Two Improved Educational Theory Based Tools to Monitor and Promote Quality of Geographical Education and Learning

Professor Mauri Åhlberg
University of Joensuu in Savonlinna, Savonlinna, Finland

Principal Vuokko Ahoranta
Kangaskylän koulu, Opintie 9, 59100 Parikkala, Finland

New improved educational tools are suggested to monitor and promote quality of geographical education. It is shown that in literature concept maps (Gowin, 1981; Novak, 1980; Novak & Gowin, 1984) and mind maps (Buzan, 1982, 1993) are not properly understood. The difference between concept maps and mind maps is made clear by constructing a mind map and a concept map using the same concepts from Geographical Education. It is shown that the concept map is an accurate representation of the main features of cognitive structure, while the mind map is an ordered association map open to multiple interpretations. Improved concept maps and Vee heuristics are presented as tools to monitor and promote meaningful, deep, creative geographical learning and metacognition. Values thinking is explicitly promoted by improved Vee heuristics. Empirical examples from a cases study of a geographical learning project are presented, and their usefulness for practical teaching and educational research is analysed and evaluated. Suggestions are made both for practice and further research.

Introduction

There are traditions (spatial, area studies, man-land, and earth science) and themes (location and distribution, place, relationship within places, people–environment relationships, spatial interaction, movement and regions) in geography and in geographical education (Archer, 1995; IGU, 1992; Natoli, 1994; Rikkinen, 1998). Spatial maps are invaluable traditional tools of geographical education. However, there is much more in geographical education than just spatial maps and graphical literacy. Kaminske (1997) presents an overview of complexity of geographical concepts, and difficulties in learning them. There are issues concerning values and conceptual and propositional structures, declarative knowledge, what is worthwhile or valuable in geographical learning, why pupils think they should learn geography, what methods for constructing knowledge students know beforehand, what knowledge constructing methods do they actually use, and what pupils know before teaching and after teaching about geographical items, and how to best monitor and promote learning. There are at least two practical tools developed for answering these kinds of basic educational questions: concept maps and Vee heuristics. As presented in Figures 1 and 2 quality of learning may vary from rote learning to high quality learning, which is at least meaningful, deep, creative proactive and metacognitive (metalearning).

1038-2046/02/02 0119-19 $20.00/0

According to Åhlberg (1997) integrating high quality learning has at least 12 aspects, including the following four aspects:

> (1) Learning can be meaningful in two senses: Firstly meaningful learning meets real needs of the learning person or organization. Secondly learning is meaningful when what is learnt is connected and built upon what has been learned earlier. Meaningful learning often means increasing hierarchy in conceptual and propositional structures. Conceptual hierarchies are very economical and powerful way to learn and represent knowledge. On the other hand because the world is a system, it is necessary to learn the basic structure and processes of it as conceptual systems. 2) Learning may be deep in two senses: Firstly all knowledge, dispositions and competence have grounds, foundations, underpinnings, justifications. So learning becomes deep, when foundations, grounds, underpinnings, justifications of what is learnt is sought after and learnt. Secondly deep knowledge, dispositions, competence is tested, examined, scrutinized, and learning becomes deeper by testing, examining, scrutinizing constructed knowledge, dispositions and competence. 3) In high quality learning one is not satisfied just to repeat what has been done earlier. The world and life are full of real problems. Real needs of individuals and societies ought to be optimally met. So high quality learning is creative proactive problem solving learning. 4) High quality learning increases person's and organization's abilities to monitor and promote one's own learning. This is called metacognitive learning or metalearning. (Flavell, 1976: 232)

In order to improve school practice it is necessary to cooperate with university researchers (Åhlberg, 1993, 1997; De Corte, 2000). Innovations often come from university researchers who have the necessary breadth and depth, and enough education, competence, time and resources for research and development activities. However skilful, expert school teachers must also be involved for testing and developing theories and tools in practice, otherwise there will be no lasting improvement in schools.

Concept Maps, Mind Maps and Improved Concept Maps

A concept map is a graphical knowledge representation method (Åhlberg, 1990a, 1993), among many (e.g. mind maps, Buzan, 1982, 1993). Concept maps were originally based on Ausubel's learning theory (Novak & Gowin, 1984: 12). Åhlberg (1993, 1997) has improved them. Everything that is said or written can be transformed into concept maps, which reveal the main features of conceptual structure of texts and discourses. In Figures 1 and 2, a mind map and an improved version of concept map of the same theme and with the same main concepts are compared. In the literature there is a confusion of the nature of concept maps. McAleese (1998: 251) rightfully claims: 'The concept map is becoming a ubiquitous tool in education.' There are over 200 published research articles of concept maps in the Educational Resources Information Center (ERIC). Candy (1991: 324) presents concept maps as tools promoting self-direction for lifelong learning. Concept maps can be easily constructed anywhere with paper and pencil. They are of great value also in new information and

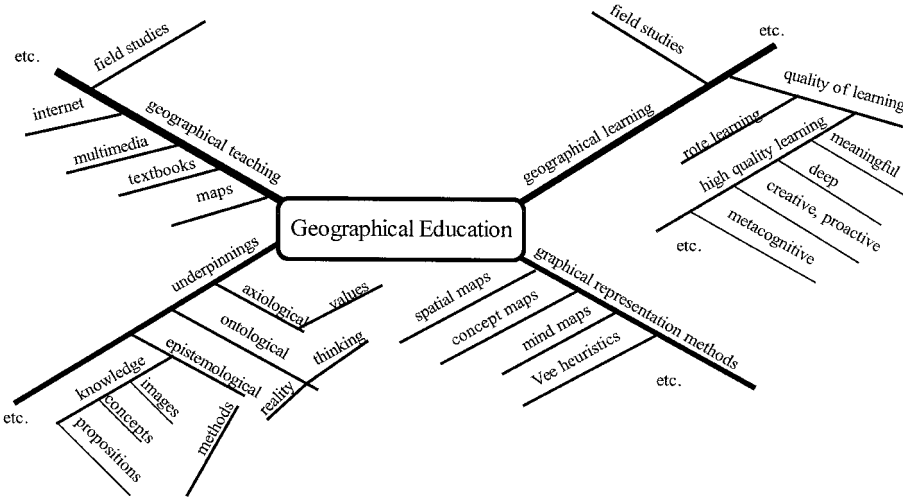

Figure 1 An example of a mind map. Figure 2 is a concept map, using the same concepts as Figure 1. A mind map is an association map

communication technology environments, which is evidenced in a special concept mapping issue of the *Journal of Interactive Learning Research* (Kommers, 1997). Rikkinen (1999: 105–7) presents concept mapping and Vee heuristics in her Finnish textbook of geographical teaching methods.

In a good concept map, every concept has just one representation, as in a good spatial map where geographic place is represented only once. In the mind map (Figure 1) the same concept may be presented several times (e.g. 'field studies'), which is associated to both the branches of geographical teaching and geographical learning. In a concept map, you may readily count links to and from each concept. The more links the more central is the concept in the concept map. In the concept map (Figure 2), the concepts 'quality of learning' and 'graphical representation methods' are the most central concepts. Both have six links to other concepts. The next concepts, in order of centrality based on the number of links are 'concept maps' and 'Vee heuristics'. Both have five links to other concepts.

There are many researchers who refer to Novak and Gowin (1984) and write about concept maps, but who clearly mix them with Buzan's (e.g. 1982, 1993) mind maps (Slotte & Lonka, 1999: 522–3). Other authors have presented as concept maps examples of primitive propositional maps (e.g. Palmer, 1993, 1998: 113). Historically the origin of concept mapping, with flexibly and accurately named links, was from Professor J.D. Novak at Cornell University in the late 1970s and in the early 1980s (Åhlberg, 1993; Novak, 1998; Novak & Gowin, 1984).

Åhlberg (1993) constructed a way to develop concept maps by using an analogy of islands and bridges; it takes about 10 minutes to learn how to construct a good concept map by using this approach. Concepts are like islands and links between the concepts are like bridges. One may move from any concept-island to another

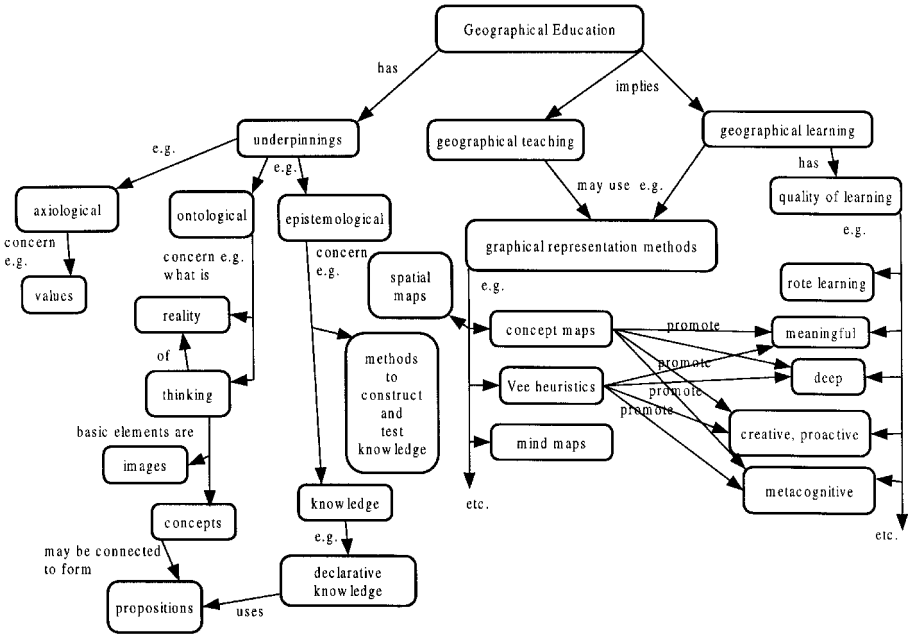

Figure 2 An example of a concept map. Figure 1 is a mind map, using the same concepts as Figure 2. A good concept map may be read as easily as an ordinary text

by naming the link-bridge in a meaningful proposition/sentence/statement about the world. All links are arrows, and they are like traffic signs showing the direction of reading/moving from one concept to another.

Vee Heuristics and Improved Vee Heuristics

The Vee heuristic/diagram/map was developed by Professor B. Gowin in the late 1970s and the early 1980s (Gowin, 1981; Novak, 1980; Novak & Gowin, 1984). It is originally based on a theory of education presented by Gowin (1981). The improved Vee heuristic is based on an integrating theory of education (Åhlberg, 1997). The Vee heuristic is a tool to monitor and promote metalearning, and metacognition. Candy (1991: 362–5) presents Vee heuristic as a tool to promote self-direction for lifelong learning. The Vee heuristic is not as popular as concept map. This paper will present evidence that the Vee heuristic provides useful data for both pupils and teachers regarding learning and thinking in geographical education.

Roth and Verechaka (1993) have presented a simplified, yet traditional Gowin type Vee maps/diagrams/heuristics using the analogy of a road map. They present the Vee map as a road map showing a route from prior knowledge to new and future knowledge. This analogy is useful in their case, because they ask at the conclusion of the learning project, 'How can this knowledge be used? Are there any new questions suggested by the data?' However, in the results

they present, there were no pupils who answered those two future oriented questions.

Alavarez (1998) has reported on the use of interactive Vee diagrams as a metacognitive tool for learning. He used traditional Gowin (1981) type Vee heuristics. He concluded that the study indicates that online Interactive Vee Diagrams are increasing student awareness and knowledge of research practices, and allowing them to share and communicate their findings with others in ways that are meaningful and noteworthy. The results reported were not detailed enough to provide evidence for the conclusion presented. The results make sense, seem plausible, but in the report there is no empirical evidence to support those conclusions.

In Gowin (1981) and in Novak and Gowin (1984) there are many versions of the Vee heuristic or Gowin's Vee or knowledge Vee. The most elaborated example of the Vee heuristic is in Novak and Gowin (1984: 56). There are 16 points or steps to ponder and answer. They are: (1) Focus question, (2) World View, (3) Philosophies, (4) Theories, (5) Principles, (6) Constructs, (7) Conceptual structures, (8) Statements of regularities or concept definitions, (9) Events/objects, (10) Records of events or objects, (11) Facts, (12) Transformations, (13) Results, (14) Interpretations, explanations, and generalisations, (15) Knowledge claims and (16) Value claims. Åhlberg (1993) used this kind of the Vee heuristic, but his university students became confused by terms like 'World View', 'Philosophy', etc. Also he proposed that the original naming the left side of the Vee as 'conceptual or thinking side' and the right side as the 'methodological or doing side' did not stand up to scrutiny. On both sides the Vee heuristic demands thinking and conceptual work.

From the 1980s Åhlberg has been interested and engaged in action research, and from 1992 in continual quality improvement (Åhlberg, 1993). It came to him by creative insight that the left side could be the planning side and the right side of the Vee heuristic could be the evaluation side. In the middle of the Vee, there is a research question and description about implementation of the plans. The improved version of Vee heuristic is presented in Figure 3. The three main phases, Planning, Implementation and Evaluation, have their underpinnings in the three main phases of action research. This is similar to the Deming cycle in continual quality improvement, which includes the phases: Plan–Do–Study–Act (Deming, 1994: 131–4).

There are 10 main points or steps to high quality learning when it is used. The first step is the research question or focus question. The second one is 'Value basis'. In the original Vee heuristic, it was called 'World View'. It proved to be too confusing and demanding for most students. Åhlberg (1993) renamed it 'Value basis' and described it so that even primary school children are able to ponder why they are studying the problem named in the middle of Vee. In the original Vee heuristic Novak and Gowin make too many theoretical distinctions: '3) Philosophies, 4) Theories, 5) Principles, 6) Constructs, 7) Conceptual structures, 8) Statements of regularities or concept definitions'. Åhlberg's students found these confusing. That is why he developed two new steps (the new third step, 'Theory basis' and the new fourth step, 'Conceptual basis') to cover the core of the original six steps. The fifth step ('Methods basis') is to ponder which data collection methods could be used. There is no equivalent in the original form of the Vee

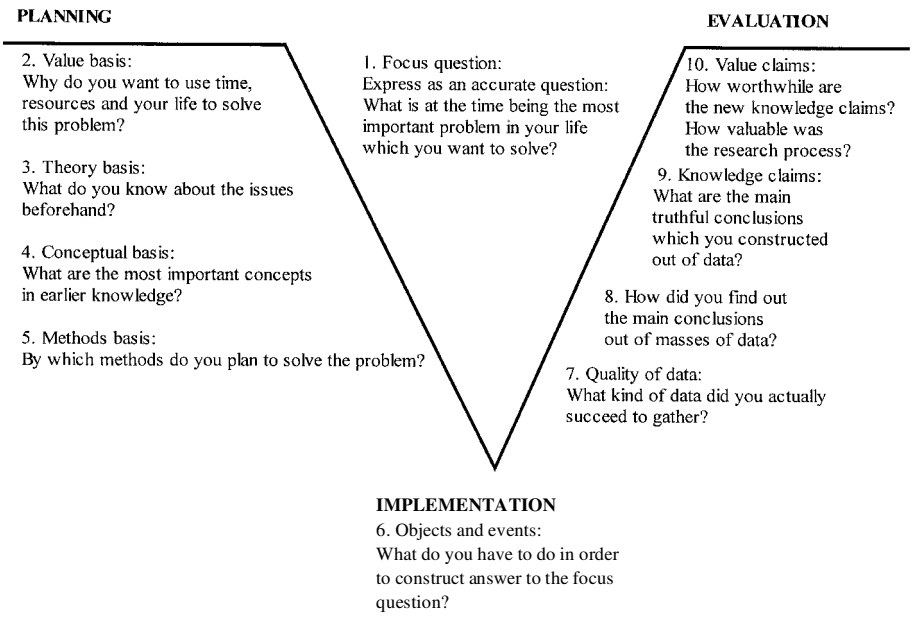

Figure 3 The basic elements of the improved Vee heuristic. Adapted from Åhlberg (1998: 39)

heuristic, presented in the books of Gowin (1981) and Novak and Gowin (1984). The sixth step (Implementation) concerns what the pupil did in order to construct answer(s) to research question. On the right side the 7th step describes what kinds of data were collected. The 8th step concerns how main conclusions have developed from the data. The 9th step concerns the main knowledge claims. The tenth step concerns the value of knowledge constructed and the value of going through the whole process of 10 steps in the improved Vee heuristic. On the right side the steps are very similar to the original Vee heuristic, but sufficiently clarified that even elementary school children are able to use them.

The basic elements of the improved Vee heuristic are presented in Figure 3.

Ahoranta developed in the beginning of 1997 her own version of the improved Vee heuristic for her pupils in 1997 (Fig. 4). Pupils like to construct the heuristic, and it gives useful, important and interesting knowledge about pupils' thinking, feeling and learning. It probably promotes pupils' metalearning and metacognition as they know more about their own learning and thinking and as result they may better monitor and promote their own learning. Also the teacher has better knowledge of pupils and their thinking, learning and development.

Research Questions, Research Strategies and Research Design

Research questions

On basis of the theoretical background the following main research questions are constructed:

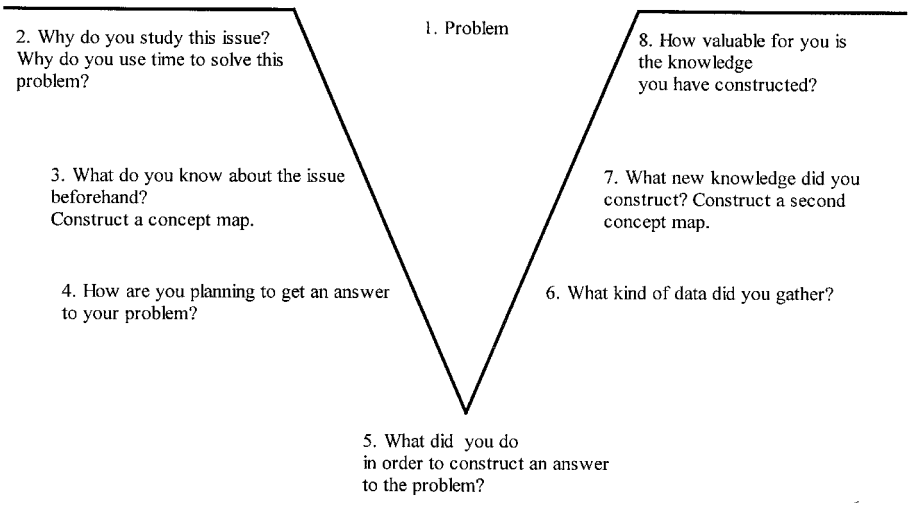

Figure 4 This version of Vee heuristic is a modification of Åhlberg's (1993) improved Vee heuristic, which was adapted from Novak and Gowin (1984)

- Research question 1: What can be learnt when improved concept maps are used to monitor and promote pupils' geographical learning?
- Research question 2: What can be learnt when improved Vee heuristics are used to monitor and promote pupils' geographical learning?

Research strategies

The research strategy was constructed on the general theory and confirming observations that there are both qualitative and quantitative aspects to a study. There is nothing incompatible in using both qualitative and quantitative research strategies and data in the same research project (e.g. Åhlberg, 1993: 4–5; Denzin & Lincoln, 1994: 2–4; Patton, 1990: 464–71; Tashakkori & Teddlie, 1998).

Research design

The research design selected to guide the study was based on multiple-cases (Leonard-Barton, 1996: 38–64; Merriam, 1988: 6–21, 153–5; Stake, 2000: 444; Yin, 1998: 236–43). A case study usually produces rich and dense idiographic knowledge, i.e. knowledge about individuals, particulars, singularities. Multiple-case studies are used to create nomothetic knowledge, i.e. regularities or generalisations across cases (Cohen & Manion, 1989: 8, 9, 28; Galtung, 1979: 20–27). Each pupil is a case, and each learning project is a case. In the beginning and in the end of each learning project a concept map is constructed. From the third learning project each pupil constructs an individual Vee heuristic about her/his learning project. The data from pupils' concept maps and Vee heuristics is tabulated and analysed in order to find regularities, and generalisations.

The action research project concerns many school subjects, not only geography. It lasted three school years from the beginning of Autumn term 1997 to the

end of Spring term 2000. Five learning projects per school year were implemented. No more than five times per year, because, it is clear if any method is used too often children become bored and frustrated. Some learning projects lasted a day or two, some of them a school week or more, some lasted almost the whole school year (the one concerning their own municipality, Parikkala).

Methods

Subjects

In the class there were 22 pupils, 12 girls and 10 boys. It was a small class and presented a favourable environment for experimentation, action research and case study research. The three high achievers, the three average achievers and the three low achieving pupils are described by Ahoranta (1999) based on three years of observations.

The high achievers

The three students in this group are responsible and diligent in their studies. Johanna's (01) concept maps are perfect. Her Vee heuristics reveal how she enjoys learning. Eija (02) does not always remember to use arrowheads in her concept maps. Eija recalls in her Vee heuristics that she enjoys learning. Jussi (03) constructs good concept maps and Vee heuristics. He does not express a similar joy of learning as do Johanna and Eija.

The average achievers

The students in this group are diligent in their studies. Anni (04) forgets to use arrowhead in her concept maps. She also includes irrelevant concepts on the concept maps. In her Vee heuristics, Anni expresses that she enjoys learning. Toni's (05) concept maps are small. The number of concepts and propositions increased very little from the beginning to the end of the learning projects. He uses few words in the Vee heuristics. Henna's (06) concept maps are good. In her Vee heuristics she expresses honestly what she liked and what kind of difficulties she encountered during lessons.

The low achievers

The students in this group were generally less engaged in school than the other two groups. Juho (07) does good concept maps and Vee heuristics. He has good relationship with his teacher. Asko (08) sometimes forgets to use arrowheads on his concept maps and sometimes he adds plenty of irrelevant concepts to them, and personal associations which just came into his mind. One of the Asko's Vee heuristic concluded that: 'I did not learn, because Sami talked to me all the time.' Pekka (09) is able to do good concept maps, but often does not elect to do so. Sometimes arrowheads, linking words, and links to proper propositions. Pekka's Vee heuristics reveal that he thinks that he learnt everything, or he already knew everything.

The class was totally involved and very attentive during their part in the educational action research project. They knew and were pleased and happy that they were used in educational research as a part of their teacher's university studies to become a Master of Education. This may have resulted in the Pygmalion effect or the Rosenthal effect that motivate the pupils to be more

effective than normally. When anything new is introduced into a classroom, many kinds of unintended side effects may result (Ball, 1988: 490). The Pygmalion side effect was used in this study in a positive way. We expected that all pupils would learn more and better while using concept maps (Novak & Gowin, 1984: 166). Because both concept maps and Vee heuristics are tools to promote learning, we expected that the low achievers would benefit most, and that they would get more and more similar achievements than the best pupils in the course of the successive learning projects. Our first research project, consisting of 15 separate learning projects, lasted three years (1997–2000) and the results were similar during all these years. During the academic year 2000–2001 we used another class, and again the results are similar. Over 20 other teachers have had half a year experiments using concept maps and Vee heuristics, and they have had similar experiences than we had (Åhlberg, 1999).

Sampling

The strategy was based on Patton's (1990: 182) recommendation to select information-rich cases for in-depth study. Size and specific cases depend on study purpose. The sampling was designed as follows: three highest achievers, three average achievers and three lowest achievers were identified from the class of 22 students as assessed by general achievements in school subjects, excluding sports, visual arts and music. The three groups took part in every learning project, and completed concept maps and Vee heuristics and all other tasks as did the other 13 pupils. The sampling design was used only for sampling data that were judged by the researcher to be representative of the general class of students.

Three pupils were selected as a minimum for each achievement group. Three is a minimum number necessary to calculate arithmetic means and standard deviation that are meaningful. In addition, case study research is time intensive and larger groups of students are impractical in terms of data analysis.

Data Collection and Analysis Methods

Data were collected through the use of improved concept maps and improved applied Vee heuristics. Concept maps were analysed first qualitatively and then quantitatively. The number of relevant concepts at the start of the learning project and the number at the end of the learning project were compared. The difference between these two figures was an estimate of concepts (elements of thinking) learnt in the project. The number of relevant propositions in the beginning and in the end of the learning project was also calculated. The difference between those figures is the estimate of number of propositions learnt. This value represents an estimate of increase in declarative knowledge among the students. The researchers decided that the most interesting aspects of Vee heuristics were:

(1) The quality and number of value justifications in the beginning of the learning project.
(2) The value statements the students make at the end of the learning project and the number of items expressed.
(3) The kinds of and number of data collection methods planned and actually used by the students.

(4) The description of what the pupils reported they learnt.

Evaluating Goodness of Research and its Conclusions

Miles and Huberman (1994: 278–80) offer a practical and theoretically sound framework, that was used to evaluate the quality of the research design, methods, data and conclusions in the present project. The following five aspects are evaluated:

(1) Objectivity: The methodology of the research is described explicitly and in detail. Both researchers retain the study data, which is available for reanalysis.
(2) Auditability: Research questions are clear and the research design is congruent with them. The results are reviewed by other researchers. Every phase of the research is carefully documented.
(3) Credibility: The research results are valid within the context of the research question. Triangulation among complementary methods and data sources produced consistent conclusions.
(4) Transferability: The results have been used to inform over 200 teachers in pre-service and in-service teacher education courses about the methodology. There is empirical evidence that over 20 in-service teachers have been able to use the methodology and collect supporting data.
(5) Application: Pupils were interviewed regarding what they thought about the concept maps and Vee heuristics. Most of the pupils liked them more than other methods used in school. However, it must be remembered that Ahoranta used them only five times during each academic year. These methods demand concentration and time commitments. They are rewarding, but they require plenty of mental energy.

Concept maps and Vee heuristics may also be evaluated for validity. Åhlberg (1990b: 54) suggested the validity of concept maps should be evaluated in two phases. First, review if the concept map corresponds to the main features of constructor's thinking. The concept map must correspond to the person's thinking in order to be valid. Second, the concept map must correspond to reality to be valid.

Other elements of Vee heuristic refer to external objects and events, such as the construction of answer(s) to the research question(s). For some parts of Vee heuristics, the evaluation is subjective. On the other hand it may be possible to compare students' justifications of the value claims. Do they stand up to critical examination? Internalised values are not subjective feelings and emotions, but are constructed in the mind on basis of real human needs and properties of the world (Åhlberg, 1998).

Results and Discussion

In our first paper, we are presenting and discussing the results of only one of the learning projects. Its topic was 'Parikkala, our own municipality'. Parikkala is a small rural municipality, about 60 km from the town of Savonlinna, where a campus of the University of Joensuu is located. The learning project was started at the beginning of the school year and it ended with the school year. A videotape

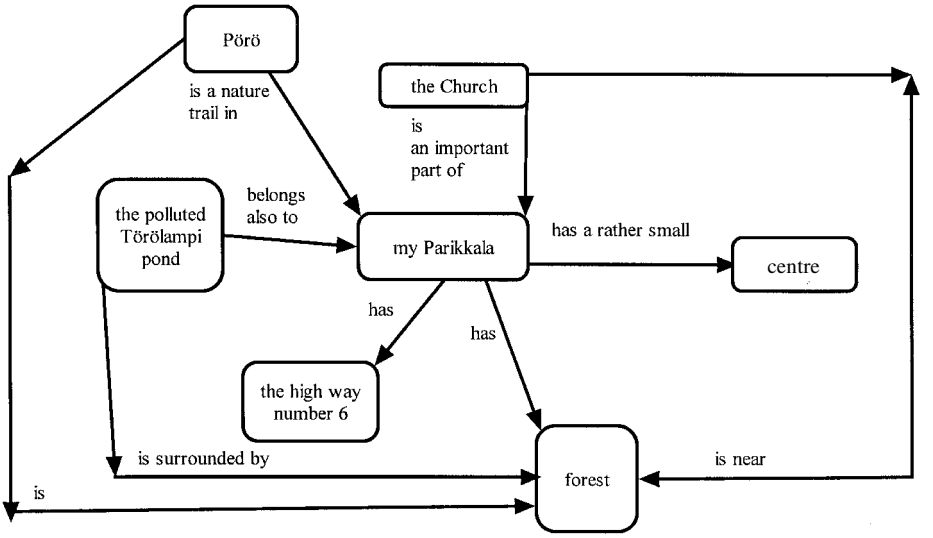

Figure 5 Johanna's first concept focuses on the central concept of forest. It is connected by four links to other concepts

of Parikkala was produced during the learning project and shown to parents in the festivities in the end of school year.

In order for readers to obtain a richer and deeper understanding of concept maps and Vee heuristics in monitoring and promoting geographical education and learning, the concept maps and Vee heuristics of two pupils are presented with comments. Figures 5, 6 and 7 are concept maps and Vee heuristic constructed by Johanna, one of the high achievers. Figures 8, 9 and 10 present concept maps and Vee heuristic made by Pekka, one of the low achievers.

The results of the high achievers, the average achievers, and the low achievers are presented in Tables 1 and 2. All concepts and propositions were relevant to each of the group projects.

Table 1 interpretation: with one exception there are more concepts in the second concept map than in the first. More concepts suggest more learning has occurred. With one exception, there are more propositions in the second concept map there are more propositions than in the first. This suggests that an increase of number of relevant concepts and propositions indicates learning. In the first concept maps there was no hierarchy. In the second concept map in every group there were two maps with hierarchy and one without hierarchy. This gives support to the Ausubelian learning theory and our integrating educational theory, that the appearance of hierarchy suggests learning and increasing order in cognitive structure.

Table 2 interpretation: The high and average achievers produced more value justifications at the beginning of the learning project. They were perhaps more motivated than the low achievers. At the end of learning project, there was practically no difference in value expressions. The high achievers reported that they used five or six knowledge gathering methods, while the

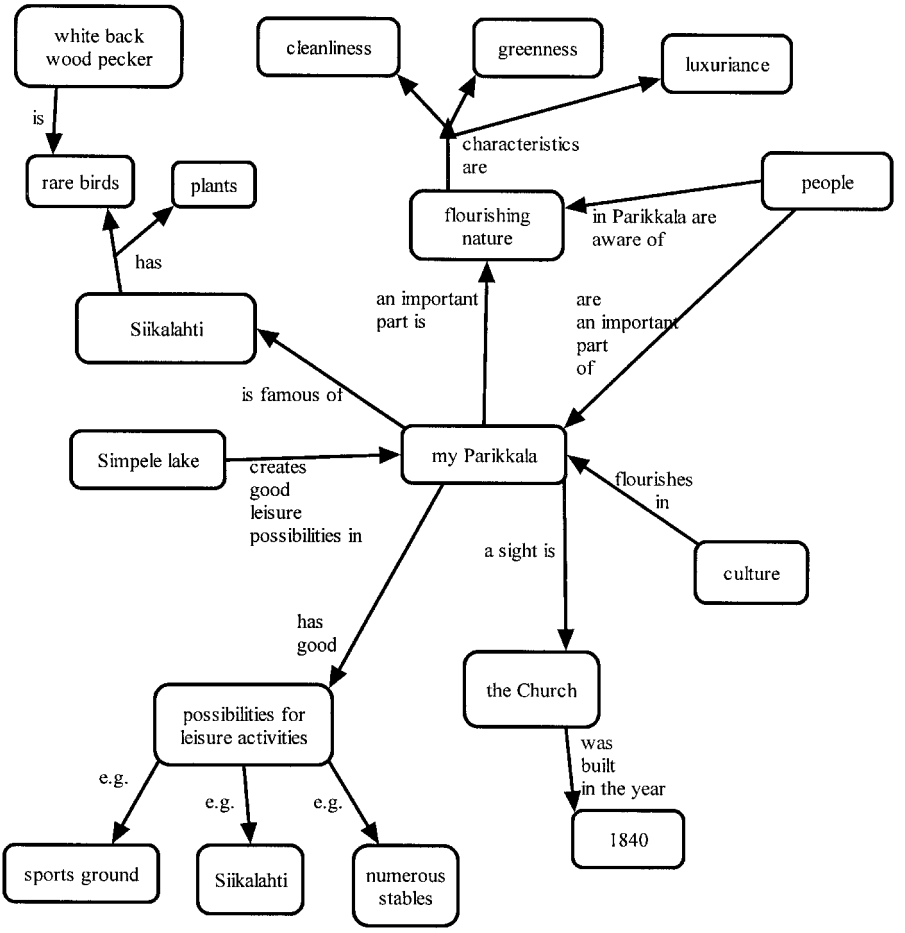

Figure 6 Johanna's second concept map at the end of the learning project, also concerns her municipality 'Parikkala as seen by 5th graders'. She is now 12 years old. The most central concept is 'flourishing nature', and it is connected by five links to other concepts

average and low achievers used generally fewer methods. However, there was a big individual variation. There was practically no difference in the number of items pupils tell that they have learned. If we compare concept maps with what pupils told they have learned, it seems that the high achievers underestimate their learning.

General Discussion and Further Research

Concept maps and mind maps were compared using the same concepts/'key words'. It was observed that the improved concept map is an accurate and flexible means to represent conceptual and propositional structures of human learning and thinking.

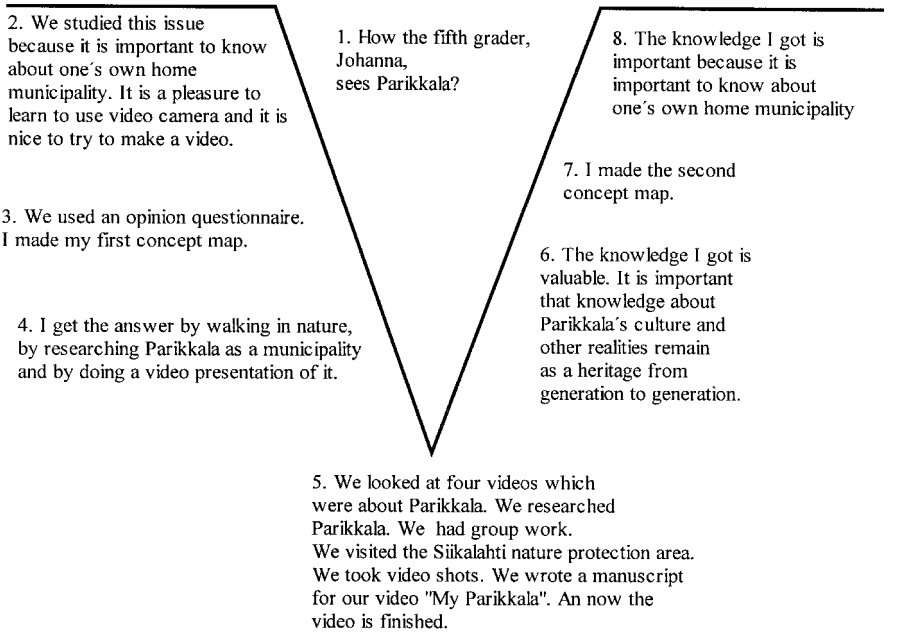

Figure 7 Johanna's Vee heuristic is of the municipality 'Parikkala as seen by 5th graders'. She is 12 years old and describes in great detail what pupils did in order to construct knowledge of their own municipality. Compare this Vee heuristic to Pekka's Vee heuristic of the same learning project. There is a big difference in details and understanding

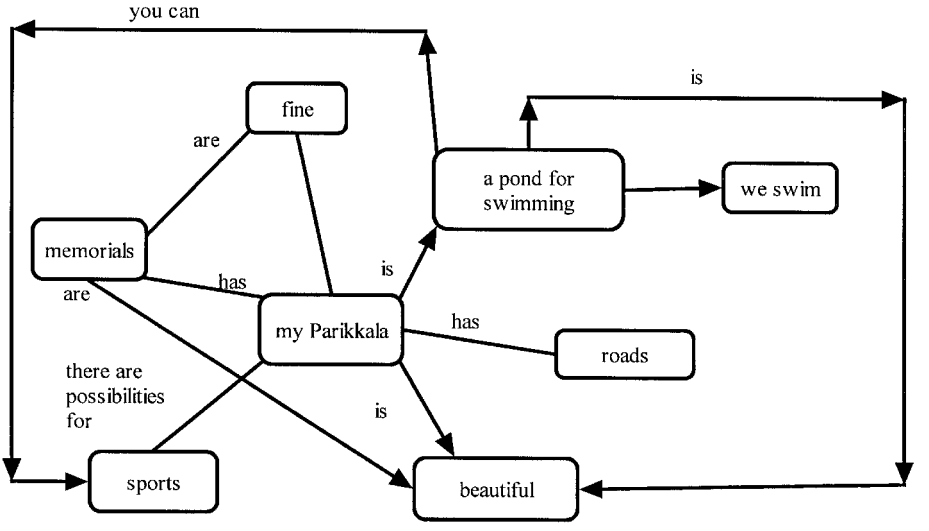

Figure 8 Pekka's first concept map was made at the beginning of the learning project. He is 12 years old and the most central concept is 'a pond for swimming'. It is connected by four links to other concepts. Note that Pekka does not always use arrowheads in links

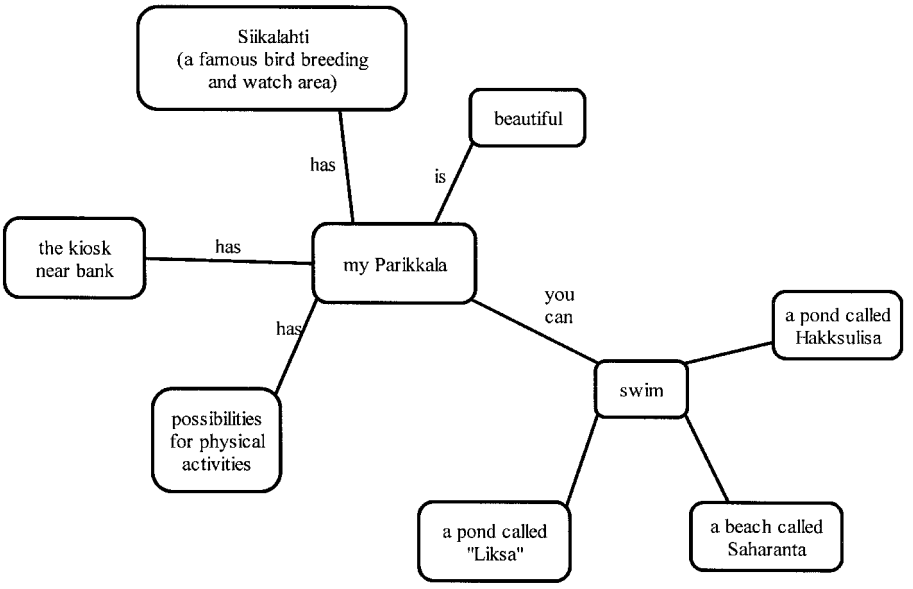

Figure 9 Pekka's second concept map at the end of the learning project concerns the municipality 'Parikkala as seen by 5th graders'. He is 12 years old and the most central concept is 'swim'. It is connected by four links to other concepts. It seems Pekka has not learnt very much during the project

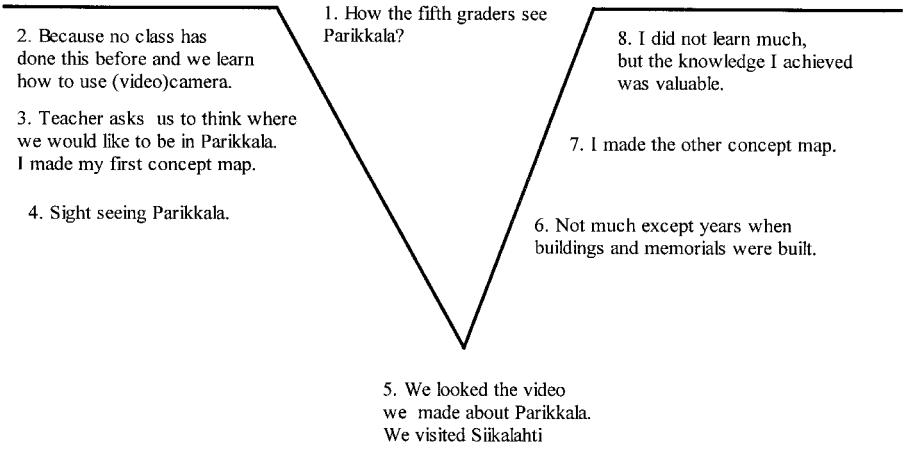

Figure 10 Pekka's Vee heuristic of the learning project concerning the municipality of 'Parikkala as seen by 5th graders'. He is 12 years old and describes relatively superficially what pupils did in order to construct knowledge of their own municipality. Compare this Vee heuristic to Johanna's Vee heuristic of the same learning project. There is a big difference in details and understanding of the project

Table 1 The first and second concept maps analyzed. The theme is 'Parikkala as seen by 5th graders'. Review Figures 5, 6, 8 and 9 for comparison. Johanna's code is 01 and Pekka's code is 09.

Pupils	*Relevant concepts*		*Relevant propositions*		*Hierarchy*	
	The 1st concept map	*The 2nd concept map*	*The 1st concept map*	*The 2nd concept map*	*The 1st concept map*	*The 2nd concept map*
The high achievers						
01	7	18	9	19	0	1
02	10	24	9	24	0	1
03	8	11	6	10	0	0
Sum	25	53	24	53	0	2
Mean	8.3	17.7	8.0	17.7	0.0	0.7
The average achievers						
04	10	11	10	10	0	1
05	5	6	4	5	0	0
06	9	21	13	20	0	1
Sum	24	38	27	35	0	2
Mean	8.0	12.7	9	11.7	0.0	0.7
The low achievers						
07	7	16	10	17	0	1
08	7	7	10	9	0	0
09	7	9	8	0	0	1
Sum	21	32	28	26	0	2
Mean	7.0	10.7	9.3	8.7	0.0	0.7

The first question was: What can be learnt when improved concept maps are used to monitor and promote pupils' geographical learning? Qualitatively detailed and valuable data and knowledge can be obtained from concept maps which help both the pupils and the teacher to monitor and promote shared geographical learning and education.

The second question was: What can be learnt when improved Vee heuristics are used to monitor and promote pupils' geographical learning? Qualitatively detailed and valuable data and knowledge can be obtained which help both the pupils and the teacher to monitor and promote shared geographical learning and education.

What has been presented in this paper opens important new possibilities for teaching geography. Using improved concept maps and Vee heuristics we have learnt:

Table 2 Vee heuristics analyzed. The theme is 'Parikkala as seen by 5th graders'. Pupils are now 12 years old. Review Figures 7 and 10 for comparison. Johanna's code is 01 and Pekka's code is 09

Pupils	*Value justifications in the beginning of the learning project*	*The frequency of the planned knowledge gathering methods*	*The frequency of knowledge gathering methods used*	*The frequency of items that the pupil told she/he had learnt*	*The frequency of value expressions in the end of the learning project*
The high achievers					
01	3	3	6	1	1
02	4	3	5	2	3
03	3	2	5	2	1
Sum	10	8	16	5	6
Mean	3.3	2.7	5.3	1.7	1.7
The average achievers					
04	2	3	3	1	2
05	1	2	2	1	1
06	3	4	6	3	2
Sum	6	9	11	5	5
Mean	2	3.0	3.7	1.7	1.7
The low achievers					
07	2	2	4	2	3
08	1	2	3	1	1
09	2	2	3	1	1
Sum	5	6	10	4	5
Mean	1.7	2.0	3.3	1.3	1.7

(1) students develop more sophisticated and complex concept structures with geographical inquiries.
(2) Concept structures are more widely linked to other content as inquiring and learning takes place.
(3) Both concept maps and Vee heuristics are a means for students and teachers to reveal the complexity of their concept structures.
(4) Concept structures are ultimately revealing regarding the degree to which a content area such as geography has been subsumed within the students' cognitive structure.

We have collected data of other geographical topics. Our next paper is undergoing intense rewriting. Its title will be 'Practical Application of an Education Theory: Concept Maps and Vee Heuristics'.

Acknowledgements

We thank Emeritus Professor Michael Bassey, PhD (University of Nottingham, now with the British Educational Research Association), Professor Patrick Dillon, PhD (earlier at University of Reading, now at University of Exeter), and Professor Bridget Somekh, PhD (Manchester Metropolitan University) for their helpful and encouraging comments concerning our research project. Our thanks are also due to Professor John Lidstone (Queensland University of Technology) and Emeritus Professor Michael Williams (University of Wales, now a consultant for OECD) for their comments and encouragement concerning geographical and environmental education parts of the research project. We thank three anonymous reviewers for their comments.

Correspondence

Any correspondence should be directed to Professor Mauri Åhlberg, University of Joensuu in Savonlinna, PO Box 55, FIN-57101 Savonlinna, Finland (mauri.ahlberg@joensuu.fi).

References

Åhlberg, M. (1990) *Käsitekarttatekniikka ja muut Vastaavat graafiset Tiedonesittämistekniikat Opettajan ja Oppilaiden Työvälineinä.* [*Concept Mapping and Other Similar Graphic Representation Techniques as Tools for Teachers and their Students.*] University of Joensuu. Research Reports of the Faculty of Education No. 30.

Åhlberg, M. (1990b) *Kasvattajille sopivien Tutkimusmenetelmien Ja-instrumentien Teoreettiset Perusteet, Tutkiminen ja Kehittäminen Elinikäisen Kasvatuksen ja Opimisen Näkökulmasta.* [*Research Methods and Instruments, which are Suitable for Teachers: Theoretical Underpinning, Research and Development from the Viewpoint of Lifelong Education and Learning.*] University of Joensuu. Research Reports of the Faculty of Education No. 31.

Åhlberg, M. (1993) Concept maps, Vee diagrams, and rhetorical argumentation analysis (RAA): Three educational theory-based tools to facilitate meaningful learning. In J. Novak and R. Abrams (eds) *Proceedings of the Third International Seminar on Misconceptions and Educational Strategies in Science and Mathematics.* Cornell University, Ithaca, NY, 1–4 August. Published electronically.

Åhlberg, M. (1997) *Jatkuva Laadunparantaminen Korkealaatuisena Oppimisena.* [*Continual Quality Improvement as High Quality Learning.*] University of Joensuu. Research Reports of the Faculty of Education No. 68.

Åhlberg, M. (1998) Education for sustainability, good environment and good life. In M. Åhlberg and W. Leal Filho (eds) *Environmental Education for Sustainability: Good Environment, Good Life* (pp. 25–43). Frankfurt am Main: Peter Lang.

Åhlberg, M. (1999) Promoting sustainable development by an in-service teacher education course 1997–1999 in Southern Savo (Finland). Unpublished manuscript.

Ahoranta, V. (1999) Laatua parantamassa ja kestävää kehitystä edistämässä peruskoulussa. Parikkalan kangaskylän koulun jatkuvan laaunparantamisen ja kestävän kehityksen projekti vuosina 1997–1999. [Improving quality and promoting sustainable development in comprehensive school. Continual quality improvement and sustainable development project of Kangaskylä school in Parikkala during 1997–1999.] MA thesis, Department of Teacher Education, University of Joensuu. Savonlinna.

Alvarez, M. (1998) Interactive Vee diagrams as a metacognitive tool for learning. On WWW at http://www.coe.uh.edu/insite/elec_pub/HTML1998/th_alva.htm. Accessed 2.1.2000.

Archer, K. (1995) A folk guide to geography as a holistic science. *Journal of Geography* 94 (3), 404–11.

Ball, S. (1988) Unintended effects in educational research. In J. Keeves (ed.) *Educational Research, Methodology, and Measurement. An International Handbook* (pp. 490–3). New York: Pergamon.
Buzan, T. (1982) *Use Your Head* (rev. edn). London: Ariel Books.
Buzan, T. (1993) *The Mind Map Book*. London: BBC Books.
Candy, P. (1991) *Self-direction for Lifelong Learning*. San Francisco: Jossey-Bass.
Cohen, L. and Manion, L. (1989) *Research Methods in Education* (3rd edn). London: Routledge.
De Corte, E. (2000) Marrying theory building and the improvement of school practice: A permanent challenge for instructional psychology. *Learning and Instruction* 10, 249–66.
Deming, E. (1994) *The New Economics* (2nd edn). Cambridge, MA: MIT.
Denzin, N. and Lincoln, Y. (1994) Introduction: Entering the field of qualitative research. In N. Denzin and Y. Lincoln (eds) *Handbook of Qualitative Research*. London: Sage.
Flavell, J. (1976) Metacognitive aspects of problem solving. In L. Resnick (ed) *The Nature of Intelligence.* Hillsdale, NJ: Lawrence Erlbaum.
Galtung, J. (1979) *Papers on Methodology* (vol. 2). Copenhagen: Christian Eijlers.
Gowin, B. (1981) *Educating*. Ithaca: Cornell University.
IGU (1992) *International Charter on Geographical Education.* Commission on Geographical Education, International Geographical Union.
Kaminske, V. (1997) Geographical concepts: Their complexity and their grading. *International Research in Geographical and Environmental Education* 6 (1), 4–26.
Kommers, P. (1997) Special issue preface: Concept mapping. *Journal of Interactive Learning Research* 8 (3/4), 281–7.
Leonard-Barton, D. (1996) A dual methodology for case studies. In G. Huber and A. Van de Ven (eds) *Longitudinal Field Research Methods*. London: Sage.
McAleese, R. (1998) The knowledge arena as an extension to the concept map: Reflection in action. *Interactive Learning Environments* 6 (3), 251–72.
Merriam, S. (1988) *Case Study Research in Education*. San Francisco: Jossey-Bass.
Miles, M. and Huberman, M. (1994) Qualitative data analysis: An expanded sourcebook (2nd edn). London: Sage.
Natoli, S. (1994) Guidelines for geographic education and the fundamental themes in geography. *Journal of Geography* 93 (1), 2–6.
Novak, J. (1980) Progress in application of learning theory. *Theory into Practice* 19 (1), 58–65.
Novak, J. (1988) *Learning, Creating and Using Knowledge. Concept Maps as Facilitative Tools in Schools and Corporations*. London: Lawrence Erlbaum.
Novak, J. and Gowin, B. (1984) *Learning How to Learn*. Cambridge: Cambridge University Press.
Palmer, J. (1993) From Santa Claus to sustainability: Emergent understanding of concepts and issues in environmental science. *International Journal of Science Education* 15 (5), 487–95.
Palmer, J. (1998) *Environmental Education in the 21st Century: Theory, Practice, Progress and Promise*. London: Routledge.
Patton, M. (1990) *Qualitative Evaluation and Research Methods* (2nd edn). London: Sage.
Rikkinen, H. (1998) Maantiede peruskoulun ala-asteella [Geography at the primary school level]. 2. painos. Department of Teacher Education, University of Helsinki. *Studia Paedagogica* 15.
Rikkinen, H. (1999) Maantiede peruskoulun yläasteella [Geography at the lower secondary school level]. 2. painos. Department of Teacher Education, University of Helsinki. *Studia Paedagogica* 18.
Roth, W.-M. and Verechaka, G. (1993) Plotting a course with Vee maps. *Science and Children* 30 (4), 24–7.
Slotte, V. and Lonka, K. (1999) Spontaneous concept maps aiding the understanding of scientific concepts. *International Journal of Science Education* 21 (5), 515–31.
Stake, R. (2000) Case studies. In N. Denzin and Y. Lincoln (eds) *Handbook of Qualitative Research* (2nd edition). London: Sage.

Tashakkori, A. and Teddlie, C. (1998) *Mixed Methodology. Combining Qualitative and Quantitative Approaches*. London: Sage.

Yin, R. (1998) The abridged version of case study research. Design and method. In L. Bickman and D. Rog (eds) *Handbook of Applied Social Research Methods*. London: Sage.