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ARTICLE

Using a Modelling Language for Supporting University Students' Orienting Activity when Studying Research Methods

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The present study focuses on examining how digitally guided conceptual mapping can be used in orienting students in higher education to learn complex domain content and practices. The educational setting investigated was targeted at doctoral students in the behavioural sciences who were learning qualitative and mixed methods in their own research activities. The students used digitalized conceptual tools to construct an external representation of research methods in the form of concept maps. The concept maps worked as orienting bases that were considered to inform their further domain-specific activity and corresponding learning goals. The students were found to implement the digital guidelines in various ways, depending on their previous knowledge and current knowledge-driven needs. The orienting bases by the students allowed the teacher to tailor her guidance according to the domain-specific challenges that the students encountered in studying the principles and practices of research methods.

Keywords: Teaching qualitative and mix methods; Conceptual mapping; Orienting basis; Higher education; E-learning

The teaching of research methods in higher education has been criticized for the insufficient connection to students' own research problems (Benson & Blackman 2003; Edwards & Thatcher 2004), and often research methods are not integrated in the overall research process. In addition, the complexity of research methods highlights difficulties in their understanding. University teachers in the field of social and behavioural sciences are nowadays challenged to train "research experts" who are able to incorporate both qualitative and quantitative methods and approaches in their research projects (Tashakkori & Teddlie 2003). This highlights the need of training in qualitative research methods for psychologists and other practitioners (e.g., in the UK, see Forrester & Koutsopoulou 2008). There is also a growing interest in the efficient ways of teaching these methods in higher education (Hansen & Rapley 2008; Navarro 2005). Navarro (2005), for example, presents her own development process of teaching qualitative methods in a practical way by simulating a true research process with her students.

One frequently used pedagogical method in higher education is to engage students in collaboratively creating concept maps of complex phenomena (Farrand et al. 2002; Hay et al. 2008). The mapping of concepts helps learners to structure, elaborate, and communicate their ideas, thoughts and knowledge about relevant disciplinary content and resources (Nesbit & Adesope 2006; Novak & Cañas 2006; 2007). Digital concept maps can also be used as processing tools to visualize different types of knowledge and information (Hill & Hannafin 2001; Novak & Cañas 2007).

Apart from the opportunities it affords, conceptual modelling also poses challenges for the semantic organization of the content in disciplines. First, even in higher education, the capacity of students to accurately and flexibly represent multifaceted conceptual relations cannot be taken for granted (Hay & Kinchin 2006; Pinto et al. 2010). Second, to fully benefit from the mapping process, students need time to reflect on the evolving maps in face-to-face discussions (Kinchin et al. 2005; Lord 1998). Third, the widely adopted hierarchical structure of concept maps may not optimally support the modelling of functional relations, dependencies and sequential content, such as processes or developments (Eppler 2006; Safayeni et al. 2005). Fourth, conventional concept maps do not afford the concise separation of concepts of critical importance from those of secondary importance (Daley 2004). In the present study, the digital mapping tool provided for the students enabled a flexible and open way for constructing concept maps. The digital tool included visual and conceptual guidelines, purported to support students in creating concept maps that would help them to *orient themselves towards research methods and pay*

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attention to the concepts of critical importance. The investigated context was a seminar conducted on the qualitative and mixed methods in the field of behavioural sciences for doctoral students.

Theoretical Background

The instructional approach that was implemented in the present study is based on the use of various knowledge representation scaffolds such as guidelines, pre-defined modelling elements or focus questions offered to learners when they create maps (Dansereau 2005; O'Donnell et al. 2002, Safayeni et al. 2005, Stoyanov & Kommers 2006). The process of creating concept maps was investigated as a guided explorative activity in creating an orienting basis for the further research activity of the students (Galperin 2002). The concept of *orienting basis of an action* (OBA) is one of the cornerstones of the theory of planned stage-by-stage formation of mental actions and concepts introduced by Galperin (1992; 2002). The OBA refers to the elements and conditions of the problem situation to which a learner orients him- or herself in acting. The concept of 'acting' in this respect is conceived as conscious attempts to change or explore objects according to some intended results or criteria. In higher education, instructional practices based on the use of OBA taking the form of orienting charts have been implemented, for instance, in the fields of medical, technical and teacher training (Edwards 1995; Reshetova 2004; Stolk et al. 2009; Terlouw 1993). The purpose of the orienting chart in the learning process is that the conceptual scheme represented by the chart is internalized and becomes a mental model for the orientation on the action; e.g. using research methods appropriately in empirical research. When the orienting chart is used, the learner is provided with all the information necessary for the correct execution of a new action. The information includes the intended outcome, objects and means of the action, and the necessary steps and conditions of action. This information is put together with students in an 'orienting chart'.

Instructional design based on the concept of orienting basis emphasizes the role of orienting devices, which provide a learner with a model of elements to be accounted for in the execution of the action to-be-learnt. According to Reshetova (2004), four interrelated components of the OBA should be distinguished in designing orienting devices: motivational, planning, exploratory and evaluative.

The motivational component accounts for the stimulation and purpose formation. The planning and exploratory components concern the structure of the target activity and its object in learning. The planning component outlines the stages in the realization of the activity as well as the related sequences, actions and operations. The exploratory component performs the function of the operational thinking schema (Galperin 2002) that facilitates the analysis of the object and the context of the target activity in learning. The evaluative component accounts for the reflection on current actions and the possible correction of them. Both the exploratory and planning component of the orienting basis of action can be viewed to bear relevancy to teaching qualitative and mixed methods. The exploratory component can be related to *diverse methodological frameworks of qualitative research and their theoretical underpinnings* that a novice investigator should account both in approaching concrete research problems and in deepening his or her understanding of the domain as a whole. The planning component, in turn, corresponds to the *concrete research techniques, procedures and practices* that a novice investigator using qualitative and mixed methods should acquire and apply to conduct sophisticated research.

Evolving activities that are not yet internally regulated (Reshetova 2004) or activities involving tasks with heuristic components (Terlouw 1993) cannot be shaped by means of ready-made orienting bases. In contrast, orienting bases should be constructed by learners during their learning process (Terlouw 1993). Subsequently the learners apply this basis while performing the action. In that case, the learners can use a provisional and partial orienting chart that creates a preliminary orienting basis (Terlouw 1993). The present study aimed at shedding light on how conceptual guidelines (Stoyanov & Kommers 2006) embedded in the digital modelling tool may serve as the elements of preliminary orienting basis to be used by students in creating their own orienting bases for the use of qualitative and mixed methods. We also investigated the feedback that the teacher gave to the students when commenting on the orienting bases created by them.

In the investigated setting, students created their concept maps in pairs, and this activity was explored as a process of creating an orienting basis for the students' own qualitative research. The process of creating orienting bases was considered as *orienting activity* (Galperin 2002), the outcome of which is the *externalized image or representation of the elements of some problem situation (in this case, appropriate usage of research methods) and the actions that allow a learner to productively address the problem*.

The process of creating concept maps was supported by *the elements of a preliminary orienting basis* (Terlow 1993), by which we mean the conceptual guidelines converted into the form of a digital modelling language used by students in creating their concept maps. These guidelines were based on the conceptual meta-model that was developed and implemented by the first author in his previous interventional studies (Kosonen & Hakkarainen 2007; Kosonen et al. 2010). The meta-model represents various generic conceptual structures partially converging with the meanings of the link-codes that are used in Texas Christian University Node-Link Mapping (TCU-NLM, Dansereau 2005). The meta-model distinguishes: a) the textual structuring of static inter-conceptual relations that characterize the examined phenomenon and b) the conceptualizations of activities, actions and processes related to it. These guidelines were designed to help the students to create the *concept maps that can function as orienting bases* for their research activities, taking into account both the planning and exploratory aspects corresponding to Galperin's notion of orienting basis. The conceptual guidelines drew the attention of the students both to the elaborations on diverse methodological frameworks

underlying qualitative research and to concrete research techniques, procedures and practices.

In the previous studies (Kosonen & Hakkarainen 2007; Kosonen et al. 2010), the meta-model was used to guide young, blind learners in their reading process to orient themselves towards expository texts as structured conceptual objects. The present study explored whether and which of the modified elements of this meta-model are usable as the digitalized elements of preliminary orienting basis (Terlouw 1993) embedded in a collaborative mapping tool. The study also aimed at shedding light on how the elements can be used to support students in higher education when they learn such complex domain as research methods. The meta-model was used as a generic conceptual frame in designing the context-specific codes of the modelling language as a set of conceptual scaffolds (Hill & Hannafin 2001). These scaffolds were used to highlight crucial issues related to qualitative and mixed methods and their use.

During the past years, various modelling languages embedded in computer technology have been used to model learning activities, resources, services and user roles in educational contexts (Dodero et al. 2010; Dodero et al. 2012, Laforcade 2010). In those cases, the modelling languages used have served as sources of abstraction for computer scientists to edit common elements of a learning design, such as activities, roles, learning flows and assessment-based adaptations. Domain-Specific Modelling languages are defined as the set of concepts and their relations within a specialized problem field (Dodero et al. 2012; Laforcade 2010). The domain in the aforementioned context is the discipline of technology-enhanced learning design (Dodero et al. 2012). The use of modelling language in the present study focused on the structuration of the content taught and modelled in the seminar investigated: the domain of qualitative and mixed methods and their use in research. A generic modelling language was modified to include domain-specific features. Unlike the conventional context of visual languages used by educators, the visual language in our study was used by the students. The modelling language served as a preliminary orienting basis for the students' concept mapping.

The aims of the study

The present study explores the pedagogical implementation of the meta-model that was contextualized to the educational setting investigated. Specific codes of a modelling language were used as the elements of the preliminary orienting basis, suggested to the students as digital guidelines to be implemented in creating their own tailored orienting bases in the form of digital concept maps. The study aimed to shed light on how the use of the elements of preliminary orienting basis mediated the reflections on the students' domain-specific prior knowledge, new knowledge and further learning needs in the concept mapping activity. The following research questions were formulated:

1. How did the students use the digitalized elements of the preliminary orienting basis and how did these elements serve the creation of the students' own tailored orienting bases?
2. How did the various elements of the orienting bases created by the students mediate their discussions with the teacher on the various domain-specific issues?

Method

This study represents an instrumental case study (Stake 1995) in which a researcher selects a small group of subjects in order to examine a certain pattern of behaviour. The context of the case study was a seminar of qualitative and mixed methods in the Institute of Behavioural Sciences at the University of Helsinki. The case investigated was the students' conceptually guided digitalized concept mapping in creating the tailored orienting bases. The case was explored by analyzing a) the tailored orienting bases (concept maps) created by the students, and b) the application of the orienting bases in educational discussions between the teacher and the students. The rationale for the selection of the setting was the need to test the benefits of the concept mapping tool and the modelling language in an authentic educational context that was not created only for research purposes.

The patterns of behaviour were investigated in order to obtain new research-based information about how students could benefit from the use of the digitalized elements of preliminary orienting basis in creating tailored orienting bases for the use of qualitative and mixed methods in their own research. The content of the orienting bases was expected to accumulate on the basis of the students' domain-specific prior knowledge and the new knowledge being acquired during the investigated seminar.

Participants

The teacher of the investigated seminar was a researcher with 15 years' experience in educational research. She had used various virtual environments in teaching.

The students participating in the seminar already had some prior knowledge about qualitative and mixed methods based on their previous studies. The participants were six doctoral students (2 males and 4 females). Attending the seminar was part of their voluntary studies and the aim was to support their research competence; the participants were either just beginning their doctoral thesis or in the mid-way through their thesis. It is a typical practice in university education to admit only a small number of participants in a doctoral seminar. The students did not have previous experience of the virtual environment used during the seminar but they all had good ICT skills so that working with the tools was not problematic.

The first author worked as an assistant teacher during some of the seminar meetings and taught the students how to use the modelling elements.

Setting

Educational design. The study was conducted in a seminar of qualitative and mixed methods. The main objective was to offer students a practice-related seminar, which combined the students' individual research work on their

Meeting	Themes	Performer	Additional material
1	Introduction, arrangements	The lecturer	Material about the course, the virtual environment
2	Issues about the research process, and How to handle complex data	The lecturer	A published research article (by the lecturer)
3	Introduction to the analysis of qualitative data, ATLAS.ti as an example tool	University IT-expert, the lecturer	A report to policy-makers about research results, A published article about content analysis
4	Investigating reliability and trustworthiness	Two students	Students' presentations (a text and a Power Point presentation)
5	Continuing the previous theme: commenting and going further	The lecturer	Research articles about good methodological practices and about calculating correlations
6	Mixed methods	Two students	Students' presentation A research article about quantifying qualitative data
7	How to write an article-based doctoral dissertation	An external expert who had recently defended her doctoral dissertation	A doctoral dissertation (including four articles)
8	Case-study	Two students	Students' presentation
9	Interview	One student	Student's materials
10	Grounded theory	Two students	Students' presentation
11	Closing session	All students, teacher	Created maps presented by students

Annex 1: The Face-to-face meetings of the seminar by theme, performer and material.

doctoral dissertation, and the research practices of the professional research community in general. Regarding the orienting basis of an action (OBA) framework, the orientation of the students towards their own research and their related learning needs created the motivational component for the investigated setting. Moreover, in creating their concept maps, the students were able to prioritize the issues related to their own research.

The seminar supported the students' work for their doctoral dissertations in two ways: a) The content of the seminar was based on students' presentations on themes related to methods in their own research; b) students conceptualized their developing understanding of the qualitative and mixed methods by creating concept maps in pairs throughout the seminar. The students were organized to work in pairs in order to enhance argumentation and critical discussion concerning the research methods. In addition, students had free access to the concept maps created by other pairs. These maps were also examined and discussed during the seminar meetings.

The seminar included 11 face-to-face meetings dedicated to separate domain-specific themes during one month (see **Annex 1**). The performers were students (5 meetings), the lecturer (3 meetings), and external experts (2 meetings). At the end there was one collaborative closing meeting.

Virtual tools. The concept maps were created by the students with a web-based tool called Visual Modelling Editor (VME). The VME is a modelling tool that is integrated in a web-based collaboration tool Knowledge Practice Environment (KPE) (Vasileva et al. 2011). The KPE is designed to support working collaboratively with knowledge artefacts. The students used this tool for storing and sharing their presentations, for creating and sharing concept maps, and for sharing other documents and web-links. The VME allows users to create concept maps as visual models in KPE. Also various tailored modelling languages consisting of visualized node and link codes can be used in the concept maps.

The students were able to modify the default titles of the modelling language codes when they used the codes in the concept maps. Students were also able to make short notes within the nodes in the separate description boxes that open by clicking the node (see **Figure 1**). The modelling language codes and the description boxes were introduced to the students as representational tools that they could implement according to their own preferences. The technical feature allowing the use of visualized codes for visual modelling is not unique to VME. Similar visual features of more widely used networked tools can be used for the same purposes.

On the basis of the findings from the previous iterations of the same seminar setting (Kosonen et al. 2009), a modelling language with specific knowledge representation guidelines was designed to support the creation of concept maps. The meta-model from the previous studies (Kosonen et al. 2009; 2010) was used as a starting point. The guidelines reflected the concepts and conceptual relations that the teacher emphasized in teaching qualitative and mixed methods as well as the relevant conceptual

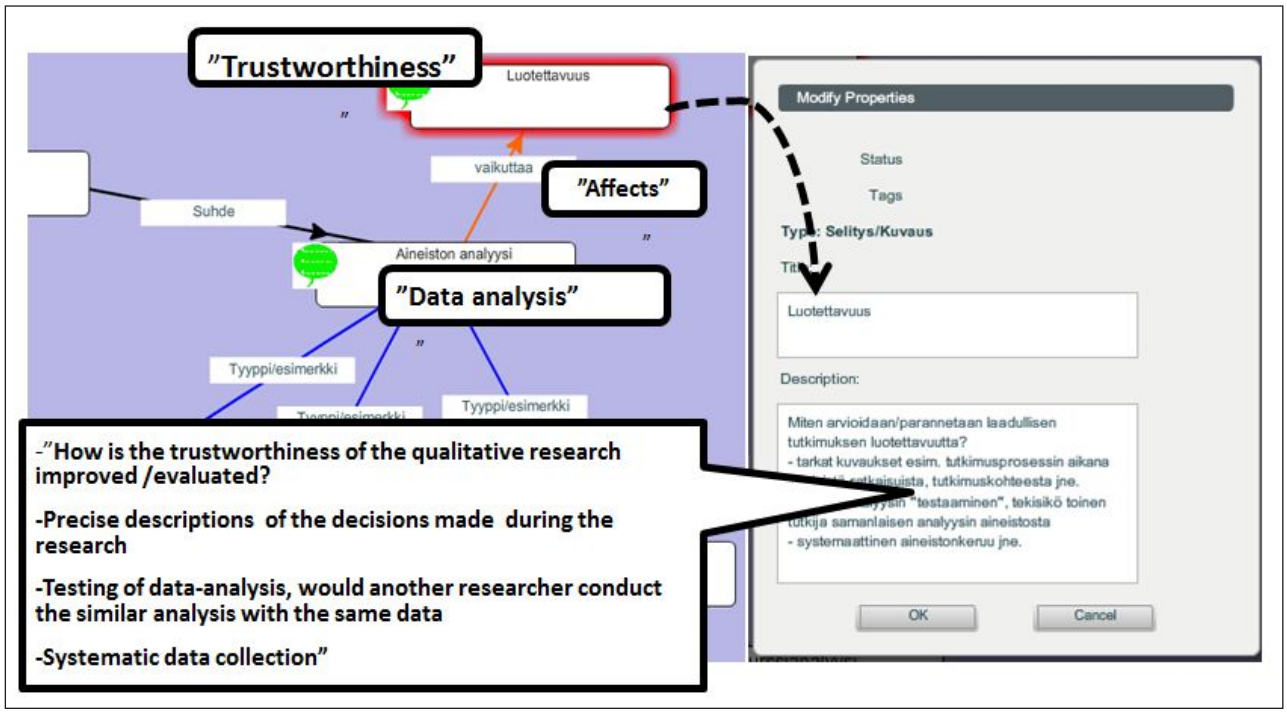

Figure 1: Using the Visual Modelling Editor (VME) in the Knowledge Practice Environment (KPE). The screen shots present a concept map and the description box of one of its nodes. On the left: A section of the concept map created using VME, on the right: the description box of a node for making notes. Finnish texts are translated in English in boxes with black lines.

structures that the students were found to have frequently used in the previous iterations.

The orienting basis of an action (OBA) concept was adopted as a structuring framework in defining the code families of the modelling language (see **Annex 2**). Two components of OBA were emphasized, exploratory and planning. The language codes promoting conceptual exploration corresponded to the exploratory component of the OBA, whereas the codes supporting practice-related elaborations paralleled the meaning of the planning component of OBA. The language codes promoting conceptual exploration highlighted the distinction between the various types, characteristics and philosophical backgrounds of the research methods as well as the conceptualization of trustworthiness issues (for instance, codes "Feature" and "Background philosophy"). The language codes for the practice-related elaborations referred to research activities and their objects, contexts, means and tools as well as related working phases (for instance code "Context of implementation"; see **Annex 2**). In addition, the modelling language included the following contextually unspecific elements: "Concept/phenomenon", Description/explanation", "Quotation of a resource", and "Relation". They afforded the epistemic organization of concepts without highlighting any particular content in the modelling.

Data Collection

Two types of data were collected from the seminar. First, the final versions of the concept maps of each student pair (3 maps) were used to study how the students had used codes of the modelling language. The data included 85 node titles, 30 descriptions inside the nodes and 90 links. Second, the closing session during which the students presented their maps was video recorded. The video data included the students' presentations of their maps and related educational discussions during the closing session. The duration of the presentations ranged from 16 to 26 minutes. The data collection concentrated on the final products and discussions because the main interest in the study was on the students' reflection on research methods at the end of the process.

Data Analysis

Analysis of the Concept Maps. The analysis of the students' concept maps provided answers to the first research question on how the participants used the codes of the modelling language as the elements of the preliminary orienting basis in creating their own tailored orienting bases. The content of the nodes served as basic data for analyzing the relations in terms of categories. This analysis captured both the title and the possible description of each node (see **Figure 1**). The analysis included the following two stages:

Stage 1: Interpreting the content of node titles and descriptions;
Stage 2: Interpreting the meaning of the explicit relations between the nodes, and the implicit relations between the titles and descriptions that are inside nodes on the basis of the analysis at Stage 1. The node title and the description were interpreted

Type	Element: *code title,* guiding exemplary expressions	Symbol
Codes meant to support conceptual exploration	Link: *"Defining",* "For defining" Example: "The method x is..."	Yellow arrow
	Link: *"Function,",* "For the description of purpose" Example: "The method x is meant for..."	Yellow arrow
	Link: *"Feature",* "For the description of feature" Example: "A characteristic feature of the method x" Node: *"Trustworthiness"*	Green arrow 
	Link: *"Type/example", "For the grouping of various types"* Example: "There are such paradigms of qualitative research as..."	Blue arrow
	Link: *"Affects,"* "For the description of influences" Example: "The research paradigm x is motivated by the philosophical framework y", "z affects trustworthiness" Node: *"Background philosophy",* "A background philosophy exerting influence on a research paradigm"	Orange arrow 
Codes meant to support practice- related elaborations	Link: *"Context of implementation",* "For the description of the context of implementation" Example: "The method is implemented in ..."	Brown arrow
	Link: *"Activity", "*For the description of activities*"* Example: "In applying the method one does/... explores"	Violet arrow
	Link: *"Is directed to",* " For the description of the object of activity" Example: "The activity of the researcher applying the method is directed to..."	Violet arrow
	Link: *"The mean of previous","* For the description of means and tools" Example: "In applying the method one uses a tool/mean..."	Violet arrow
	Link: *"Phase in previous", "* For the description of regular phases" Example: "The first working phase in applying the method is..."	Violet arrow
Unspecific code	Node: *"Concept/Phenomenon"* 	
	Node: "*Explanation/Description*" 	
	Node: "*Quotation of a resource*" 	
	Link: "*Relation*"	Black arrow

Annex 2: Language codes functioning as the elements of the preliminary orienting basis.

to be connected to each other as if an explicit link existed between them.

Based on the preliminary data survey, a set of categories was created to analyze the content of the node titles and descriptions at Stage 1. This set included seven categories:

- *Qualitative research methods*: Research approach in general or its specific type (e.g., action research, grounded theory, etc.).
- *Qualitative research techniques*: Concrete research technique or a category of research techniques (interview, observation, content analysis, discourse analysis).
- *Trustworthiness*: The title is concept "trustworthiness", its synonym or sub-category.
- *Philosophical, paradigmatic or methodological principle*: Philosophical approach ("hermeneutics") or general methodological principle ("quantification of qualitative data").
- *Definition or characterization*: Definition or characterization of phenomenon (e.g. "provides an opportunity to investigate complex phenomena", "is a typical research strategy") concerned in another, connected node.

- *Activities, means and tools*: Activities (data collection, data analysis, creating an indicator), used means or tools (Atlasti 6, video recordings) or more detailed actions (classifying, selecting informants, reporting).
- *Objects and outcomes of activities or procedures*: Phenomenon or object that the research activities can be directed to (data, phenomenon, case) or result in (reported findings).

The analysis at Stage 2 focused on the meaning of relations that, in general, play a central role in concept maps. To analyze the meaning of relational links at Stage 2, two categories were created and used. These were based on the conceptual distinction between the conceptual exploration and the practice-related elaborations as well as on the content analysis of nodes. The categories were the following:

- *Relations structuring conceptual exploration*: Either one of the linked titles or the title or description inside a node belongs to or is scored in the category of "Definition or characterization". None of the linked titles, neither the title nor the description inside a node, is coded in the categories of either "Activities, means and tools" or "Objects of activities or procedures".
- *Relations structuring practice-related elaborations*: One of the linked titles, the title or description inside a node is coded in the categories "Activities, means and tools" and "Objects and outcomes of activities or procedures".

The relations between the titles and descriptions of the nodes were coded in a similar way as the relations between the titles of separate nodes.

The outcomes of the analysis were organized in a separate table (**Table 2**), where the findings were presented according to the interpreted meanings of the relations and the language codes used by the students in the links and nodes. This enabled an exploration of the correspondence between the interpreted meanings of the links and the language codes actually used by the students.

Analysis of the Video Recordings. The video recorded data was transcribed and sequenced according to the content specific topics that the participants' verbalizations focused on. A section of the video data was considered to be a sequence when the verbalizations related to the same concept or conceptualization that was referred to in a separate map element or in a group of elements. Two types of sequences were selected on this basis. The first type included the students' descriptions of the map elements or the related modelling process that were not immediately preceded or followed by the teacher's related comments. The second type of sequences consisted of the episodes during which the teacher commented on or referred to the map elements, or when both the students and the teacher discussed the same map elements.

Both types of sequences were analyzed in terms of the following categories to explore whether the students' and the teacher's statements concerned an orientation related to conceptual framing, practice-related orientation, or to both:

- Sequences including reflections on conceptual exploration: These verbalizations describe qualitative research methods and trustworthiness, or philosophical, paradigmatic or methodological principles *without concerning related activities, their objects, means and tools or procedures*. For example: "But what I got to know most was the analysis I use myself (pointing to "Content analysis"): I grasped it a bit better".
- Sequences including reflections on practices: These statements concern qualitative research methods and trustworthiness, or philosophical, paradigmatic or methodological principles *from the perspective of related activities, their objects, means and tools or procedures*. For example: "As far as these are concerned, you could think each of them, "data collection" could be expanded, besides writings and interviews there are still other ones… "
- Sequences including reflections on *both conceptual framing and practices*: A sequence contains verbalizations that meet both the aforementioned criteria. For example: "We have elaborated on general issues, then on method and on data… on what the data is like."

The analysis of the sequences including only the student statements aimed at answering the first research question on how the students used the modelling editor and the available codes of the modelling language. The analysis of the sequences also included the teacher statements which served as answers to the second research question on how the various elements of the maps mediated educational discussions with the teacher on various domain-specific issues.

Validity and Reliability. The analysis categories were based on the content analysis conducted by the first author, in which he developed the structure over several iterations. The second author evaluated that structure, which was then simplified.

The inter-coder reliability of the link analysis was tested by the second author. She used the classification schema to analyze 20% of the randomly selected titles and descriptions of the nodes. No differences emerged except in the category of "Trustworthiness", in which there was a systematic difference in classification. This difference was based on a misunderstanding about the definition of the category. The authors then agreed to keep the original categorization but to clarify the description of the category. The video analysis was not tested by the second author because, following a joint discussion between the researchers, the categories appeared to be unambiguous.

Results

Students' Concept Mapping Activity

The analysis of the students' concept maps revealed a considerable range in their content and structure as well as differences in their use of the modelling language. The

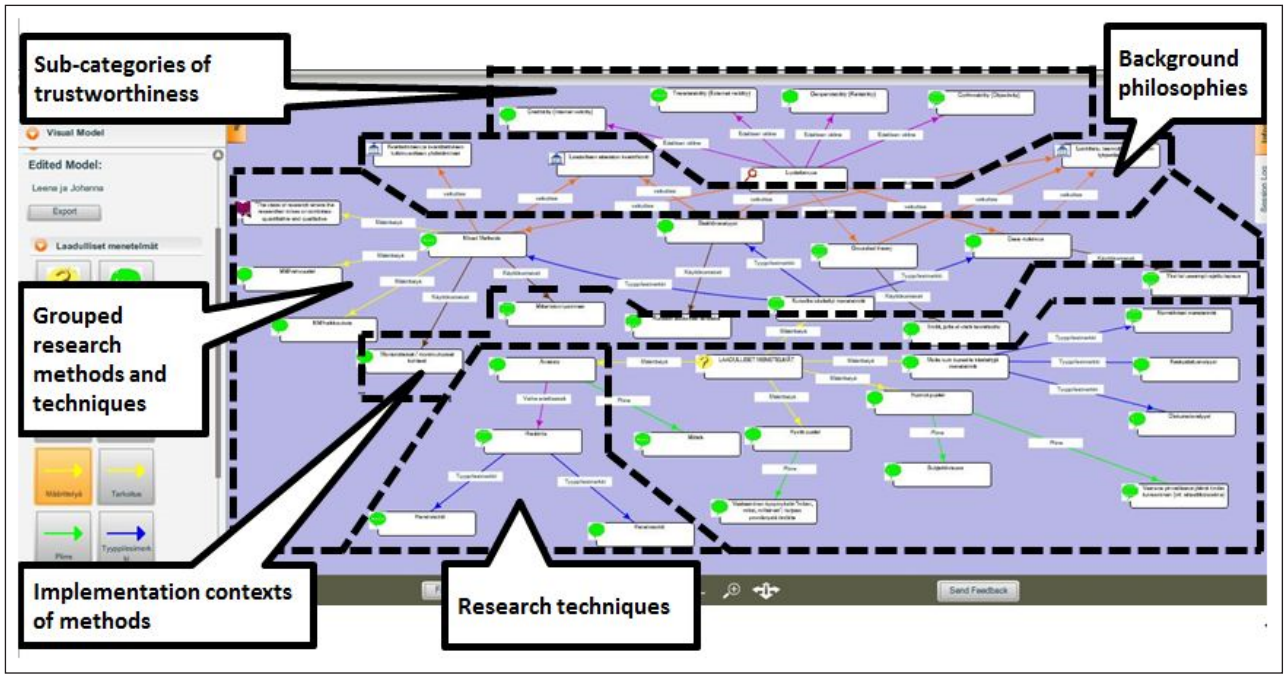

Figure 2: The concept map of Pair 2. The text-boxes added in the figure explain the main contents of the nodes in separate sections of the concept map that are marked with the dotted lines.

Relation type	Pair 1		Pair 2		Pair 3	
	Conceptual exploration	Practice-related	Conceptual exploration	Practice- related	Conceptual exploration	Practice-related
Explicit relations	3	25	26	14	10	12
Implicit relations	7	11	1	1	4	6
Total	10	36	27	15	14	18

Table 1: Relation types (established in the analysis), either explicit (links between nodes) or implicit (titles and descriptions inside nodes) in the concept maps.

number of the elements used from the modelling language ranged from five to twelve (a map with the 12 codes used is presented in **Figure 2**.

The findings regarding the relation types and elements of the modelling language used by the student pairs are summarized in **Tables 1** and **2**. As **Table 1** demonstrates, the analysis of the concept maps revealed considerable differences between the student pairs in respect of the quantitative distribution of the relation types as well as the number or implicit and explicit relations in their maps. Two pairs created many descriptions within the nodes of their maps, whereas one pair only minimally implemented the description function.

The findings summarized in **Table 2** reveal that the student pairs also remarkably differed in respect of the link and node codes used.

The analysis of the video data revealed a total number of 14 sequences during which the students described the elements of their content maps or the modelling process in general without the teacher's comments immediately preceding or following. Eight of these sequences concerned conceptual framing, five were found to include descriptions of the practice-related orientation towards the target domain. One sequence was found to include statements concerning both conceptual framing and the practice related orientation.

As **Table 2** shows, the participants more frequently used the language codes designed for conceptual framing (see **Annex 1**) than the codes of the practice-related orientation(see **Annex 1**). However, the meaning of many of the relations that the students had created using codes designed for conceptual framing, were interpreted in the content analysis as actually being practice-related. In what follows, the use of the language codes by the students is portrayed in more detail separately concerning conceptual exploration and practice related elaborations, based on the findings summarized in **Table 2**.

Relations Structuring Conceptual Exploration. The pairs participating in the study created a total number of 51 explicit or implicit links that were interpreted to structure conceptual exploration and serve as the *exploratory components of their orienting bases.* Pair 1 created 10 relations that were categorized as structuring conceptual exploration. The majority (seven relations) was implicitly created by means of description boxes, and three by link codes (two with the code "Defining"). These relations

Relation type	Pair 1		Pair 2		Pair 3	
	Conceptual exploration	Practice-related	Conceptual exploration	Practice-related	Conceptual exploration	Practice-related
Link codes used in relations (explicit)						
Defining	2	13	7	1	2	
Type/example			6	2	5	7
Feature			3	1	1	1
Affects			6	4	1	1
Activity		3				
Context of implementation				5		
Tool of previous			4			
Phase in previous				1		
Relation	1	9			1	3
Total	3	25	26	14	10	11
Node codes involved in relations (explicit and implicit)						
Background philosophy			2	4		
Trustworthiness	2	12	8			
Concept/ phenomenon	9	36				
Explanation/ description			27	15	11	18
Quotation of resource			1		2	
Total	11	48	38	19	13	18

Table 2: Link and node codes used by the student pairs in two different types of relations (conceptual exploration or practice-related).

connected the listed research methods, research techniques, generic characterization of trustworthiness and qualitative research. In the closing meeting, the presenter of the map stated that the pair repeatedly also used the description boxes in listing the various domain-specific concepts instead of creating separate nodes referring to them. Pair 3 created four implicit relations that were categorized as structuring conceptual exploration by using the description boxes of the nodes. Two node descriptions listed the concrete types of research techniques that were referred to in the titles of the nodes.

Pair 2 used the code "Type/example" in six relations structuring conceptual exploration that connected the nodes referring to both research methods and techniques. Pair 2 also organized the nodes representing methods and techniques into two groups, one including those discussed during the seminar meetings and the other including the methods and techniques that were not discussed during the meetings. Like Pair 2, Pair 3 listed research methods in separate nodes and grouped them by creating five explicit relations with the code "Type/example". A student from Pair 2 stated in the closing meeting that this division of methods was a basic principle that the pair followed when working on the map. She also described the difficulties in making a conceptual distinction between research techniques and methods as well as the definition of the various methodological concepts and their relations in general.

In the map of Pair 2, three explicit relations with the "Feature" code and four ones with the "Defining" code connected the nodes in which the pair explicated their reflections on the advantages and potential shortcomings related to the use of qualitative methods. The link code "Feature" was also used by Pair 3 to connect the generic characterization of the qualitative methods. In addition, Pair 3 used the link code "Affects" to connect the explication of critique of qualitative methods to the first node of the map referring to this topic. The presenter of Pair 2 said that if there had been more time, she would have liked to elaborate on the positive and negative sides of each specific method separately.

Pairs 2 and 3 quoted an external knowledge resource in defining the method that one student in the pair adopted in her own research. Both pairs marked these quotations with codes "Quotation of a resource" and "Defining". Furthermore, Pair 2 created multiple explicit relations that were categorized as structuring conceptual exploration by connecting a node to the language code

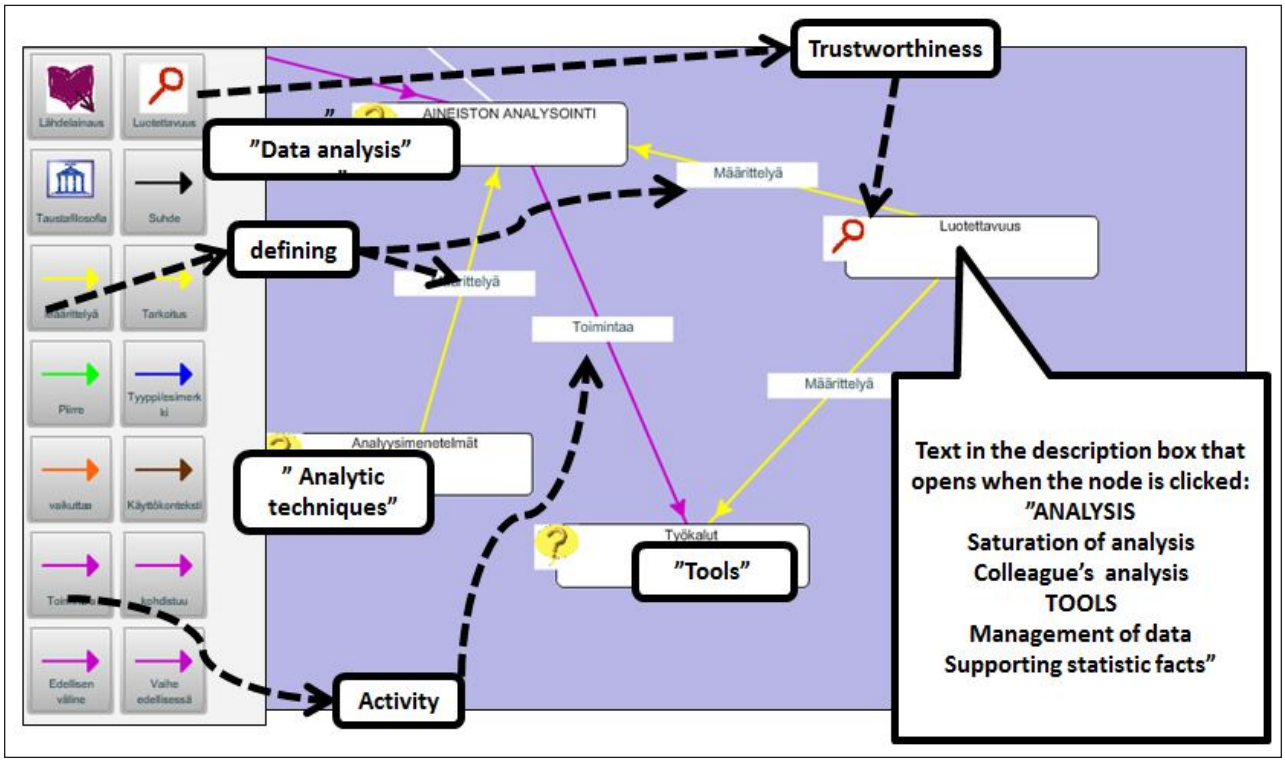

Figure 3: A section of the concept map of Pair 1 referring to the important features of data analysis and the tools used from the perspective of trustworthiness. The arrows indicate which elements of the modelling language are used in the map. Finnish texts are translated in English in boxes with black lines.

"Trustworthiness". Four relations with the code "Tool of previous" connected the former node to the nodes referring to credibility, transformability and to other dimensions related to the trustworthiness of research. In addition, the pair marked the unspecified dependencies between trustworthiness, methods and techniques by creating four explicit relations between the related nodes by using the link code "Affects".

In the closing meeting, Pair 2 described how they used the node code "Background philosophy" to link various not clearly philosophical "keywords" to various methods. The pair used the code "Affects" in these relations. When the presenter of the pair showed these conceptualizations, she framed them with more philosophically oriented expressions such as "mixes somehow positivistic and hermeneutic frameworks" or "understanding background philosophy". The presenter emphasized the order of the nodes that referred to the methods: the nodes were horizontally organized in a row with the most positivistic-oriented methods at its left end. Using the code "Background philosophy", Pair 3 created one node entitled "Hermeneutics", but left the node unlinked and placed it at the top of its map.

Relations Structuring Practice-Related Elaborations. The pairs participating in the study created a total number of 68 explicit or implicit links that were interpreted to structure practice-related elaborations and serve as the *planning components of their orienting bases*. Pair 1 created 13 relations that were categorized as structuring practice-related elaborations by using the code "Defining". These relations, in conjunction with the three links created by the code "Activity", connected the nodes referring to data, its collection, the procedures related to interviews, data analysis and related tools and means. The pair created a total number of eight relations that structured the practice-related elaborations by using the language codes "Defining" and "Trustworthiness". Four implicit relations inside the nodes with the code "Trustworthiness" connected the elaborations of the pair on how the aforementioned procedures improve trustworthiness as the pursued characteristic of research. An example of this kind of elaborations is presented in **Figure 3**.

Similarly, Pair 1 created ten other implicit relations in the nodes of its map, connecting the elaborations on working phases and the use of data. Pair 3 implemented the description of one node in the same way as Pair 1 in listing the concrete actions and procedures improving trustworthiness. Pair 3 also created six implicit relations inside the nodes of its map, and these connected its elaborations on the various forms of data and investigated phenomena. One of these relations was created inside the node with the code name "Quotation of resource" and it connected a quotation of a publication that described the phenomena investigated by using the method that the node defined.

Pair 2 created four explicit relations with the codes "Affects", and "Background philosophy" that were categorized as structuring practice-related elaborations. The elaborations that were connected by these four relations referred to concrete research procedures such as the quantification, thematization and classification of data.

Using the language code "Context of implementation", Pair 2 created five explicit relations that were categorized in the data analysis as structuring practice-related

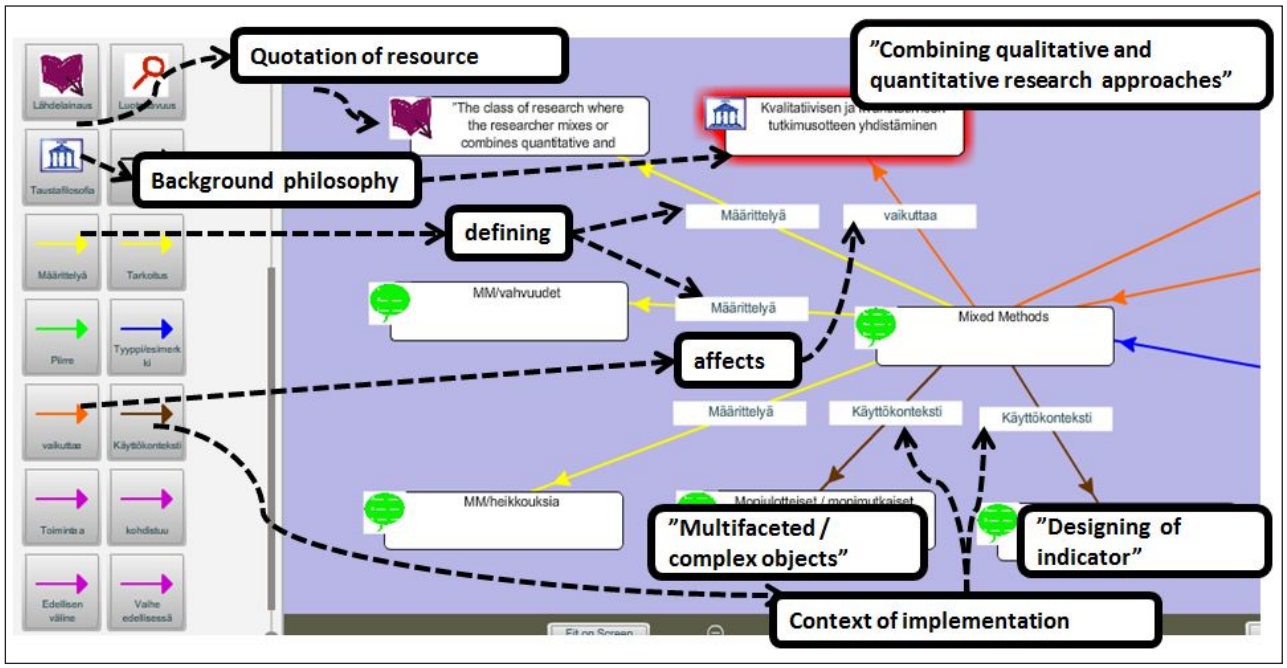

Figure 4: A section of the concept map of Pair 2 referring to Mixed Methods, their background philosophy and context of implementation. The arrows indicate which elements of the modelling language are used in the map. Finnish texts are translated in English in boxes with black lines.

elaborations. These relations connected the nodes that referred to separate research methods to the descriptions of the objects being addressed in research. An example of the elaborations in the concept map of Pair 2 is presented in **Figure 4**.

In addition, also some explicit relations with the code names "Type-example", "Defining", "Feature" and "Phase of previous" were used by Pair 2 to structure practice-related elaborations. They connected nodes that referred to data and data-collection. Pair 3 created seven relations that were categorized as structuring practice-related elaborations with the code "Type/Example". These relations connected the nodes that referred to the types of data, data collection and data analysis.

Map Elements Mediating Domain-Specific Discussion

The analysis of the video data from the closing session established there to be a total number of 15 sequences including the teacher's comments, or both the teacher's and the students' comments and reflections regarding the same map elements. Seven sequences were found to have reflections on conceptual exploration and seven sequences had reflections on the practice-related elaborations on the target domain. One sequence included verbalizations concerning both the conceptual exploration and the practice-related elaborations.

Reflections Concerning Conceptual Exploration. In the seven video sequences categorized as being related to conceptual exploration, one topic that was repeatedly addressed was the diverse methods and their philosophical underpinnings. As the following examples demonstrate, the reflections were mediated by separate map elements that were created by the student pairs and that referred to methods and philosophical background. In one of these sequences, the presenter of Pair 3 pointed to the nodes that referred to diverse methods and wondered whether all the nodes are correctly grouped as methods. The pair also described the difficulties in conceptual distinction between research strategies and research methods. Responding to these considerations, the teacher emphasized the distinctive role of the background philosophies behind diverse research methods. The list of methods presented in one node of the map by Pair 1 triggered discussion on the difference between two separate methods, ethnography and ethnomethodology.

Pointing to the unlinked node with the code of "Background philosophy" on the map of Pair 3, one member of the pair stated that their general understanding of the background philosophies still remained vague. The aforementioned spatial arrangement remaining one of the nodes unlinked was thus used by the pair to explicate related conceptual challenges. The teacher subsequently began to elaborate on this issue. In speaking about philosophical approaches and research methods, she visually illustrated the relations between the methods and the background philosophies by consecutively pointing to the nodes that referred to those methods in the map of Pair 3. At the same time, she clarified these relations by saying: "If we think that these [pointing to the nodes referring to various methods] have various background philosophies, you can say, for instance, let's say action research [pointing to the related node], that there is an idea of emancipating theology behind it..."

Reflections Concerning Practice-Related Elaborations. The reflections on practice-related elaborations particularly highlighted such issues as the trustworthiness of the research, and the character of studied phenomena. These reflections, as the examples below demonstrate, were mediated by the elements of the maps and language codes that referred to trustworthiness,

diverse methods and the contexts of their implementation. Thus, the elements of the node descriptions of Pair 1 that portrayed issues of trustworthiness, reviewed during the closing meeting, evoked multiple comments and reflections from the teacher. In presenting the content of these nodes, one student clarified them by adhering to his related knowledge that he had acquired before the seminar. Viewing one of the nodes, the presenter said: "About this "Selection of informants" [referring to the node description], well, by this proportional distribution I mean ... One member of our group is doing a study on giftedness and is investigating what kind of perceptions teachers have. He carefully thinks about, while doing it across the regions, how to do it, how many [interviewees] to take from each region."

In her comments, the teacher referred to some of the trustworthiness-related notions that were presented in the nodes of the map created by Pair 1, linking them to domain-specific practices and conventions. For instance, in reviewing a description that concerned the objectivity of authors, whose writings constitute research data, as factor affecting the reliability of a study, the teacher said: "I wouldn't use the word objectivity here because objectivity as such doesn't exist in this respect. This relates to your research somewhat ... when we were talking about the trustworthiness of your research ... The description and understanding of the writer's background is essential...". The map elements can be viewed to have mediated the reflections on the pair's prior domain-specific knowledge in their discussion with the teacher.

In one of the sequences reflecting on practice-related elaborations, the teacher also pointed out that background philosophies exert an influence on how the trustworthiness of a study is described. To illustrate this dependency, the teacher drew a line in the air with her finger between the two nodes of the map by Pair 3, one referring to ethnography, another to trustworthiness. At the same time, the teacher emphasized that when describing trustworthiness, it is important to explain a researcher's own participation in the context investigated.

In commenting on the maps, the teacher repeatedly emphasized the character of a phenomenon and the available data as noteworthy starting points to be adhered to when creating concept maps on qualitative research. For instance, she positively characterized the way Pair 2 used a link with the code "Context of implementation" to connect various descriptions of data and phenomena by using nodes that referred to research methods: "So, we have a large set of qualitative data, well how to analyze it?... Or the phenomena that aren't yet theorized ... [pointing to nodes]... What came to my mind was that these kinds of issues could be added here, thus one could start looking at a phenomenon or data and then consider how to analyze it".

Discussion

In the present study, we investigated university students' concept mapping activity, in which the participants examined their prior knowledge and current understanding of qualitative and mixed methods. The concept maps performed the function of orienting bases in learning research methods, and the mapping activity was supported by language codes which were meant to serve as the elements of preliminary orienting basis (Terlouw 1993). Our findings demonstrate that the maps created by the three student groups were quite different, and the groups also differed in their ways to use the elements of the modelling language, depending on their current needs and interests. The elements of the concept maps, reviewed together with the teacher, mediated the discussions and allowed the teacher to adjust her comments and guidance to the students' elaborations. In what follows, the results are discussed and summarized related to the two research questions.

The Use of Tool Functions and Language Codes

The results shed light on how the visual modelling language was used by the students as a semiotic instructional device to support the creation of orienting bases in the form of concept maps. The students were able to use the elements of the modelling language in their repeated elaborations on the specific issues that stemmed from an educational setting. The default set of the codes of the modelling language performed a function of "embedded suggestions" for what to consider in creating concept maps as the students' own orienting bases for using the qualitative and mixed methods. The codes particularly meant to afford *conceptual exploration* were used repeatedly by the students to organize their elaborations on the existing methods, their general characteristics, issues of trustworthiness and related philosophical frameworks. Applying the theory of Galperin (2002), we may assume that the participants used these codes as diverse components of an externalized operational thinking schema in their exploration of the qualitative and mixed methods. The codes designed mainly for conceptual exploration were also used by the students to reflect on research activities and actions in addition to codes specially designed for practice-related purpose. The functions that the students attributed to the language codes, thus, often did not precisely converge with the meanings that they were meant to highlight.

The use of language codes also exposed the participants to the conceptual complexities of the domain. Unlike the case found in conventional educational settings based on the more strictly organized assignments, the students were able to choose the conceptual challenges that they focused on in creating their maps. The linking and spatial organization of the elements that were created with the language elements were also used to explicate conceptual challenges; for instance, in referring to the "Vague understanding of the influence of philosophical backgrounds" (Pair 3). One of the most central conceptual complexities encountered by the students was the distinction between a research method and research techniques. This challenge can be seen to be partially related to the ambiguity of the concepts in the Finnish language in which one word refers to both research methods and techniques.

Only a limited number of the language codes were actually used by the students in creating their understanding of research methods and were repeatedly used by them

as conceptual scaffolds. Particularly the use of language codes such as "Type/example", "Philosophic background", "Context of implementation" and "Trustworthiness", appears to have afforded various elaborations within the target domain. Students were able to separately use each of these codes to reflect on the phenomena conceptualized in the other nodes of the maps.

The Role of Map Elements Mediating Domain-Specific Discussions

During the closing seminar session, the students conveyed their current understanding of the target domain by adhering to the elaborations that they aggregated into the map elements. These elaborations, which were mediated by separate language codes, provided the teacher with a window into the current state of the students' understanding and afforded her attempts to expand this understanding. For instance, the teacher elucidated her elaborations on the relations between research methods and their philosophical backgrounds by pointing to some related elements in the students' maps. Especially the codes "Trustworthiness" and "Context of implementation" that the students had used frequently in their concept maps evoked multiple comments from the teacher. Some domain-specific issues highlighted by the language codes also motivated the teacher to make suggestions on how the students could continue working on their maps and advancing their orienting bases.

Although the students did not always use the language codes in an expected way (e.g., used the codes meant for conceptual elaborations to model activities and actions), the teacher apparently did not find it difficult to interpret and reflect on the codes that the students had used.

Conclusions

The findings appear to indicate that a flexible concept mapping tool and pre-designed language codes can serve as the elements of preliminary orienting basis that support students in creating their own orienting bases in learning complex domain content and practices. Since the modelling language adopted in the present study was extended from the previous version, used in another context (Kosonen & Hakkarainen 2007; Kosonen et al. 2010.), to also include some domain-specific elements, it included numerous embedded codes. Only a limited number of these codes actually served the doctoral students in creating their understanding of a complex and ill-defined domain and were repeatedly used as conceptual scaffolds. These scaffolds apparently mediated the creation of the students' concept maps and they also served the collaborative discussion with the teacher by helping her to concentrate on the basic questions concerning research methods. The teacher had also included the concept mapping activity in the previous iterations of the seminar (see Kosonen et al. 2010), but the usage of the modelling language as a scaffolding tool was a new element in the present iteration and a novel practice for the teacher. With better pedagogical planning and student guidance, the modelling language could have served students' concept mapping activity even better.

Some of the findings are critical from the perspective of the need to further develop and revise the domain-specific elements of the modelling language used in the investigated setting. *First*, the modelling language should more explicitly guide students to think of methods and techniques as distinguishable tools for research activity in their orienting bases. *Second*, given the findings of the study, it appears legitimate to explicitly introduce the notion of trustworthiness as the component of the preliminary orienting basis meant to afford practice-related elaborations rather than conceptual explorations. *Third,* the students should take into account the investigated phenomena and the character of data in question when they are orienting themselves to the use of research methods. This is an issue that should also be explained in the modelling language.

The maps created by the three student groups were quite different, and the groups also differed in their ways to use the elements of the modelling language. The concept mapping tool and the modelling language provided the students with an opportunity to build their own orienting bases in their own way depending on their own learning needs. On one hand, this highlights the value of such features as freedom to spatially arrange map elements, open linking possibilities, and freedom to name the nodes, add descriptions and use the codes in various ways. On the other hand, the differences in mapping outcomes might be due to some students' inadequate ability to use this type of instrument and activity in enhancing their learning, which should be taken into account by the teacher in guiding and supporting students.

The findings of our study appear to indicate that a generic modelling language modified with domain-specific conceptualizations helps students to focus on the central issues and concepts of a domain. In this regard, it is important to strictly link the use of a modelling language to the specific needs of a pedagogical setting. The findings also highlight the importance of the sufficient simplicity of a modelling language. The redundancy of language codes should be avoided to ensure that students really find a domain-specific modelling language helpful.

In future studies, one central issue is to investigate the teacher's ideas and intentions in using conceptual mapping as a means to support students. One possibility is to use the intervention study approach in order to inspire and guide the teacher in using mapping with students. In addition, it would be important to interview students about their mapping experience, in order to get data about the students' own opinions about the benefits and challenges of the modelling activity.

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