1990s, I was a member of the Finnish Society for Quality (Suomen laatuyhdistys) and I published with two of my university students a paper of concept mapping as a new quality tool (Åhlberg, Nevalainen, & Mäkinen 1997). Elina Mäkinen (1996) used improved Novakian concept mapping in her Master's Thesis. She later became an officer in the Finnish Society for Quality (Suomen laatuyhdistys. The theme of Mäkinen's Master's Thesis (1996) was continual quality improvement in Savonlinna. Department of Teacher Education (University of Joensuu). We even had a couple of seminars arranged by the Finnish Society for Quality for business people. At that time the Finnish Society for Quality was selling Åhlberg (1997) in which improved concept maps were presented as a new quality tool. Some business people became interested. However, many of them were already users of mind mapping. They enjoyed comparison of different knowledge representation tools, but were already comfortable with mind mapping. It was enough for their purposes.

In 2004, I met Dr. Alberto Cañas and her wife Carmen Collado. I asked and arranged them several time to visit Finland. I learnt how to use CmapTools (Cañas *et al.,* 2004). I arranged two persons from my research group to translate CmapTools to both main languages of Finland: Finnish and Swedish. Mr. Jarkko Mylläri, MA (Education) translated CmapTools into Finnish. Lecturer Romi Rancen MSc (Forestry) translated CmapTools into Swedish. I arranged with help of many persons the Ministry of Education to pay one public CmapTools server to Teacher Education in Finland and the National Board of Education to pay another public server for Finnish schools, teachers and pupils. The initial idea for The Third International Conference on Concept mapping (CMC2008) emerged in Spring 2007 during a visit to my research group by Dr. Alberto Cañas, Carmen Collado, and Prof. Priit Reiska.

Hopefully in later research history of different versions of concept mapping in Finland will be researched on, in more detail.

4 Sweden

I visited Universities and University Colleges in Stockholm, Uppsala and Härnösand several times during years 1988 – 1993. I taught there improved concept mapping in several seminars and conferences. I studied Swedish educational research literature and I found one earlier writer of concept maps (in Swedish begreppskarttor) than me: Dahlgren 1988 and 1989. I published in Swedish an article about concept mapping and argumentation analysis (Åhlberg 1993). As far as I know there were only Dahlgren's (1988 and 1989) before me as Swedish publications about concept mapping. I met in 1990s Gustav Hellden in European conferences where I used concept mapping in my presentations. Later on I met him at Cornell University 1993, but he had not yet started to use concept mapping himself. Later on he has learnt concept mapping (e.g Magntorn & Helldén 2006).

Using Swedish version of the Google http://www.google.se/ and keyword 'begreppskarta' we found very little hits in Sweden, in April 30, 2008. The first hit was from Finland, and the site was University of Helsinki, and it uses improved Novakian concept mapping in the sense of Åhlberg (1988 – 2004). The site directly refers to Åhlberg (1990b). Concept maps have never become as popular in Sweden as in Finland. Later research hopefully may illuminate reasons for this.

5 Estonia

I was invited to visit Tallinn Educational University in 1991. I had there a presentation about concept mapping. Later on a student came to Savonlinna from Tallinn Educational University to study more about improved concept mapping. Her name was Katrin Poom. In 1992 she published an article about her use of improved concept mapping in Estonian (Poom 1992). Using Estonian version of Google (Google.ee) and Estonian word for concept map (Moistekaart) as keyword, we found no proper concept map links in 30.4.2008. Concept maps have never become as popular in Estonia as in Finland. Mind mapping seem to be much more popular. Later research hopefully may illuminate reasons for this.

6 Russia

Åhlberg's university students have used often concept mapping in their Masters' Theses. E.g. Malinen (2001) studied concept mapping in Russian school in St. Petersburg. During 1995 – 1998 Åhlberg taught concept mapping to many Russian school and university teachers both in Savonlinna Campus of University Joensuu and in Russian schools during international seminars of Environmental Education (e.g. Åhlberg, Pölönen & Hynninen (Eds.) 2000). Concept maps have never become as popular in Russia as in Finland. Later research hopefully may illuminate reasons for this.

7 Communicating for innovations

Rogers (1983 – 2003) claims in his theory of communication and diffusion of innovations that adopters of any new innovation or idea could be categorized as innovators (2.5%), early adopters (13.5%), early majority (34%), late majority (34%) and laggards (16%). Åhlberg in the 1980s was first an early adopter, and then a co-innovator when he with his research group created what they called improved concept mapping. There has been heavy struggle for popularity between mind mapping and concept mapping also in Finland. As far as I know there are no empirical data concerning proper use of concept mapping vs. mind mapping in Finland, Sweden or Estonia. Based on scattered observations in many university courses and scientific conferences, my hypothesis is that Tony Buzan's (1974 – 2000) mind mapping technique is more widely spread than real Novakian concept mapping (Åhlberg 2004). Many people say that they are familiar with concept mapping, but when they demonstrate their use of it, they clearly are using rather mind mapping not concept mapping. Very common is also what Rico (1983 – 2008) calls clustering.

8 Conclusions

Concept mapping was developed at Cornell University in 1970s, and its best known Novakian version in 1980s. It was an educational innovation which has spread in different ways in different countries. It is important to know better the history and spreading of concept mapping as innovation. It is important also to understand more deeply reasons for development and spread of different versions of concept mapping. There is a family tree of concept mapping in each country and it can be revealed by later educational research.

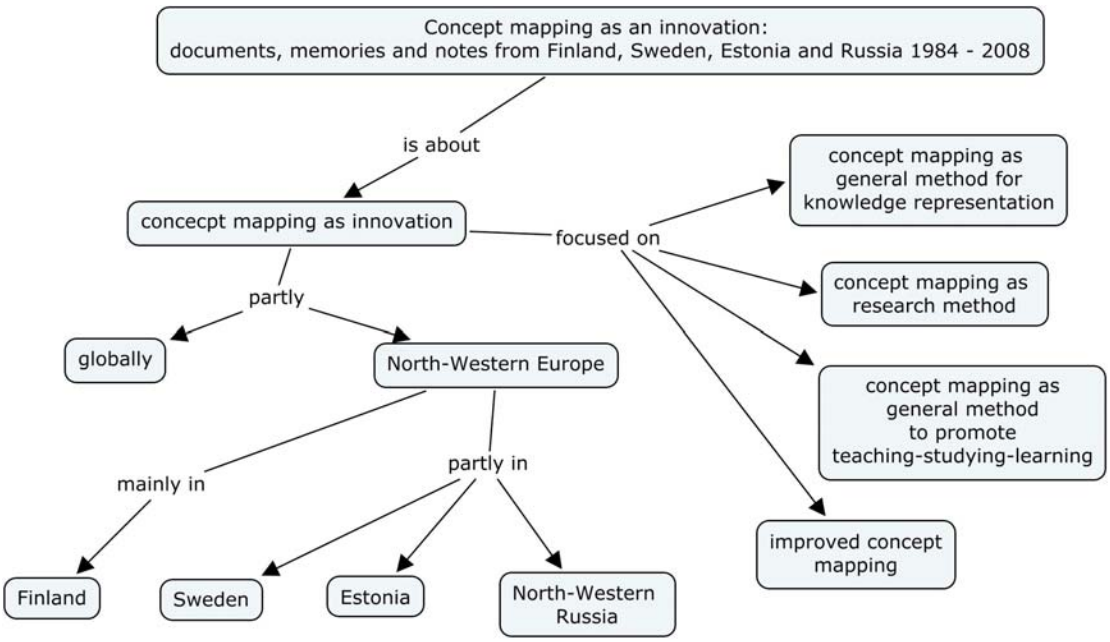

Fig. 1. Main ideas of the paper presented as a concept map. The most central concept is 'concept mapping as innovation'. It has seven links with other concepts. The second in centrality is the concept 'North-Western Europe. It has five links with other concepts.

References

Åhlberg, M. (1987). Kasvatuksen evaluaatio. [Evaluation of education.] (manuscript)

Åhlberg, M. (1988). Dosentuuria varten pidetty luento ja luennolla jaettu opetusmoniste: 'Käsitekartat (concept maps) oppilaiden oppimisen ja ajattelun tutkimisen välineinä'. [Concept maps as research methods of pupils' learning and thinking. An oral presentation and a paper for adjunct professorship (docentship).] Helsingin yliopiston kasvatustieteellinen tiedekunta. Kasvatustieteen laitos. 21. 11. 1988.

Åhlberg, M. (1989a). Biologian ja maantieteen opettamisen ja oppimisen tutkimisen perusteista. [Underpinnings of research on teaching and learning of biology and geography.] Meisalo, V. & K. Sarmavuori (Eds.) Ainedidaktiikan tutkimus ja tulevaisuus II. Helsingin yliopiston opettajankoulutuslaitoksen tutkimuksia 68, s. 161-185.

Åhlberg, M. (1989b). Concept mapping and other graphic representation techniques in science and technology education. Teoksessa Meisalo, V. ja Kuitunen, H. (ed.) (1989) Innovations in the science and technology education. Proceedings of the Second Nordic Conference on Science and Technology education. Heinola 8-11, August 1989. National Board of General Education. Information Bulletin 2, 273-279.

Åhlberg, M. (1989c). Environmental educators need conceptual innovations and scientific ontology and epistemology. In Meisalo, V. ja Kuitunen, H. (ed) (1989) Innovations in the science and technology education. Proceedings of the Second Nordic Conference on Science and Technology education. Heinola 8-11 August 1989. National Board of General Education. Information Bulletin 2, 280-286.

Åhlberg, M. (1990a). Kasvattajille sopivien tutkimusmenetelmien ja -instrumenttien teoreettiset perusteet, tutkiminen ja kehittäminen elinikäisen kasvatuksen ja oppimisen näkökulmasta: KST-projektin tutkimussuunnitelma. [Research methods and instruments which are suitable for educators - theoretical underpinnings, research and development from the viewpoint of lifelong education and learning. A research program.] University of Joensuu. Research Reports of the Faculty of Education N:o 31.

Åhlberg, M. (1990b). Käsitekarttatekniikka ja muut vastaavat graafiset tiedonesittämistekniikat opettajan ja oppilaiden työvälineinä. [Concept mapping and other graphical knowledge representation methods as tools for teachers and pupils.] University of Joensuu. Research Reports of the Faculty of Education N:o 30.

Åhlberg, M. (1991a). Concept mapping, concept matrices, link tables and argumentation analysis as techniques for educational research on textbooks and educational discourse and as tools for teachers and their pupils in their everyday work. In Julkunen, M.-L., Selander, S. & Åhlberg, M. 1991. Research on texts at school. University of Joensuu. Research Reports of the Faculty of Education N:o 37, 89 - 154.

Åhlberg, M. (1991b). Käsitekarttatekniikka ja muut vastaavat graafiset tekniikat opettajan ja oppilaiden työvälineinä. [Concept mapping technique and other similar graphic representation techniques as tools for teachers and pupiuls.] Dimensio 55(4), s. 35-40.

Åhlberg, M. (1993a). Concept maps, Vee diagrams and Rhetorical Argumentation (RA) Analysis: Three educational theory-based tools to facilitate meaningful learning. Paper presented at The Third International Seminar on Misconceptions in Science and Mathematics. August 1- 5, 1993. Cornell University. Published digitally in the Proceedings of the Seminar, http://www.mlrg.org/proc3abstracts.html (Read 28 4. 2008.) The whole paper: http://www.scribd.com/doc/2868664/Ahlberg-Cornell-University-August-1-5-1993

Åhlberg, M. (1993b). Argumentationsanalys och begreppskartor. [Argumentation analysis and concept maps.] Studier av den pedagogiska väven SPOV N:o 21, s. 37-45.

Åhlberg, M. (1997). Jatkuva laadunparantaminen korkealaatuisena oppimisena. [Continual Quality Improvement as High Quality Learning.] University of Joensuu. Research Reports of the Faculty of Education N:o 68.

Åhlberg, M. (2004). Varieties of concept mapping. In Cañas, A. J., Novak, J., Gonzales, F. (Eds.) Concept Maps: Theory, Methodology, Technology. Proceedings of the First International Conference on Concept mapping.. Pamplona, Spain, Sept 14 – 17, Vol. 2, 25- 28, http://cmc.ihmc.us/papers/cmc2004-206.pdf

Åhlberg, M. (2007). History of Graphic Tools Presenting Concepts and Propositions. A Supplementary file of Reflecting Education 3(1-2), http://www.reflectingeducation.net/index.php/reflecting/rt/suppFiles/49/0

Åhlberg, M. & Ahoranta, V. (2002). Two improved educational theory based tools to monitor and promote quality of geographical education and learning. International Research in Geographical and Environmental Education 11(2), 119 - 137, http://www.multilingual-matters.net/irgee/011/0119/irgee0110119.pdf

Åhlberg, M. & Kaivola, T. (2006a). Käsitekartat, Vee-heuristiikka ja argumentaatioanalyysi kestävää kehitystä edistävän tutkivan opiskeluprosessin apuvälineinä. [Concept maps, Vee heuristics and argumentation

analysis as tools for inquiring studies to promote sustainable development.] In Kaivola, T. & Rohweder, L. (Eds.) Korkeakouluopetus kestäväksi. Opetusministeriön julkaisuja [Publications of Ministry of Education] 2006:4, 74 – 83, http://www.minedu.fi/export/sites/default/OPM/Julkaisut/2006/liitteet/opm_8_opm04.pdf?lang=fi

Åhlberg, M. & Kaivola, T. (2006b). Korkeakouluopettajat (opetus)työnsä tutkijoina ja kehittäjinä. [University teachers as researchers and developers of their own (teaching) work.] In Kaivola, T. & Rohweder, L. (Eds.) Korkeakouluopetus kestäväksi. Ministry of Education. Opetusministeriön julkaisuja 2006:4, 156 - 161. Publications of Ministry of Education, http://www.minedu.fi/export/sites/default/OPM/Julkaisut/2006/liitteet/opm_8_opm04.pdf?lang=fi

Åhlberg, M. & Kaivola, T. (2006c). Approaches to learning and teaching environmental and geographical education for sustainability. In Lee, J. & Williams, M. (Eds.) Environmental and Geographical Education for Sustainability. New York: Nova, 79 - 93.

Åhlberg, M., Nevalainen, P. & Mäkinen, E. (1997). Käsitekartat – korkealaatuisen oppimisen ja ajattelun uusi laatutyökalu. [Concept maps – a new quality tool for high quality learning and thinking.] Laatuviesti 12(3), 16 - 18.

Åhlberg, M., Pölönen, A. & Hynninen, P. (Eds.) (2000). Case studies of environmental education and networking in Finland and Russia. Rantasalmi: Rantasalmi Institute of Environmental Education.

Ahoranta, V. 2004. Oppimisen laatu peruskoulun vuosiluokilla 4-6 yleisdidaktiikan näkökulmasta käsitekarttojen ja Vee-heuristiikkojen avulla tutkittuna. [Quality of learning in a primary school grades 4-6 from the viewpoint of general didactics using concept maps and vee-heuristics.] University of Joensuu. Publications in Education No. 99.

Buzan, T. (1974). *Use of your head.* London: BBC Books.

Buzan, T., & Buzan, B. (2000). *The mind map book* (Millenium ed.). London: BBC Books.

Cañas, A. J., Hill, G., Carff, R., Suri, N., Lott, J., Eskridge, T., et al. (2004). CmapTools: A Knowledge Modeling and Sharing Environment. In A. J. Cañas, J. D. Novak & F. M. González (Eds.), *Concept Maps: Theory, Methodology, Technology. Proceedings of the First International Conference on Concept Mapping* (Vol. I, pp. 125-133). Pamplona, Spain: Universidad Pública de Navarra.

Dahlgren, H. (1988). 3GGG Basmaterial för kompletteringsutbildning I Grundläggande Gemensam Grundskollärarkompetens. Solna: Ekelunds Förlag.

Kaivola, T. (2000). GLOBE-ohjelma ympäristökasvatuksen innovaationa Suomessa. [Globe program as an innovation of environmental education in Finland.] Helsingin yliopiston opettajankoulutuslaitos. Tutkimuksia 218.

Kaivola, T. (2008). Teemana maailmanlaajuinen vastuu: Käsitekartat ilmiöiden ja oppimisprosessien jäsentäjinä. [Theme worldwide responsibility: Concept maps as organizers of phenomena and learning processes.] Opetusministeriön Etusivu -verkkolehti 21. 2. 2008, http://www.minedu.fi/etusivu/arkisto/2008/2102/kehitys.html

Kaivola, T. & Åhlberg, M. (2005). How to use concept mapping as a facilitating tool in order to indentify and solve complex problems in research-based teaching-studying-learning processes? Abstract of the workshop in Research-Based Teaching in Higher Education, March 22 - 23, 2005. University of Helsinki, 44 - 45. In the PDF file of the seminar abstracts the presentation abstract is on pages 43 -44, http://bulsa.helsinki.fi/~maahlber/LERU-abstracts_March_22-23_05.pdf

Kaivola, T. & Åhlberg, M. (2007). Theoretical Underpinnings of Education for Sustainable Development. In Kaivola, T. & Rohweder, L. (Eds.) Towards Sustainable Development in Higher Education – Reflections. Publications of the Ministry of Education 2007:6, 42-48, http://www.minedu.fi/export/sites/default/OPM/Julkaisut/2007/liitteet/opm06.pdf?lang=en

Kankkunen, M. (1999). Opittujen käsitteiden merkitysten ymmärtäminen sekä ajattelun rakenteiden analyysi käsitekarttamenetelmän avulla. [Understanding of meaning of learnt concepts and analysis of structure of thoughts using concept mapping.] University of Joensuu. Publications in Education n:o 54. Doctoral Dissertation.

Kankkunen, M. (2001). Concept mapping and Peirce's semiotic paradigm meet in the classroom environment. Learning Environments Research, 4(3), 287-324.

Kankkunen, M. (2004). How to acquire "the habit of changing habits": the marriage of Charles Peirce's semiotic paradigm and concept mapping. In Cañas, A. J., Novak, J., Gonzales, F. (Eds.) Concept Maps: Theory, Methodology, Technology. Proceedings of the First International Conference on Concept mapping. CMC 2004. Pamplona, Spain, Sept 14 – 17, Vol. 1, http://cmc.ihmc.us/papers/cmc2004-109.pdf

Keinonen, .(2005). Primary school teacher students' views of science education. University of Joensuu. Publication in Education n:o 10.

Kuitunen, H. (1993). Käsitekartta: TPO-ohjelman oppimateriaali. [Concept map: a text for TPO program.]Helsinki: Finneduca.

Kurki-Suonio, K. ja Kurki-Suonio, R. (1994). Fysiikan merkitykset ja rakenteet. [Meanings and structures in physics.] Helsinki: Limes

Lavonen, J. (1996). Fysiikan opetuksen kokeellisuus ja mittausautomaatio. [Experimental approach and automation of measurements in teaching physics.] University of Helsinki. Report Series in Physics. Hu-P-D64. Doctoral Dissertation.

Magntorn, O. & Helldén, G. (2006). Reading nature from a bottom-up perspective. In Cañas, A. J. & Novak, J. (Eds.) Concept Maps: Theory, Methodology, Technology. Proceedings of the Second International Conference on Concept Mapping. San José, Costa Rica - September 5-8, 2006. San Jose: Universidad de Costa Rica, http://cmc.ihmc.us/cmc2006Papers/cmc2006-p76.pdf

Malinen, R. (2001). Käsitekartat ympäristöopin opetuksessa venäläisen keskikoulun ala-asteen toisella luokalla. [Concept maps in teaching of environmental issues at the second grade level of Russian primary school.] Master's Thesis. University of Joensuu. Masters Thesis.

Mäkinen, E. 1996. Laatuajattelua savolaisittain: Savonlinnan opettajankoulutuslaitoksen laadunkehittämisen alkutilanteen kartoitusta. [Quality thinking in the province of Savo: Empirical research for the beginning phase of quality improvement program in Savonlinna Department of Teacher Education.] University of Joensuu. Master's Thesis.

Niskanen, I. (2007). Käsitekarttaympäristön kehittäminen opettamisen apuvälineeksi. [Developing concept mapping environment to a tool for teaching of physics.] Master's Thesis. University of Helsinki. Department of Physics, http://per.physics.helsinki.fi/kirjasto/ont/iniskanen/index.html

Novak, J. (1979). Applying psychology and philosophy to the improvement of laboratory teaching. The American Biology Teacher, 41(8), 466 – 470.

Novak, J. (1980). Learning theory applied to the biology classroom. The American Biology Teacher, 42(5), 280 – 285.

Novak, J. (1981). Applying learning psychology and philosophy to biology teaching. The American Biology Teacher, 43(1), 12 – 20.

Novak, J. D. (1998). Learning, creating, and using knowledge: Concept Maps as Facilitative Tools in Schools and Corporations. Mahweh, NJ: Lawrence Erlbaum Associates.

Novak, J. D., & Gowin, D. B. (1984). Learning How to Learn. New York: Cambridge University Press.

Pehkonen, M. (2007). Fysiikan käsitekarttojen sisällön ja graafisen rakenteen arviointi opettajankoulutuksessa.][Evaluation of concept maps in physics and their graphical structure in teacher education.] Master's Thesis. University of Helsinki. Department of Physics http://per.physics.helsinki.fi/kirjasto/ont/mpehkonen/index.html

Poom, K. (1992). Moistekaart ja moistekaarttehnika. [Concept map and technique of concept mapping.] Haridus 7/8, 58 – 60.

Rico, Gabrielle. (1983). Writing the Natural Way. New York: Tarcher.

Rico, Gabrielle. (2000). Writing the Natural Way. 2nd Edition. New York: Tarcher.

Rico, Garrielle. (2008). Gabrielle Rico's web page of Writing the Natural Way, http://www.gabrielerico.com/Main/ClusteringSampleVignettes.htm

Rogers, E. (1983). Diffusion of innovations. New York: Free Press.

Rogers, E. (2003). Diffusion of innovations. 5th Edition. New York: Free Press.

Rogers, E. & Shoemaker, F. (1971). Communication of innovations: a cross-cultural approach. New York: Free Press.

Salmio, K. (2004). Esimerkkejä peruskoulun valtakunnallisista arviointihankkeista kestävän kehityksen didaktiikan näkökulmasta. [Examples of National Basic Education Evaluation Programs from the Perspective of the Didactics of Sustainable Development.](Doctoral dissertation) University of Joensuu. Joensuun yliopiston kasvatustieteellisiä julkaisuja n:o 98, http://joypub.joensuu.fi/publications/dissertations/salmio_arviointihankkeista/salmio.pdf

Stewart, J., Van Kirk, J., & Rowell, R. (1979). Concept maps: A tool for use in biology teaching. The American Biology Teacher, 41(3), 171 – 175.