
# Knowledge sharing for distributed professionals: Methodologies for experimentation of concept mapping

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# Content

# List of figures

# List of tables

# 1 Introduction

This document presents the final thesis of the Master of Science program 'Technology Applications in Education and Training', from the Faculty of Behavioral Sciences of the University of Twente. This paper describes the project, which is part of "Multimodal e-learning System based on Simulations, Role-Playing, Automatic Coaching and Voice Recognition Interaction for Affective Profiling" (Myself) project (sponsored by the EU-CRAFT programme). A reference link is made between this Master's project and the Myself project. This Master's project contributes to the Myself project by identifying methodology for experimenting with the concept mapping principle for knowledge sharing among professions.

One of successful key factors for an organization is to have knowledge-based teamwork of well-educated professionals. There is an old saying "one and one makes three". This saying probably has one of its values in education. When two or more professionals learn together the effect on the knowledge, skills and attitudes of the individual learners is perceived more than just an addition. Specific attention in the project is given to methodological aspects in the implementation process. This means the definition of tasks, the specification of output criteria and the control of procedural conditions during knowledge sharing activities. This study will focus on methods to implement concept mapping principles in knowledge sharing tasks.

This chapter gives an introduction into the topic of the thesis and presents the problem statement and goals of the project which it reflects.

- Section 1.1 presents the statement of the problem.
- Section 1.2 refines the research question of this master project that will be answered in this thesis.
- Section 1.3 gives an overview of the content of the subsequent chapters.

## 1.1 Statement of the Problem

Sharing and documenting knowledge in knowledge-based teamwork of well-educated professionals is one of the essential key-factors in an organization. Knowledge sharing among professionals is done in many different ways. Concept mapping is a way to support knowledge sharing, based on the principle of making tacit knowledge explicit by putting knowledge elements

in relation to each other to form meaningful constructs. The implementation of concept mapping in knowledge communities is not always an easy task (Schau, Mattern, Zeilik, Teague, & Weber, 2001).

Most of the developments related to use Knowledge Management (KM) to share knowledge have been undertaken by large organizations. These full scale KM systems, which normally require data mining tools, intelligent agent technology and expert systems, are difficult to afford and maintain. In these knowledge sharing settings, the professionals are often considered as domain experts in their fields. The knowledge sharing forms as a "question and answer" format. For those cases, the professionals provide certain solutions for a specific question. The knowledge sharing is mainly transferred from the experts' side to the non-experienced employees' side. The mainstream of knowledge sharing is bi-directional. However, it is questionable if this type of KM can be successfully used by well-educated professionals who are in distributed locations but lack expertise resources. In these cases, it is hard to get a direct answer from a domain expert. Instead, knowledge sharing and discussing certain interesting topics among professionals would be more suitable. In addition, professionals may need more communication to inspire innovative thinking instead of being provided a simple solution. The shared knowledge requires more in depth thinking and analysis. Given this context, research questions are presented in section 1.2.

## 1.2 Research question

Given this situation, this study focuses on identifying a methodology for a knowledge-sharing process which can facilitate knowledge capture and utilization among professionals. The methodology developed in this study should include detailed steps and activities of using the concept mapping principle for knowledge sharing purposes. Special attention is paid on how to utilize the concept mapping principle into the knowledge sharing process for highly educated professionals. This requires that the knowledge sharing process should not be simply resource exchange, but also foster creating new knowledge by collaboration among professionals. The project is based on the following research questions:

- What methodology can be used to implement the use of concept mapping in knowledge management at the individual level as well as in knowledge sharing in groups? This study tries to identify necessary steps of using concept mapping for knowledge sharing purposes. The methodology involves designing and refining knowledge sharing preparation activities at

the individual level and knowledge exchange activities at group level. In addition, the relationship and consequences of these activities are investigated as well.

- How can tacit knowledge be captured and made explicit when used for knowledge sharing purposes?

  Tacit and explicit knowledge are analyzed in the literature review section, which brings a better understand of how knowledge is presented and exchanged among professionals. In this section, the research questions are focused on what the formats of tacit and explicit knowledge are, in which kind of situations, how the different knowledge can be transferred, and how the value can be added.
- How can the capturing process of tacit knowledge be instrumentalized by means of tools based on concept mapping principles? What are the necessary activities and facilities from tools? It is interesting to figure out the mechanisms of using a concept mapping tool to promote tacit knowledge capture at both individual and group levels.

Evaluation of the methodology focuses on three areas: the value of transition from tacit to explicit knowledge within the knowledge management process, the value of concept mapping tools for this transition, and the characteristics of the group involved in the knowledge sharing activity.

The project will deliver methodologies for applying concept mapping in knowledge sharing activities. The setting for the project will be higher education graduate students. A pilot experiment will be set up with a small size group of graduate students to evaluate methodologies. Experiences from these pilots are used as input for (iterative) refinement. Section 1.3 gives an overview of this thesis.

## 1.3 Overview of the Thesis

The following chapters will be presented in the structure of this thesis:
Chapter 2 is the theoretical framework of the thesis, which focuses on knowledge categories. The connection of knowledge sharing and the concept mapping principle is made as well.
Chapter 3 presents the design decisions and research strategy of this study. The introduction of the tool used in this study is given.
Chapter 4 represents the process and evaluation of the pilot experiment.
Chapter 5 shows the process and evaluation of the second experiment.
Chapter 6 gives final conclusions and recommendations for future work.

The next chapter introduces findings from literature to the above-mentioned research questions about the key features of knowledge sharing. Special attention is paid on the explicit and tacit knowledge. The connection of knowledge sharing and the concept mapping principle is made. The possibility of using concept mapping to contribute for knowledge sharing is discussed as well.

# 2 Conceptual Background

This chapter presents the results of a literature study about knowledge transaction. The connection of knowledge sharing and the concept mapping principle are made as well.

- In section 2.1, categories of knowledge and how knowledge transfers into different formats are discussed.
- In section 2.2, the concept mapping principle is introduced.
- In section 2.3 network enabled concept maps are presented. The possibilities of such a concept mapping principle for knowledge sharing among professionals is discussed.

## 2.1 Tacit and explicit knowledge

Knowledge is identified as both explicit and tacit knowledge (Nonaka and Takeuchi,1995, pp. 63-69). According to Nonaka and Takeuchi explicit knowledge (1995) is that which "can be expressed in words and numbers and can be easily communicated and shared in the form of hard data, scientific formulae, codified procedures or universal principles", whereas tacit knowledge is "highly personal and hard to formalize. Subjective insights, intuitions and hunches fall into this category of knowledge"(Nonaka and Takeuchi,1995, pp. 63-69). Zack further emphasized that

> *Tacit knowledge is the form of knowledge that is subconsciously understood and applied, difficult to articulate, developed from direct experience and action and usually shared through highly interactive conversation, storytelling and shared experience. Explicit knowledge, on the other hand, is easy to articulate, capture and distribute in different formats, since it is formal and systematic* (Zack, 1999).

Nonaka and Takeuchi (1995) also stated that explicit knowledge is typically found in documents and databases, while tacit knowledge is more difficult to pin down, formalize and communicate (Nonaka and Takeuchi, 1995). However, there are four basic patterns of knowledge transfer between tacit and explicit knowledge, which refers to the Socialization, Externalization, Combination, Internalization (SECI) model (Nonaka and Takeuchi,1995, pp. 71). Figure 1 explains this situation:

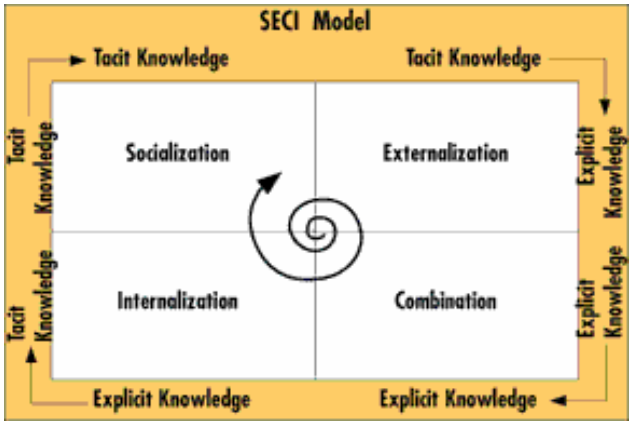



**Figure 1: SECI model (Nonaka and Takeuchi,1995, pp. 71)**

Four forms of transactions were identified: tacit to tacit, explicit to explicit, tacit to explicit and explicit to explicit. The SECI model also points out the channels for each transaction:

- Tacit to tacit – acquiring and sharing someone else's knowledge through observation, imitation and practice.
- Explicit to explicit – combining an individual's pieces of explicit knowledge together to form new explicit knowledge.
- Tacit to explicit – conversion of acquired tacit knowledge into specifications.
- Explicit to tacit – internalizing new explicit organizational knowledge, when it is shared by staff members.

Snowden (1999) further clarified how each particular type of knowledge is evoked. He writes that "the optimization of explicit knowledge is achieved by the consolidation and making available of artifacts. The optimization of tacit knowledge is achieved through the creation of communities to hold, share, and grow the tacit knowledge". Nonaka, Takeuchi, Zack and Snowden focused on clarifying the category of the knowledge and the conversion of the knowledge, which serves as a foundation for much of the research in this discipline. Previous research showed the importance of the tacit knowledge. However, the research retains generic assumptions concerning the nature of knowledge. More issues need to be addressed to current practice managing knowledge in an organizational setting, such as knowledge sharing among professionals in an institution. Other complex topics need to be explored, such as how to connect knowledge transformation with knowledge management activities, and how to promote the transaction of tacit knowledge into explicit knowledge in an easy, but effective and efficiency way. This study will focus on knowledge transaction by achieving optimized knowledge sharing

among professionals. In addition, because tacit knowledge is more difficult to pin down, how to transfer tacit knowledge into explicit knowledge is also the focus of this study. A literature review is presented in section 2.1, which connects knowledge sharing and knowledge transaction.

## 2.2 Knowledge Sharing

Constructing a shared knowledge environment is a significant factor in the SECI process, which can act as a shared framework of understanding and contribute to 'knowledge stickiness' (Gherardi, 2000; Inkpen, 2001). Becker (2001) argued that knowledge sharing, while significantly depending on 'explicit' procedures and processes, also depends on strategies of personal interaction to address 'tacit' issues of uncertainty and integration.

Consider the context of knowledge sharing among professionals, their knowledge has high value, which is also difficult to understand and obtain by others. The expertise knowledge can easily be lost if the professionals retire or leave the institution. Consequently, knowledge sharing is critical. The challenge of sharing and capturing expertise knowledge is how to encourage professionals to share both their explicit and tacit knowledge.

While capturing both tacit knowledge and explicit knowledge is important, a more valuable aspect of knowledge sharing among professionals is that it stimulates creation of new knowledge (Nonaka and Takeuchi, 1995). Nonaka and Takeuchi argued that the interaction between explicit and tacit knowledge, called the "knowledge spiral," is a key source for creating new knowledge. This interaction of knowledge transfer can be achieved by knowledge sharing among individuals.

To summarize, Nonaka and Takeuch (Nonaka and Takeuchi, 1995) gave the foundation of the knowledge categories (tacit and explicit) and explains how the knowledge can be added value. Later researchers found out that the knowledge sharing process can foster new knowledge by the transition of tacit and explicit knowledge. Moreover, according to the characteristics of the professionals, it is recommended that capturing tacit knowledge is essential for them. However, no clear answers were given as how to provide a suitable solution for high educated professionals, which can be used to

- exchange newest information
- capture the tacit knowledge,
- facilitate tacit knowledge transferring into explicit knowledge

- inspire creative thinking

In section 2.3, the possibility of using the concept mapping principle for the given problems is discussed.

## 2.3 Concept mapping principle

One of the principles used for knowledge management is concept mapping. Concept mapping, developed by Prof. Joseph D. Nonack of Cornell University (Novak, J. D. (1998), is a technique for visually representing the structure of information. It is about how concepts within a domain are interrelated. Knowledge in the domain is presented as a network of concepts. This network consists of certain nodes and links. Nodes are used to represent concepts, while links represent the relations between concepts. The links between the concepts can be one-way, two-way, or non-directional (Plotnick, 1997).

Concept mapping has a variety of applications within a broad range of domains. It can be used to (Plotnick, 1997; Gaines and Shaw,1995; Seaman, 1990; Williams,1997):

- generate ideas (brainstorming, etc.)
- design a complex structure (long texts, hypermedia, large web sites, etc.)
- communicate complex ideas (can aid collaborative projects)
- aid learning by explicitly integrating new and old knowledge
- assess understanding or diagnose misunderstanding
- enhance the problem-solving phases of generating alternative solutions and options
- facilitate knowledge elicitation and management
- analyze organizational decision making processes
- support reading comprehension
- encourage positive self-concept

From this summary of possible applications of concept mapping, we see the potential advantage of using concept mapping for capturing tacit knowledge. Fourie, Schilawa and Cloete (2004) further proposed that concept mapping can be used to acquire and represent tacit knowledge by formalizing and displaying it, as well as transferring it with the help of pictures, movie clips, voice, text, structure or other forms of description to explicit knowledge. Concept mapping is a type of knowledge representation, which requires clearly articulating the concepts and their propositions in explicit and concise words. Moreover, Plotnick (1997) argued that concept mapping can facilitate creative thinking. Constructing a concept map involves the process of a

brainstorming session. “As one puts ideas down on paper without criticism, the ideas become clearer and the mind becomes free to receive new ideas” Plotnick (1997). These new ideas may be linked to ideas already on a concept map, to represent the relationship between them, and they may also trigger new associations leading to new ideas.

We see value in using concept mapping to support tacit and explicit knowledge sharing. However, it is possible to use new information and communication technology to support the concept mapping principle? The answer is given in section 2.4.

## 2.4 Networked concept maps

As we know from the previous discussion, an overview of a domain of knowledge can be gained by adding new concepts and connecting them with other concepts. This brings the opportunity of providing a complete picture of a domain instead of unstructured and unrelated individual concepts. The concepts are not isolated anymore. Further, with matured information and communication technologies, the meaning of “networked concept maps” has a more meaningful sense.

Traditionally, concept mapping was carried out using paper and pen, which caused some problems (Chiu, Huang,, Chang & Liang 1999): paper-based concepts maps are very time and effort consuming, which may require more time on revising and maintaining on concentrating on the knowledge. In addition, the concept maps generated by individuals are isolated. The knowledge in this level is not sharable. However, with the fast development of personal computers and local area network technologies, it is possible to enable a group of people to cooperatively work on the concept maps together. Networked personal computers can facilitate sharing by groups of people in the construction of the concept maps. Moreover, with the integration with World-Wide Web (WWW) servers and browsers, the external resources from Internet can be hyperlinked to a concept map. Kommers and Lanzing (1997) proposed that the benefits of integrating WWW into concept mapping include:

- ease of recognition
- the possibility to quickly scan picture and find differences or keywords
- compactness of representation,
- the observation capability

To summarize, research indicates that concept mapping can facilitate knowledge capture, especially transferring tacit knowledge to explicit. Networked enabled concept maps allow people to collaboratively work on one concept map. With the advantage of the WWW, external information can also be captured and stored. These advantages offer a great value to knowledge sharing among professionals.

Since the use of concept mapping tools in knowledge management, especially for knowledge sharing issues among professionals is relatively new, little research has been made to design a methodology for using computer network based concept mapping tool to support knowledge sharing. To achieve this objective, experiments with using a networked concept mapping tool for knowledge sharing activities are carried out in this study. Chapter 3 moves a step forward to the design decisions of the experiments.

# 3 Design decisions

The literature review identified the knowledge types and the importance of knowledge transition. How to design a methodology of using networked concept mapping to promote this transition? What are the design decisions of the experiment? These questions are answered in this chapter.

- Chapter 3.1 represents the context of the problem.
- Chapter 3.2 shows the research method and strategies used in this study.
- Chapter 3.3 introduces the tool used for the experiments.

## 3.1 Context of the problem

The MySelf project is meant to emphasise the experiential training by developing and validating a multimodal learning platform based on vocal recognition, role playing via web and collaborative learning. The innovation will be constituted by the use of the affective computing and recognition of the user's emotional state. In addition, the platform will be designed and validated for on-line fruition; the focus is on the enrichment of the simulations and the affective computing methodologies traditionally carried out in didactic classroom with the recognition of user's emotions through his learning path and systematic distance learning based on Internet.

In an organization which is characterized by a strong diversity in backgrounds of professionals as well as technology support media such as in the MySelf project it is important within a working group to have a common understanding about the domain knowledge, the working process, the conditions, the methods, the resources and the outcomes. As part of the MySelf project, a methodology of using concept mapping for knowledge sharing has been developed in this study.

This method has been piloted in a session at the University of Twente in 2005 in the context of a project for the master programme. Each year, master students of Twente University are required to conduct their final project. The final project should concur sufficiently with the expertise of the involved department. In spite of different departments from the university, the general phases of conducting a master thesis are similar. Master students are confronted with the problems like how to find a suitable topic, what are the strategies for the literature study, what kind of research methods can be applied, etc. On one side, the master students are well-educated professionals, they have certain experience in their studying field; on the other hand, normally each master

student is doing his/her own project, they are relatively isolated for knowledge sharing. It can be valuable to let them share knowledge and experience related to conducting a master thesis with a platform: networked concept mapping tool. In section 3.2, further research decisions are introduced.

## 3.2 Research method and strategy

Concept mapping can be seen as an effective strategy for both individuals and groups to structure their ideas, knowledge, and plans. When people do not have experience in preparing concept maps the beginning can be a bit difficult. To support our subjects in this study in structuring knowledge in concept maps a stepwise method is presented.

Moreover, promoting transaction of tacit to explicit knowledge is also the interest of this study. Concept mapping can be seen as an effective strategy for both individuals and groups to structure their ideas, knowledge, and plans. From literature study, it is recommended that the tacit knowledge can be transferred by

- acquiring and sharing someone else's knowledge through observation, imitation and practice,
- conversion of acquired tacit knowledge into specifications.

To support this, various group activities from subjects of using concept mapping for knowledge sharing are designed. The strategy is to combine individual and group processes to arrange ideas in a way that a graphical product is prepared about which consensus in the group is very important.

The case study research method is used in this study, since the object of this study is to develop methodologies for knowledge sharing based on concept mapping among professionals. The proposed method is applied and tested by subjects while conducting a given task with concept mapping principles. This requires researchers carefully observing the characteristics of the subject's actual behaviors when they use concept mapping tools to conduct certain tasks. The experience of using a stepwise method can be analyzed and summarized by researchers of this study. Afterwards recommendations can be made for a better performance.

In this study, the unit of analysis is knowledge sharing at individual and group levels among professionals. The subjects of this study are Master's degree students. The subjects are firstly required to accomplish a task with the facilitation of the concept mapping tools. At this stage,

they need to complete a concept map related to the given task individually. This process requires the individual's structuring knowledge, which results an individual concept map and a collection of interesting information (research paper, web sites, documentation, etc). This stage is also a preparation step for group knowledge sharing.

To promote knowledge sharing especially of tacit knowledge, group activities are designed. At the group level, all group members need to have agreement with each other and present the group discussion results into a group concept map. To achieve this, group members need to actively communicate and collaborate with each other. The information and experience is shared at the group level. During conversion and practice, the tacit knowledge can be transferred into explicit knowledge, which is presented and shared by the group map. New ideas are inspired and generated are captured and presented in the group concept maps as well.

The main purpose of this research is to develop a methodology of using web-based concept mapping tool for knowledge sharing purpose. However, the comparison of different experiment groups was planned to improve validity of outcomes. The success factors may be found from different subject groups. These success factors and experiences can be utilized for better knowledge sharing performance.

To support the computer-based activities the tool CMAP is used. Section 3.3 gives an overview about the tool.

## 3.3 Introduction of the concept mapping tool

There are several concept mapping applications in the market, such as Inspiration, Semnet, MindManager, etc. Freely available concept mapping software has been around for some time from the Institute for Human and Machine Cognition (IHMC), University of West Florida. IHMC CmapTools version 3.6 was used for this study. For extended information about CMAP as well as documentation and research papers see http://cmap.ihmc.us/. The Cmap was chosen because

- Cmap provides complete functions to add meaningful concepts and their relationships,
- A client-server architecture enables shareable concepts between individuals,
- Communication and collaboration functions provide facilitations for the group activities for this study.

Each of the reasons is explained below:

### 3.3.1 Meaningful concepts and their relationships

This tool allows users to represent meaningful concepts and their relationships in a knowledge domain. Figure 2 shows an example of a concept map generated with Cmap. The concepts are represented by nodes, which are labeled with keywords. The concepts can be enriched with icons under each concept, which indicate sources of information. The resources related to a concept can be Word-files, PDF-files, images, video and audio links to Web pages, etc. Concepts within a map are connected by linking words to form propositions. A concept map can be hierarchically structured from abstract concepts on the top to the detailed concepts. The concept maps generated by this tool also provide a browsing interface of hierarchical concepts and associated information resources.

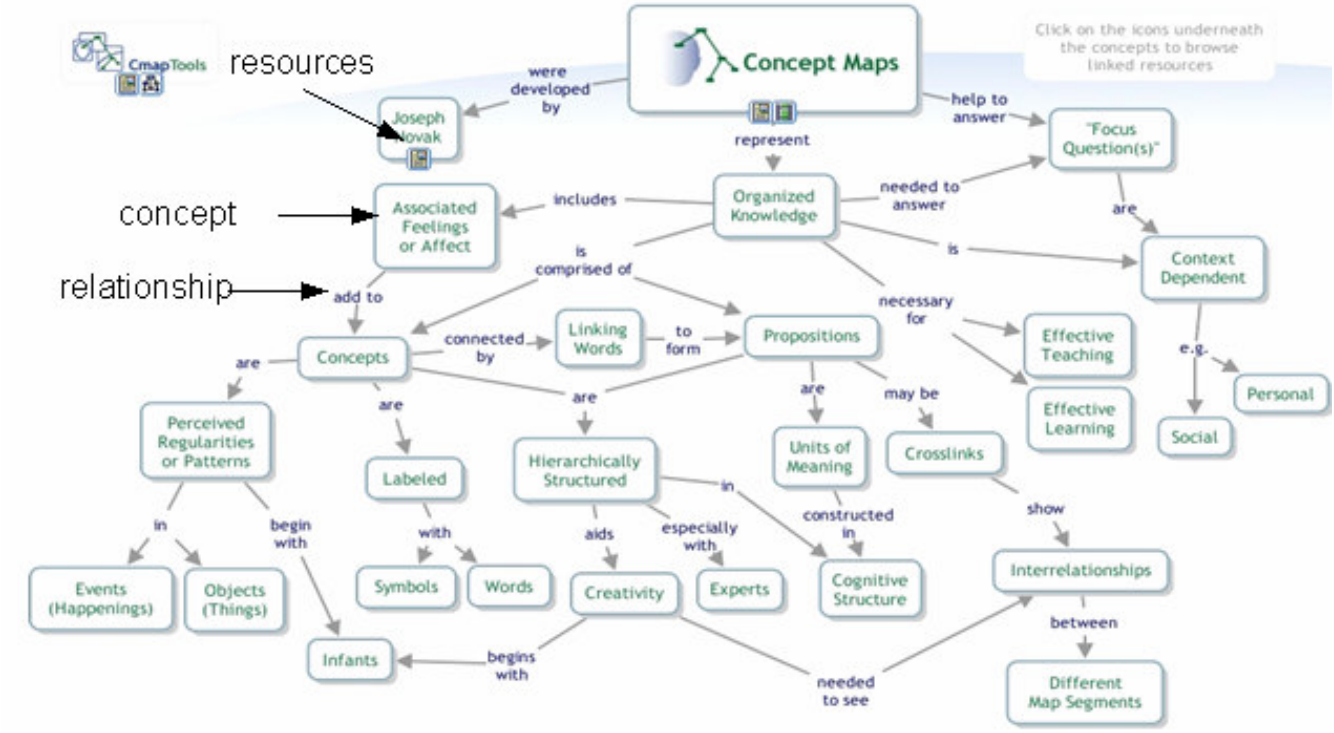



**Figure 2: An example of a concept map generated with Cmap (IHMC Cmaptools , n.d.)**

### 3.3.2 A client-server architecture

Since CMAP is developed based on a client-server architecture, it is possible to use it in groups where members are physically in the same room but also where group members are distributed

over different cities, countries and even continents. The users can store maps and resources on their local computers. In addition, these concept maps and resources can be shared through *Places* on the server. Figure 3 explains how this type of client-server architecture works with Cmap tool (Cañas, Hill, Granados, Pérez, & Pérez, 2003): On the client side, the Cmaptool is running on the local computer. Local Area Network (LAN) connects different clients with the server. The *Place* on the server side stores all the data (concept maps and resources) uploaded from clients. The authorized users can access the same *Place* concurrently, storing and retrieving concept maps (Cañas et al., 2003). Moreover, the Cmap server application can locate *Places* from different servers throughout the Internet. Different Cmap servers are connected by accessing the Directory of Places with their Internet address and other pertinent data, such as a server's name (*Place*) and identifying information (Cañas et al., 2003).

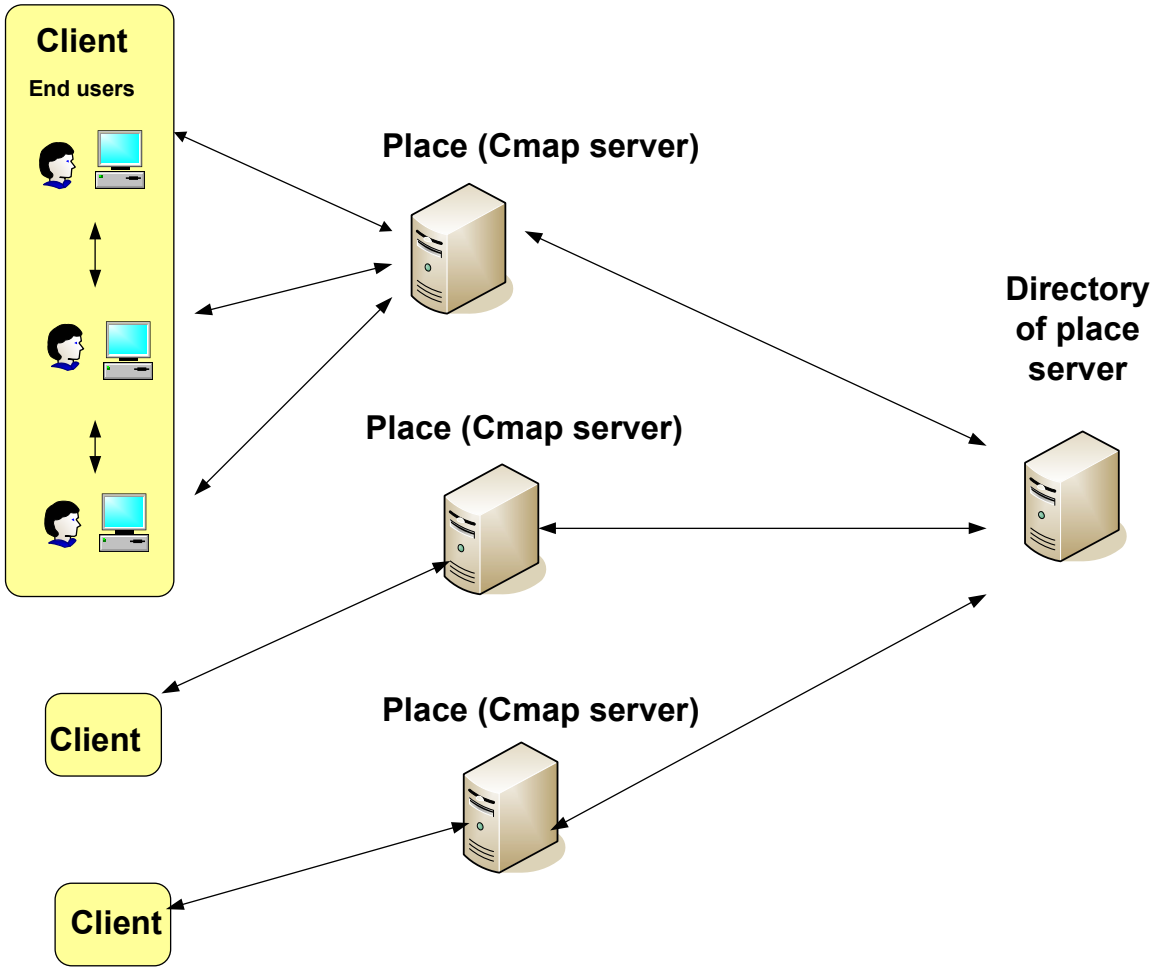



**Figure 3: The client_server architecture of Cmap tool (Cañas et al., 2003)**

### 3.3.3 Communication and collaboration facilitations

The users can easily share and collaborate in the construction of concept maps. Besides individual concept map building functions, Cmap provides several useful functions to facilitate knowledge sharing:

- **Asynchronous collaboration**: users can work on the same concept maps at different time
- **Threaded discussion:** users can leave a message to discuss a particular concept, relationship between concepts, structure of a map, etc.
- **Synchronous collaboration**: The Cmap tool enables concurrent editing of a concept map among authorized users. Any change made by a user appears at the same time on the screen with user ID.
- **Real time chatting:** During the synchronous collaboration session, the chatting function can be used with text-based messages for communication purpose.

To design the methodology of using concept mapping to support knowledge sharing, computer based interactions between subjects and concept mapping tools are involved. The Cmap tool serves basic requirements for meaningful concept mapping construction, as well as providing advanced communication and facilitation. In the following section, the preliminary methodology of using networked concept mapping to share knowledge among group members is presented.

## 3.4 The preliminary methodology

Novak (1998, Appendix I, pp. 227-8) proposed some basic steps of construction of a concept map. However, this instruction is mainly intended for paper based concept maps. In this study, we evolved this instruction into a new methodology with focus on the needs of computer based networked concept maps. In this methodology, working individually stage is based on Novak's instruction. Moreover, more steps were defined in this study, which includes using computer based tool to add resource to a concept map and using groupware for group construction. This methodology was distributed to the subjects during the pilot study, as the guideline to develop a concept map.

## The methodology of using networked concept mapping to support knowledge sharing – the first version

**Table 1: Working individually**

***Stage 1: Working individually***

1. *"Identify a focus question that addresses the problem, issues, or knowledge domain you wish to map. This is something to be done individually by all group members. (Novak 1998)"*

**Add concepts:**

2. *"Guided by the question identify 10 to 20 concepts that are pertinent to the question and list these concepts on your computer in the Cmap client. Concept labels should be a single word, or at most two or three words. (Novak 1998)"*
3. *"Rank Order the concepts by placing the broadest and most inclusive idea at the top of the map. It is sometimes difficult to identify the broadest, most inclusive concept. It is helpful to reflect on you focus question to help decide the ranking of the concepts. Sometimes this process leads to modification of the focus question or writing a new focus question. (Novak 1998)"*
4. *"Work down the list and add more concepts as needed. (Novak 1998)"*
5. *"Begin to build your map by placing the most inclusive, most general concept(s) at the top. Usually there will be only one, two, or three most general concepts at the top of the map. (Novak 1998)"*
6. *"Next select the two, three, or four subconcepts to place under each general concept. Avoid placing more than three or four concepts under any other concept. If there seems to be six or eight concepts that belong under a major concept or subconcept, it is usually possible to identify some appropriate concept of intermediate inclusiveness, thus creating another level of hierarchy in your map. (Novak 1998)"*

**Add resources to a concept**

7. *Add useful URLs or files such as Word, PDF, JPG, etc, to different concepts. This is both for you as a reference about the deeper meaning of the concept and also for others, reusing your concept map, to find additional information or explanation.*

**Refine the concept map**

8. *Connect the concepts by links. Label the links with one or a few linking words. The linking*

*words should define the relationship between the two concepts so that it reads as a valid statement or proposition. The connection creates meaning. When you hierarchically link together a large number of related ideas, you can see the structure of meaning for a given subject domain.*

9. *Look for crosslinks between concepts in different sections of the map and label these lines. Crosslinks can often help to see new creative relationships in the knowledge domain.*

**Finalize the concept map**

10. *Rework the structure of your map, which may include adding, subtracting, or changing super ordinate concepts. You may need to do this reworking several times, and in fact this process can go on indefinitely as you gain new knowledge or new insights.*
11. *Be creative in a constructive way through the use of colors, fonts, shapes, border thickness, etc.*
12. *Concept maps could be made in many different forms for the same set of concepts. There is no one way to draw a concept map. As your understanding of relationships between concepts changes, so will your maps.*

**Table 2: Working in a group**

**Stage 2: working in a group**

The second part of the concept mapping activity is a group activity. The main purpose of building a group concept map is to share knowledge and foster new ideas among group members.

***Peer review phase (in this phase group members still work on their own but the phase is already part of the group process):***

1. Each individual concept map is reviewed by all members individually. In a group of three A reviews the maps from B and C, B reviews the map from A and C etc.
2. Make notes, to prepare for the group discussion.

***Face –to face phase (Group members sit together and discuss the collection of concept maps)***

1. Decide about the main focus to consider.
2. Decide top and second level concepts and their relationship.
3. Build an initial common concept map.

***Remote phase***

1. Group members work separately to add sublevel of concepts and their relationships.
2. Resources are added to different concepts. Client communication channels are used to inform other group members about what each member is doing related to updating the common concept map.

***Discussion phase***

3. Decide a main structure of the concept map.
4. Decide concepts on each level.
5. The thread discussion and real time chatting are used to facilitate communication. The discussion and chatting files are saved.

***Finalizing phase***

6. Make an agreement for the final version of the concept map. Discuss if there are group members who wish to change the common concept map.
7. Read the checklist to make possible changes. See if he concept map meets criteria from the following checklist.

A checklist was also developed for the pilot to help subjects complete a concept map. The subjects were asked to go through concept maps with this checklist before they submit the concept maps.

**Table 3: The checklist for completing a concept map**

| **Check list for completing a concept map** |
|---|
| **Concepts:** |
| Does it contain all the concepts related to the given tasks or the discussion topics? |
| Are necessary annotations added to all concepts? |
| Are necessary resources are added to all concepts? |
| Are necessary URLs added to all concepts? |
| Is the main concept easily identified, either by use of a larger font, a graphic or other means |

| |
|---|
| of emphasis? |
| **Links** |
| Are all the relationships identified among concepts and presented by links? |
| Do all links show the correct and meaningful relationships between each connected concept, and have defensible directions? |
| All connections are labeled? |
| Do the labels accurately describe the relationship between concepts? |
| Are links established in the most economical way possible, without becoming too general in nature? |
| **Logic flow** |
| Are concepts well organized in a logical manner? |
| Does it present a level of familiarity and detail appropriate for given tasks or the discussion topics? But it does not overwhelm the learner with detail? |
| Is the concept map coherent? |
| Does the concept map show an understanding of how key ideas are linked together? |
| **Layout** |
| Is the text clear and easy to read; the font is neither too small nor too large? |
| Is the amount of text appropriate for the intended audience? |
| Is the color effectively used for emphasis and increased comprehension? |
| Are graphics used only when necessary to increase comprehension? |
| **Overall** |
| Is the concept map clear, legible, and focused? |
| Do the concepts reflect the essential information about the topic? |
| Is information clear, accurate, and well organized? |
| Is content logically arranged on the page to facilitate comprehension? |

This chapter gives the initial context of the study. The Cmap concept mapping tool was chosen to facilitate this study. The first version of the methodology was proposed. However, this methodology has to be applied and tested in the experiment. The experiment of using this methodology to support knowledge sharing among Master's students is discussed in the next chapter.

# 4 Pilot experiment

The pilot experiment was set up to apply the first version of the methodology of knowledge sharing activities. Experiences from this pilot are used as input for iterative refinement. The evaluation of the first version methodology was made as well. This chapter presents the process of the pilot study and what experience was obtained.
Section 4.1 introduces the detail phases of the pilot experiment.
Section 4.2 explains the evaluation process for the pilot experiment.
Section 4.2 discusses the experience learned from the pilot experiment.

## 4.1 Pilot study process

This section presents detailed steps for the pilot experiment, which include experiment task, experiment preparation, individual activities and group activities.

### 4.1.1 Task/topic for knowledge sharing

This pilot study was conducted to evaluate the experimental instructions, the stepwise methods and use of the software. The subjects are Master's students, who are carrying out the final Master's projects. Thus the task for this pilot experiment was set to "share knowledge between each other about how to conduct a master project with the concept mapping principle". Three subjects volunteered to participate in the experiment. They showed common interests for the given task. One of the subject mentioned, although he has a mentor to guide the master project, it would be still interesting to share experience and information with his fellow students, who may have different views and opinions with the professors. In the start of the pilot experiment, 3 students were gathered with the researcher. A 10-minute introduction for concept mapping was given to the subjects. A short overview about concept mapping principle was presented with some examples of concept maps. Afterwards, the researcher outlined and explained the task to the three students: they need to use the Cmap tool to build concept maps, which should show their understanding of how to conduct a master project. The useful resources considered to be important need to be collected as well. They first have to build a concept map individually, which is a step for building a group concept map.

### 4.1.2 Preparation activities

After explaining the task, demo of how to use the Cmap tool to build a concept map was given. The step by step demo includes how to

- open and save a concept map,
- add and edit a concept,
- add a resource (Word, PDF, URL links, etc),
- add a relationship between concepts,
- adjust the layout.

Theses functions are basic steps to build a concept map at an individual level. Communication and collaboration functions would be explained later for the group activities. During the experiment, technical facilitation was given for the possible technical problems of using the Cmap tool. The difficulties that subjects had were recorded with notes by researcher.

### 4.1.3 Individual phase

The students were required to read through the instruction (see "*The methodology of using networked concept mapping to support knowledge sharing – the first version"* from chapter 3.) for developing a concept map at the individual level. The three subjects had to build their individual concept map on three computers, where the Cmap tool was installed. In order to make close observation, these three computers were located in one lab. However, at the individual experiment stage, the three subjects were not allowed to communicate with each other.

The Master students worked individually based on the defined stepwise method with the Cmap tool for 50 minutes. During this period of time, it was also possible for them to upload resources to the concept map they were building. They were able to get support from technicians in case of possible problems in using the Cmap tool. Direct observations were made during this session by the researcher and recorded with notes. All questions and problems the subjects had were recorded with notes by the researcher as well. In the end of the individual stage, the students were required to go through the checklist (see *Table 1: The checklist for completing a concept map)* to be sure that their concept map was completed. Figure 4 shows a concept map built by one subject. Other two individual concept maps are shown in the Appendix 3 and Appendix 4. This concept map includes some basic concepts related to Master's project, the concepts are linked by their

relationships, resources and extra comments are attached to some concepts, which can be reviewed by clicking or icons.

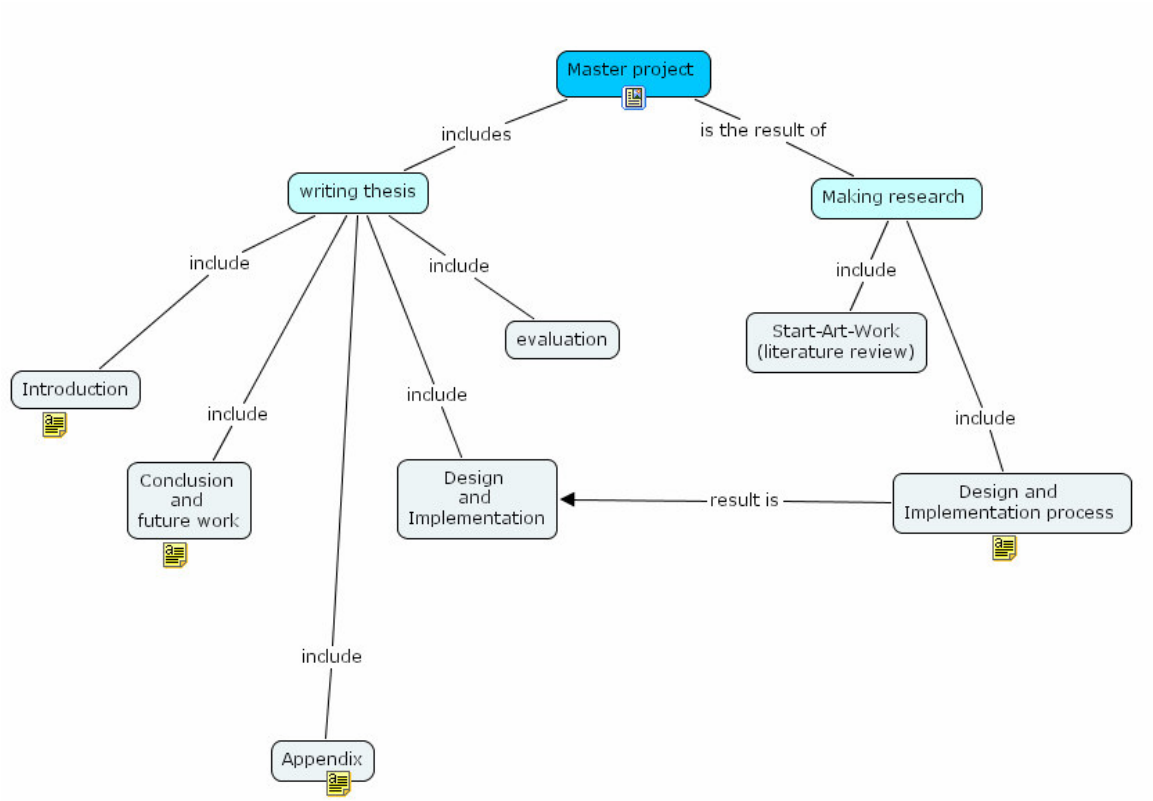



**Figure 4: Individual concept map**

After all subjects completed their concept maps, they exchanged and reviewed them with each other. They were recommended to make notes about differences among their maps and prepare questions for the next session, which is about building a concept map all three subjects together.

### 4.1.4 Group stage

At the group level, a concept map was required from the group formed by these three Master's students. This means that the group members had to get agreements with each other in order to generate a new concept map. During the group level, the subjects were asked to use following instructions from the proposed methodology (see "The methodology of using networked concept

mapping to support knowledge sharing – the first version" about group stage part, section 3.4) for group activities.

A 30-minute face-to-face meeting was carried out. The meeting started with discussing each individual map. The differences between maps were compared. Some agreements were made by three students for building a group concept map after the discussion. A direct observation was made during the meetings with notes by researchers. The main goal of the observation is to find out the behaviors characteristics when group members have to make an agreement with each other. Three students worked together with the Cmap tool to generate the first version of the group concept map. This concept map includes three layers concepts, which ranges from abstract to concrete. This concept map was saved on the server, which is accessible for all group members.

After this face-to-face meeting, the subjects were asked to work "remotely" on the initial concept map they built together. The "remote" model was simulated by connecting client computers together with Cmap server, which means three students can "remotely" communicate with each other by networked computers. Although three students sat together in one lab, they are only allowed to "talk" to each other with Cmap communication facilitated functions. This "remote" environment imitates a real situation, where professions can locate at different places. In addition, this arrangement made it possible to closely observe experiment.

There are three functions from the Cmap tool to support knowledge sharing while building a group concept map:

- **Threaded discussion**
- **Synchronous collaboratio**n
- **Real time chatting:**

By means of synchronous collaboration, the three students could "read" each other's thinking by concurrently editing one group map. The actions of each subject were highlighted with a different color, with the user's name visible next to the actions taken by each person, so that it's easy to identify the changes that were being made. The subjects also could share ideas by chatting, annotation and threaded discussion. The text-based messages were automatically stored for later analysis.

In the end of the group level phase, the subjects were asked to go through the checklist again and finalize the group concepts (see Figure 5).

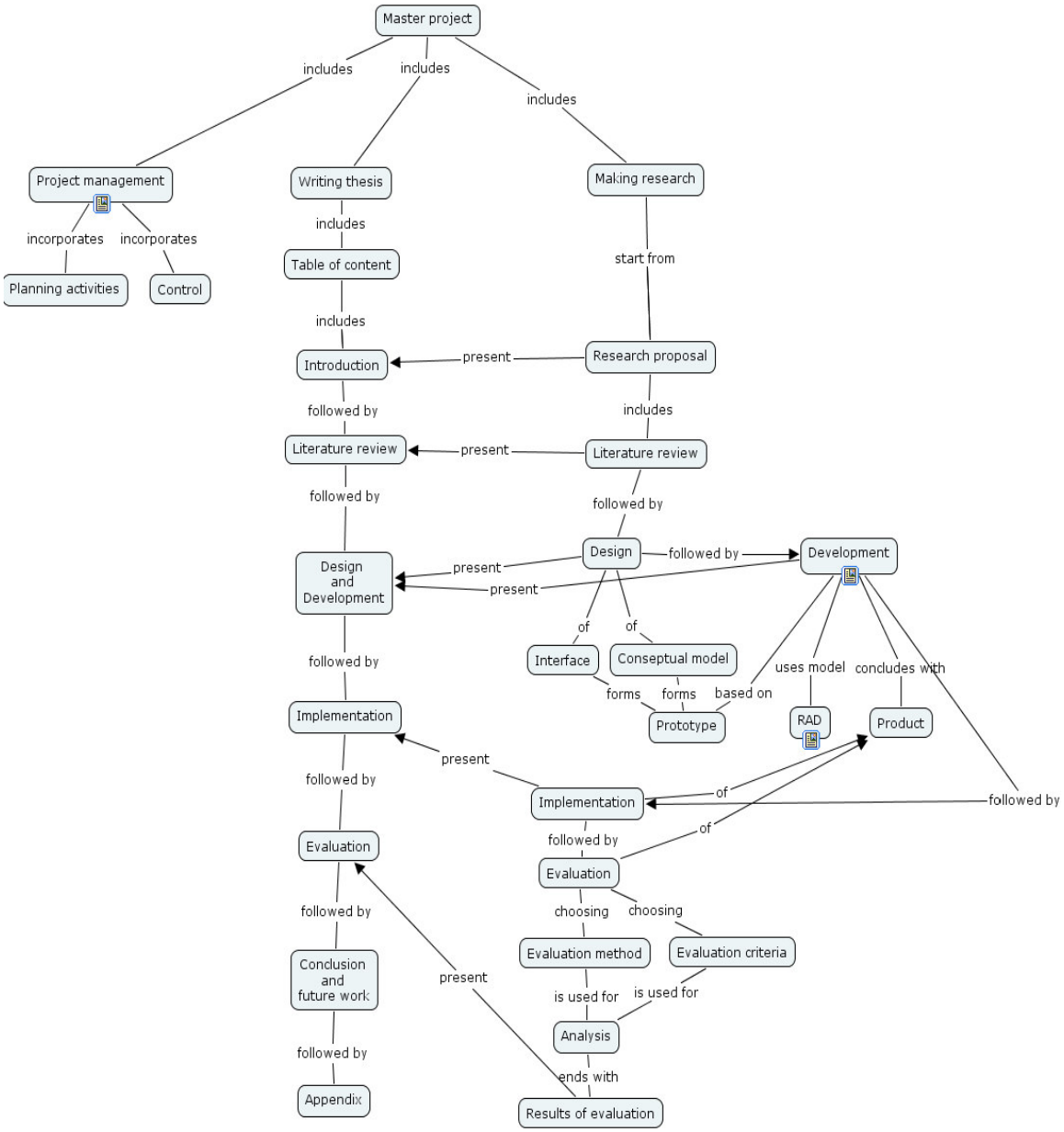



**Figure 5: The group map generated during the pilot experiment**

The pilot experiment was conduct based on the first version methodology. The evaluation of using this methodology to support knowledge sharing with the concept mapping principle is discussed in the next chapter.

## 4.2 Evaluation of the pilot experiment

The pilot experiment with the first version of the methodology went smoothly, however in order to include make evaluation process, more data needs to be collected and analyzed. This section presents the detailed procedure of the evaluation for the pilot experiment.

- Section 4.2.1 introduces the data collection process.
- Section 4.2.2 discusses the results of concept maps generated during the experiment.
- Section 4.2.3 presents the questionnaire response analysis.
- Section 4.2.4 gives an overview about notes made during the pilot experiment.

### 4.2.1 Data collection process

In order to make the evaluation more convincing, valid and accurate, multiple data collection methods were applied. The data were collected by observation, questionnaires and artifacts (concept maps generated by the subjects, chat and threaded discussion files).
Figure 6 presents the process of the data collection during the phases of individual concept map generating and group concept map generation.

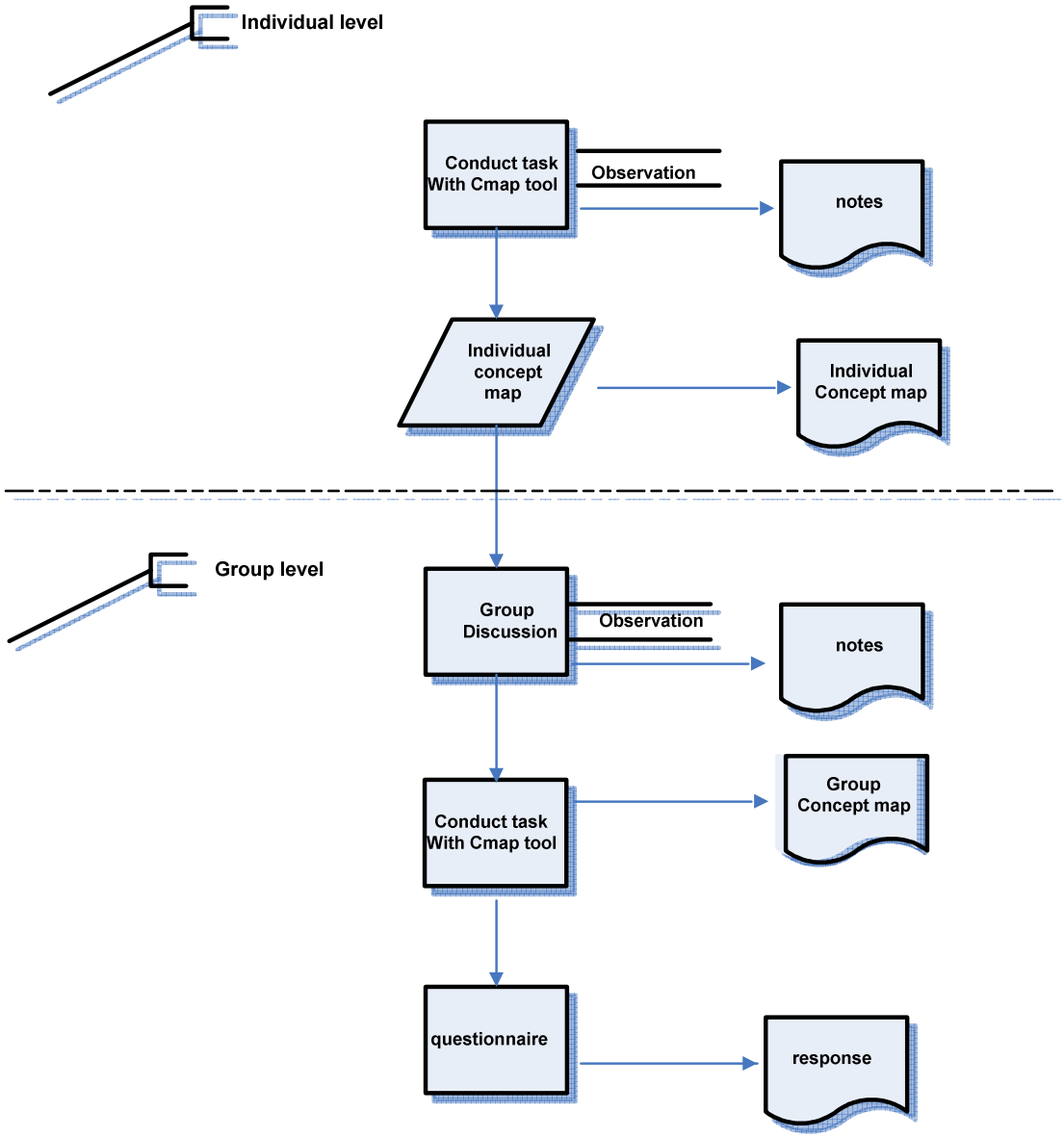



**Figure 6: Experiment with data collection process**

The detailed results for each phase are presented in the following sections.

### 4.2.2 Concept maps results

To analyze the knowledge sharing effectiveness of the first experiment, we compared the group maps with each individual map. One of the factors we used is enrichment, which includes both concept enrichment and resources enrichment. These terms are defined in the formulae below (Stoyanova and Kommers, 2002):

***Concept Enrichment (CE)*** = *(number of concepts from group map –individual's)/ number of concepts from individual map*100%*

***Resource Enrichment (SE)*** = *(number of resources from group map –individual's)/ number of resources from individual map*100%*

The result from individual and group concept maps (Table 4) shows both CE and SE rates from each subject are > 0. This means after the group level stage of constructing concept maps, each individual gets more knowledge (concepts and resources) from each other than before.

**Table 4: Enrichment result**

| ***Concept map*** | ***Concept number*** | ***Resource number*** | ***Concept Enrichment (CE)*** | ***Resource Enrichment (SE)*** |
|---|---|---|---|---|
| Individual_1 | 10 | 0 | 190% | ∞ |
| Individual_2 | 26 | 4 | 11% | 25% |
| Individual_3 | 10 | 1 | 190% | 400% |
| Group | 29 | 5 | | |

As discussed in chapter 2, tacit knowledge is more difficult to capture and pin down than explicit knowledge. It can be hidden in the individual's mind and experience. Knowledge sharing processes when using the Cmap tool to construct a group map have a possibility to transfer individual's tacit knowledge into explicit knowledge. Concept enrichment (CE) rates can be considered as one of the factors for tacit into explicit knowledge transition. In addition, from the number of new ideas inspired and generated during the group construction of concept maps, we also can see if the knowledge sharing process is successful. In this study, 'new concepts' are defined as those concepts generated in the group map that could not be found in any of the individual's maps. A creativity factor is used to represent the formula below

***Creativity (C)*** = *number of new concepts from group map/ number of concepts from individual map*100%*

In the first experiment, two new concepts were found in the group map. They are "prototype" and "research proposal". These two concepts are important elements for "Master's project" task. The creativity results from this experiment session are shown in the Table 5:

**Table 5: Creativity result**

| *Concept map* | *Concept number* | *Creativity Influence* |
|---|---|---|
| Individual_1 | 10 | 20% |
| Individual_2 | 26 | 7.7% |
| Individual_3 | 10 | 20% |
| Group | 29 | 6.9% |

The creativity factor for each subject is > 0. This means after group knowledge sharing, new ideas were inspired. These new ideas resulted in new concepts, which were generated by group knowledge. In addition, the proposed methodology may have a positive effect on promoting creativity after knowledge sharing. However, because of characteristic of the tacit knowledge, it is difficult to measure the transaction rate from tacit knowledge into explicit knowledge. A questionnaire can be a useful instrument to know more about it from the subject's experience.

### 4.2.3 Questionnaire response analysis

A questionnaire has been designed (Appendix 1), which aims at collecting data about the subject's user experience of using the Cmap tool, the subject's satisfaction about using concept mapping for knowledge sharing activities, as well as the subject's opinions about the first version of methodology of this specific approach to use concept mapping in order to make tacit knowledge more explicit. The questionnaire was distributed to the subjects right after they completed the group concept map.

The subjects completed the questionnaire questions at the end of the experiment. Since this study mainly focuses on the knowledge sharing topic, which was carried out mainly by the group construction session, thus the questionnaire questions also pay more attention to issues related to the construction of group maps. Other relevant topics such as subject's satisfaction of using the Cmap tool for knowledge sharing and user experience with the tool are also covered in this questionnaire. The data analysis of the questionnaire response results is presented below:

**Group activities for knowledge sharing questions: preparation sessions**

The first question of the questionnaire tries to find out the subjects' opinions about the relationship between individual work and group activities (Figure 7):

| 1. Do you agree that building your own concept map is useful step for preparing a group map? | | | |
|---|---|---|---|
| | | Response Percent | Response Total |
| Strongly agree | | 33.3% | 1 |
| **Agree** | | **66.7%** | **2** |
| Neutral | | 0% | 0 |
| Disagree | | 0% | 0 |
| Strongly disagree | | 0% | 0 |

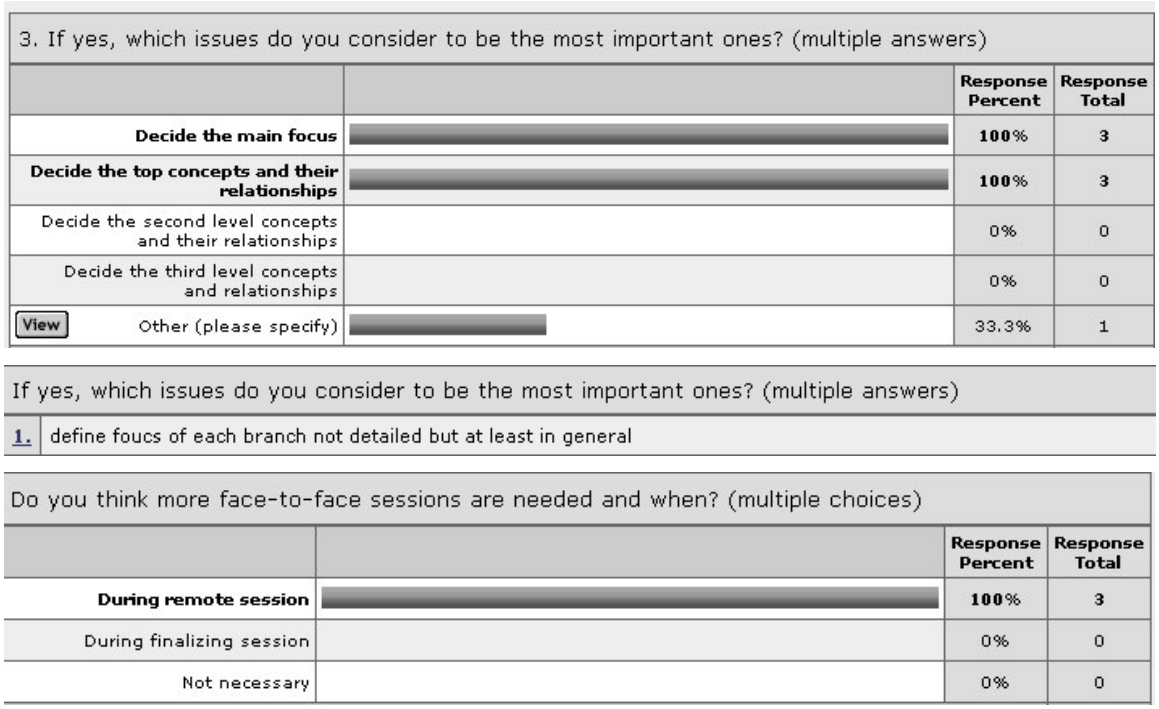
**Figure 7: Questionnaire response analysis 1**

All subjects think that building their own individual concept maps is a useful step to prepare a group map (Figure 7). Some of them (one subject) consider an individual concept map is very important for later building a group map. Knowledge sharing is a process of collecting individual's ideas and experience. The individual session of building a concept map is the first step to organize and realize ideas into artifacts. In our first version of methodology, building an individual map was designed as a necessary step for a group map and important for knowledge sharing. This proposition is confirmed by the questionnaire response.

**Group activities for knowledge sharing questions: face-to-face sessions**

There are three questions to figure out the subjects' opinions about the face-to-face meeting (Figure 8):

| 2. Do you agree that a face-to-face discussion session is important for building a group map later? | | | |
|---|---|---|---|
| | | Response Percent | Response Total |
| **Strongly agree** | | **100%** | **3** |
| Agree | | 0% | 0 |
| Neutral | | 0% | 0 |
| Disagree | | 0% | 0 |
| Strongly disagree | | 0% | 0 |



3. If yes, which issues do you consider to be the most important ones? (multiple answers)

| | | Response Percent | Response Total |
|---|---|---|---|
| **Decide the main focus** | | **100%** | **3** |
| **Decide the top concepts and their relationships** | | **100%** | **3** |
| Decide the second level concepts and their relationships | | 0% | 0 |
| Decide the third level concepts and relationships | | 0% | 0 |
| View Other (please specify) | | 33.3% | 1 |

If yes, which issues do you consider to be the most important ones? (multiple answers)

| | |
|---|---|
| 1. | define foucs of each branch not detailed but at least in general |

Do you think more face-to-face sessions are needed and when? (multiple choices)

| | | Response Percent | Response Total |
|---|---|---|---|
| **During remote session** | | **100%** | **3** |
| During finalizing session | | 0% | 0 |
| Not necessary | | 0% | 0 |

**Figure 8: Questionnaire response analysis 2**

All subjects "strongly agree" that face-to-face session is very important. During the pilot experiment, only one face-to-face session was scheduled in the beginning of group activities. However, all subjects wish to have more face-to-face sessions for the group map construction. For topics that should be discussed during the first meeting, they consider deciding about the main focus for the map, as well as agreeing on top concepts and their relationships are very important. An extra comment was made by one subject: "define focus of each branch not detailed but at least in general". She/he possibly means face-to-face meeting should stick on the main topics but not too detailed.

**Group activities for knowledge sharing questions: remote activities**

During the first experiment of knowledge sharing activities, the three subjects were facilitated by the tool with chatting and concurrent editing on one concept map (real time collaboration) functions. The questions below show their opinions about these activities (Figure 9).

| 5. Do you agree that the chatting function is useful for building a group map later? | | | |
|---|---|---|---|
| | | Response Percent | Response Total |
| Strongly agree | | 33.3% | 1 |
| **Agree** | | **66.7%** | **2** |
| Neutral | | 0% | 0 |
| Disagree | | 0% | 0 |
| Strongly disagree | | 0% | 0 |

| 6. If no, what are the problems? | |
|---|---|
| **Total Respondents** | **0** |

| 7. Do you agree that the collaboration function is useful to build a group map later? | | | |
|---|---|---|---|
| | | Response Percent | Response Total |
| Strongly agree | | 0% | 0 |
| **Agree** | | **66.7%** | **2** |
| Neutral | | 33.3% | 1 |
| Disagree | | 0% | 0 |
| Strongly disagree | | 0% | 0 |

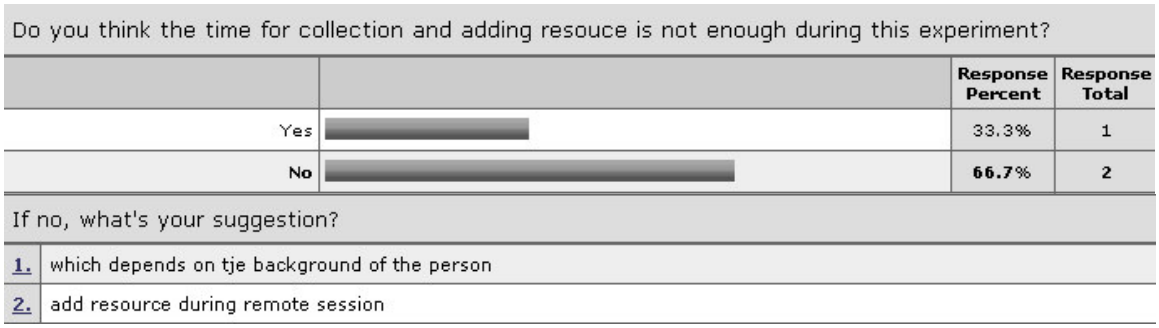
| 9. Please make a rank for the most effective and efficiency communication ways for using concept mapping for knowledge sharing (from 1 to 4 or more) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Response Average |
| Face to face | **100% (3)** | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | **1.00** |
| Chatting | 0% (0) | **67% (2)** | 33% (1) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | **2.33** |
| Real-time collaboration | 0% (0) | 33% (1) | **67% (2)** | 0% (0) | 0% (0) | 0% (0) | 0% (0) | **2.67** |
| Other (Please specify) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | **0.00** |
| Other (Please specify) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | **0.00** |

**Figure 9: Questionnaire response 3**

Two subjects agree that both chatting and real time collaboration are important for building a group map. In addition, one of them considers chatting is very important. One subject has a "neutral" attitude for collaboration's contribution to construct a group map. However, for the question "Please make a rank for the most effective and efficient communication way for using concept mapping for knowledge sharing", all subjects give the first place to the face-to-face meeting; chatting is on the second place and real-time collaboration is in the third place. These results show that the subjects prefer and possibly feel more comfortable with natural face-to-face meeting and network facilitated ways are only their second choices.

**Share resources**

Exchanging resources is one of the processes for knowledge sharing. During the first experiment, subjects could upload resources they considered interesting to the server, which then become available for all group members. The results from questionnaire show that two subjects think that the time for collecting and adding resource to the group map was too limited (Figure 10). This time issue should be taken into account for the next experiment.



Do you think the time for collection and adding resouce is not enough during this experiment?

| | | Response Percent | Response Total |
|---|---|---|---|
| Yes | | 33.3% | 1 |
| **No** | | **66.7%** | **2** |

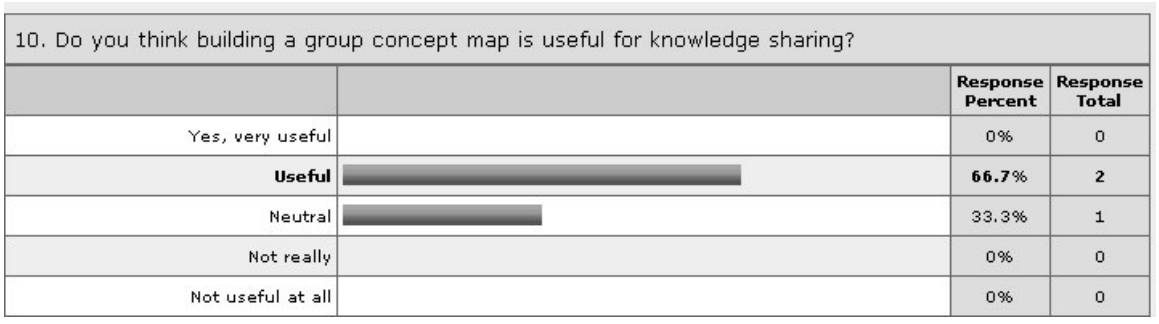
If no, what's your suggestion?

| | |
|---|---|
| 1. | which depends on tje background of the person |
| 2. | add resource during remote session |

**Figure 10: Questionnaire response analysis 4**

**Subject's opinions for constructing a group map for knowledge sharing purposes**

There are questions that refer to the subject's opinions about using concept mapping to share knowledge among group members (Figure 11). Two subjects consider building a group map is useful for knowledge sharing, however, 33.3% of subjects have a neutral attitude.



10. Do you think building a group concept map is useful for knowledge sharing?

| | | Response Percent | Response Total |
|---|---|---|---|
| Yes, very useful | | 0% | 0 |
| **Useful** | | **66.7%** | **2** |
| Neutral | | 33.3% | 1 |
| Not really | | 0% | 0 |
| Not useful at all | | 0% | 0 |

**Figure 11: Questionnaire response analysis 8**

Next question further asks subjects in which ways do they consider group concept map construction are useful for knowledge sharing and management (Figure 12).

If yes, in which ways? (multiple choice)

| | | Response Percent | Response Total |
|---|---|---|---|
| **Exchanging recourses** | | **100%** | **3** |
| Capturing new knowledge (by earning new concepts from group members) | | 66.7% | 2 |
| Foster creativity thinking (new deas are generated during group session) | | 66.7% | 2 |
| Pinning down the tacit knowledge (ideas, experience are captured and formatted by when constructing a group concept map) | | 66.7% | 2 |
| Other (please specify) | | 0% | 0 |

**Figure 12: Questionnaire response analysis 9**

All subjects think exchanging resources is useful. Besides this, two subjects think group concept mapping helps capture new knowledge (by knowing new concepts from others) and foster creativity thinking (new ideas were generated during group session). In addition, two subjects also think group map construction is useful for pinning down tacit knowledge, which means ideas and experience can be captured and formatted by a group concept map. The results from these questions show that the first version of methodology of using concept mapping has a positive impact on knowledge sharing.

### User experience with the tool

It is also necessary to know about subjects' experience with the Cmap tool: Is it hard for them to use it? Which functions are hard for them to work with (Figure 13)? The responses from subjects are very different for the usage of the tool, which are "very easy to use", "easy to use" and "not easy".

4. Is Cmap tool easy to use?

| | | Response Percent | Response Total |
|---|---|---|---|
| **Yes, very easy** | | **33.3%** | **1** |
| **Easy** | | **33.3%** | **1** |
| **Not easy** | | **33.3%** | **1** |
| Very hard | | 0% | 0 |

| Which functions are difficult for you? (multiple choice) | | | |
|---|---|---|---|
| | | Response Percent | Response Total |
| Adding concepts | | 33.3% | 1 |
| Adding links (relationships) between concepts | | 0% | 0 |
| Add recourses | | 33.3% | 1 |
| Add Url Links | | 0% | 0 |
| Chatting | | 33.3% | 1 |
| **Collaboration** | | **66.7%** | **2** |
| Other (please specify) | | 0% | 0 |

**Figure 13: Questionnaire response analysis 10**

In addition, the most difficult function for them is the real time collaboration (66.7 % of subjects), the rest are adding concepts, adding links, adding resources and chatting (33.3% of subject vote for each) functions. These results gave some useful information, which remind us we should pay more attention on these difficult issues during the tool instruction and demo.

**Final remarks**

The subjects were asked to give some comments about the concept mapping and the tool (Figure 14):

| Final remarks Please give some suggestions or remarks for using concept mapping for knowledge sharing purposes: | |
|---|---|
| 1. | maybe the final face-to-face meeting is needed to build the final session of document. however it's only in case if group product is important |
| 2. | It's better to have a face-to-face session at the beginning. Then people can make an general outline for concept maps |
| 3. | people who use the concept mapping should have some background and more knowledge in the field, so that they can use it better |

| Final remarks Please give some suggestions or remarks for using concept mapping for knowledge sharing purposes: | |
|---|---|
| 1. | The arrow is not clear show the relationship of concept |
| 2. | I think the tool is important and useful, but first make it clear that how to use it |

**Figure 14: Questionnaire response analysis 11**

These comments confirm the findings from this previous questions answers. Two main points are:

- More face-to-face sessions are necessary, which can be at the beginning of the group map construction, during remote construction and finalizing map session.

- It is important to explain clearly how to use the tool. The subjects felt difficulty for some functions, such as real time collaboration, which may cause them to consider these functions to be less important for knowledge sharing.

### 4.2.4 Notes analysis

Some notes were made during the whole process of the experiment, which are represented in Table 6.

**Table 6: Notes from the first experiment**

| Number | Content |
|---|---|
| Individual session | |
| 1 | All three subjects asked to clearly explain the given topic. |
| 2 | One subject had problems to add concepts and links to the map. |
| 3 | Time for collecting resources is too little according to all three subjects. |
| Group session | |
| 4 | The subjects often spent too much time on details, but hardly get an agreement. |
| 5 | Attention was paid on details while the main topic and structure was ignored. |
| 6 | 2 subjects had problems to use the real-time collaboration function. |

The notes reflect some problems found by questionnaire like resource time limitation and technical difficulties. Moreover, it is also interesting to realize subjects had difficulty to focus on the main issues of the group meeting; instead they often get stuck on details.

## 4.3 Experience learned from the first experiment

After analysis of the concept maps generated during the first experiment, together with the questionnaire response and notes, the general impression of the first version of the methodology is positive. However, some experience was gained as well about things to improve:

- The topic of knowledge sharing should be made clear enough among all group members.

- More face-to-face sessions may be necessary, which can be scheduled at the beginning of the group activities, during the remote construction session and during the finalizing map session.
- Group members should stick to the main meeting topics during the face-to-face session.
- The group members should have a longer period available for collecting resources to share.
- The instruction and demo of the tool should be made more clearly, especially for some difficult functions like real time collaboration.

These experiences should be taken into account for the next experiment, to achieve a better performance. The pilot experiment shows the positive effect of the proposed methodology. The pilot experiment is a successful test. The experience can be gained to refine the next round experiment.

# 5 The second experiment

The previous chapter shows the success factors of the proposed methodology. To make the results more reliable and achieve a better performance, a second experiment was conducted. This experiment will follow the main stepwise methods from the proposed methodology. However, some problems of the pilot experiment should be taken into account.

Section 5.1 presents the process of the second experiment.

Section 5.2 discusses the evaluation process.

Section 5.3 gives the conclusion from the second experiment.

## 5.1 The second experiment process

The subjects for the second experiment are still three master students, who were different from the pilot experiment. Because of their common interests, the task, same as the pilot study, was set up to share knowledge about master project with concept mapping principle.

Due to the successful results from the pilot experiment, the main activities and their sequences developed from the first version methods were applied again in the second experiment. The main activities and their sequences are summarized in Table 7:

**Table 7: The process for the second experiment**

| | |
|---|---|
| **Preparation stage** | I. Introduce concept mapping principle<br>II. Introduce and demo how to use Cmap tool<br>III. Assign task for all group members |
| **Individual stage** | I. Add concepts and their relationship<br>II. Add resources<br>III. Adjust the layout and refine the concept map<br>IV. Finalize the concept map with checklist |
| **Group stage preparation** | Each individual concept map is reviewed by all members individually. |
| **Group stage** | I. Face-to-face meeting<br>II. Build an initial concept map together<br>III. Remotely work on one group map, which was facilitated by |

| | |
|---|---|
| | a. threaded discussion<br>b. real-time collaboration<br>c. chatting , etc,<br>IV. The second face-to-face meeting is planned in between of the remote phase.<br>V. Finalize the concept map, possible with a third meeting. |

The second experiment was conducted based on the steps described in the Table 7. In addition, some problems from the pilot experiment need to be addressed. Some adjustments were made during the second experiment.

The task for the experiment was intended to be clear for three subjects. To check whether subjects have a clear goal, they were asked to repeat and explain the tasks by themselves.
More face-to-face sessions were conducted, which were not only limited at the beginning of the group activities, but also during the remote construction session and during the finalizing map session.

- The topic of knowledge sharing should be made clear enough among all group members.
- The demo about how to use the tool was repeated twice, until the subjects confirmed it was clear for them.
- More face-to-face sessions may be necessary, which can be scheduled at the beginning of the group activities, during the remote construction session and during the finalizing map session.
- To make meetings more effective, the subjects were required to make the plan by themselves before a meeting. The topics and goals for the meeting should be decided before a meeting.
- A longer period of time was given to subjects for uploading resources.

The second experiment was conducted based on the steps described in Table 5. In addition, some problems from the pilot experiment needed to be addressed. Some adjustments were made during the second experiment. Figure 15 illustrates a collaboration session where three subjects were modifying their concept map.

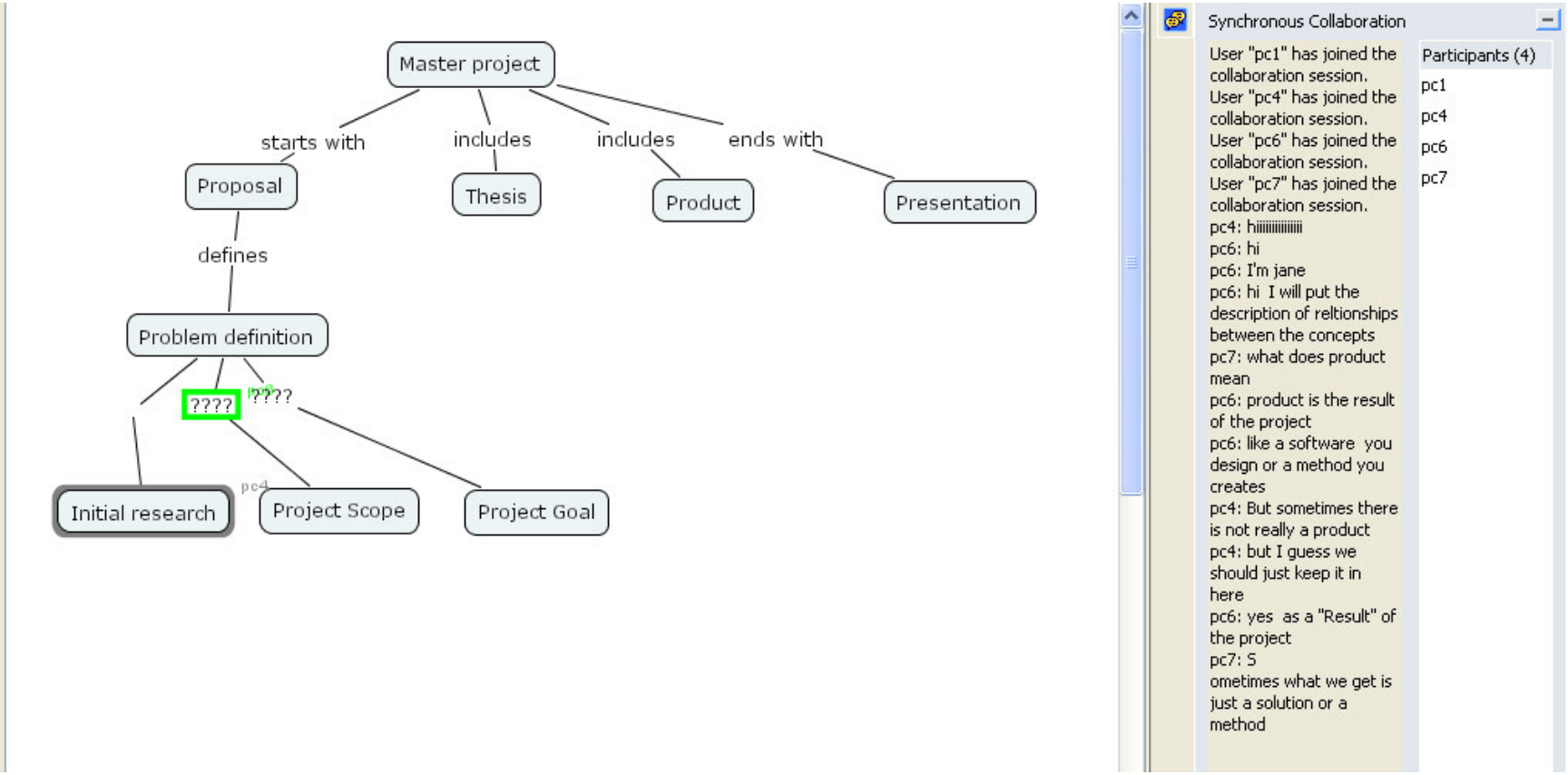



**Figure 15: Cmap screendump illustrating the collaboration mode**

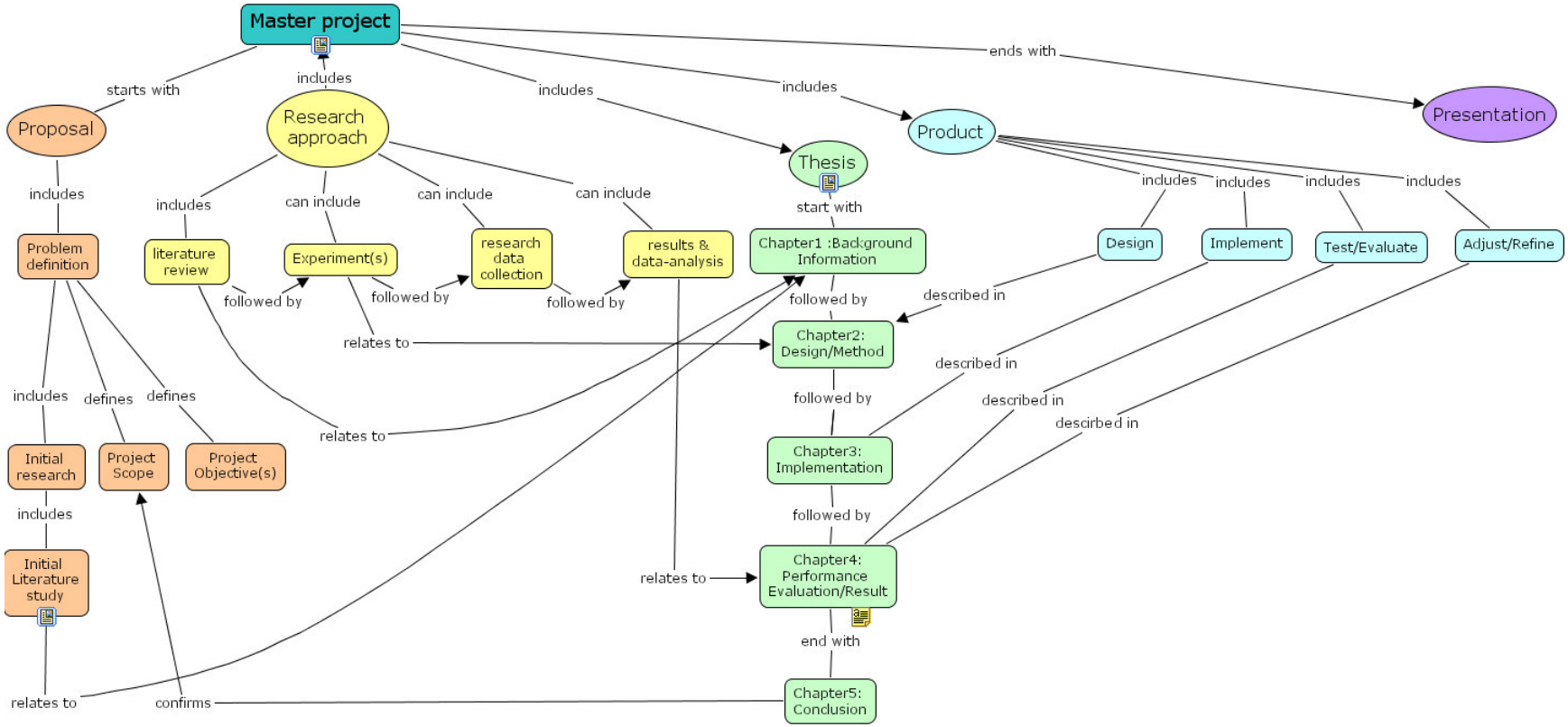



**Figure 16: Final group concept map**

The subjects can discuss with each other by the real time chatting function (see Figure 15 right side). Every subject on a collaboration session could see the chat window in Figure 15, through which they can exchange text messages and see the names of the other subjects connected to this session. In this experiment, there were 4 participants appeared on the chatting pane. “pc1” is username of the researcher, who uses the access rights only for monitor purpose. The rest users, “pc4”, “pc6”, and “pc7” are the usernames of three subjects. The left side of Figure 15 shows how three subjects simultaneously edited on the concept map. The highlighted concepts with different color show the moment action from a subject. This way enables each group member to be aware about what does each other doing.

To make a complete concept map, three subjects categorized concepts by different clusters with different color and shapes (See Figure 16). Figure 16 shows the final concept map generated by the second experiment. Each individual map is presented in the Appendix. Compared to the group map from the first experiment, this one has more clear hierarchy. However, more data needs to be collected and analyzed to make an evaluation.

## 5.2 Evaluation of the second experiment

The evaluation process follows the same procedure as the pilot experiment, which focuses on the analysis of the individual and group concept maps and questionnaire responses. Because of the similarity between data collection from two experiments, this section presents only the data analysis results.

### 5.2.1 Concept maps results

A comparison was made between individual and group maps. The terms of concept enrichment (CE) and Resource Enrichment were applied to check the knowledge sharing effectiveness from the second experiment.

> ***Concept Enrichment (CE)*** *= (number of concepts from group map –individual’s)/ number of concepts from individual map*100%*

> ***Resource Enrichment (SE)*** *= (number of resources from group map –individual’s)/ number of resources from individual map*100%*

From the results from Table 8, it shows that the enrichment rates of both concepts and resources are >0 for each subject. This is the success factor for knowledge sharing.

**Table 8: Enrichment result**

| ***Concept map*** | ***Concept number*** | ***Resource number*** | ***Concept Enrichment (CE)*** | ***Resource Enrichment (SE)*** |
|---|---|---|---|---|
| Individual_1 | 8 | 1 | 200% | 600% |
| Individual_2 | 10 | 2 | 140% | 250% |
| Individual_3 | 15 | 1 | 60% | 600% |
| Group | 24 | 7 | | |

A creativity factor was applied to check how new ideas and creativity thinking were inspired during the second experiment:

> ***Creativity (C)*** *= number of new concepts from group map/ number of concepts from individual map*100%*

Four new concepts were found in the group map, which didn't exist in any individual concept map. Four new concepts were found in the group map. The creativity results from this experiment session are shown in the Table 9:

**Table 9: Creativity result**

| ***Concept map*** | ***Concept number*** | ***Creativity Influence*** |
|---|---|---|
| Individual_1 | 8 | 50% |
| Individual_2 | 10 | 40% |
| Individual_3 | 15 | 26.7% |
| Group | 24 | 16.7% |

Compare with the first experiment, the CE and RE results are similar. However, Creativity result increased a lot. The average Creativity influence from the second experiment is 33.5%, while the first experiment is 13.65%. This results shows that the second experiment successfully promotes creativity thinking by using concept mapping share knowledge between each group member. However, more confirmation needs to be found from questionnaire response.

### 5.2.2 Questionnaire response analysis

Due to some changes between the two experiments, some adjustments were made in the questionnaire. More questions were added regarding to more frequent meetings during the second experiment. In addition, extra questions were added about tacit knowledge transfer issues, which were hard to measure from concept maps. The main goal for this questionnaire is to find out the three subjects' opinions about applying the stepwise methods for knowledge sharing. Special attention was paid to the methodologies effect on tacit knowledge transfer. Three subjects completed the questionnaire right after they completed the group concept map. The results were processed by "*survey monkey"* (http://www.surveymonkey.com).

Same as the pilot experiment, all subjects consider building an individual concept map is useful for knowledge sharing (see Figure 17). These results confirm that individual map construction is a necessary step for building a group map, thus as a preparation for knowledge sharing as well.

1. Do you agree that building your own concept map is a useful step of preparing a group map for knowledge sharing purpose?

| | | Response Percent | Response Total |
|---|---|---|---|
| Strongly agree | | 33.3% | 1 |
| **Agree** | | **66.7%** | **2** |
| Neutral | | 0% | 0 |
| Disagree | | 0% | 0 |
| Strongly disagree | | 0% | 0 |

**Figure 17: Individual map**

According to the problems with the pilot experiment, more meetings were scheduled for the second experiment. The results from the questionnaire (see Figure 18) show that all subjects consider meetings are important before constructing a group map, during construction of the group map and at the phase of finalizing a group map. Moreover, the meeting before constructing map is the most important one. This results show the importance of face-to-face interactions for knowledge sharing. However, it may be difficult to arrange meetings for disturbed professionals. Thus, it will be a challenge about how to make a balance between human personal interactions and human interaction through computer in real field settings.

Do you agree that the face-to-face discussion before constructing a group is important?

| | | Response Percent | Response Total |
|---|---|---|---|
| **Strongly agree** | | **66.7%** | **2** |
| Agree | | 33.3% | 1 |
| Neutral | | 0% | 0 |
| Disagree | | 0% | 0 |
| Strongly disagree | | 0% | 0 |

Do you agree that the face-to-face discussion during construction group map is important?

| | | Response Percent | Response Total |
|---|---|---|---|
| Strongly agree | | 33.3% | 1 |
| **Agree** | | **66.7%** | **2** |
| Neutral | | 0% | 0 |
| Disagree | | 0% | 0 |
| Strongly disagree | | 0% | 0 |

Do you agree that the face-to-face meeting is important for finalizing a group map?

| | | Response Percent | Response Total |
|---|---|---|---|
| Strongly agree | | 0% | 0 |
| **Agree** | | **100%** | **3** |
| Neutral | | 0% | 0 |
| Disagree | | 0% | 0 |
| Strongly disagree | | 0% | 0 |

**Figure 18: Face-to-face meetings**

The discussion of different remote communication and collaboration modes for knowledge sharing was made (see Figure 19). All subjects agree that the chatting function is useful for knowledge sharing while constructing a group concept map. In addition, two subjects agree that real-time collaboration is important and one subject strongly agree with it. Compared to the pilot study (two agree and one neutral), some improvement has been made by the second experiment. This is due to more effort and attention having been made to explain how to use this function to the subjects. It shows that technical support is very important to increase the usability of the tool for knowledge sharing activities.

Do you agree that chatting is useful for knowledge sharing during construction group map?

| | | Response Percent | Response Total |
|---|---|---|---|
| Strongly agree | | 0% | 0 |
| **Agree** | | **100%** | **3** |
| Neutral | | 0% | 0 |
| Disagree | | 0% | 0 |
| Strongly disagree | | 0% | 0 |

7. Do you agree that real-time collaboration is useful for knowledge sharing during construction group map?

| | | Response Percent | Response Total |
|---|---|---|---|
| Strongly agree | | 33.3% | 1 |
| **Agree** | | **66.7%** | **2** |
| Neutral | | 0% | 0 |
| Disagree | | 0% | 0 |
| Strongly disagree | | 0% | 0 |

If no, what are the problems?

| | Total Respondents | 0 |
|---|---|---|

**Figure 19: Chatting and real-time collaboration**

Different with previous functions, subjects have a neutral of negative attitude for the threaded discussion function (see figure 20). Some comments were made that threaded discussion is less effective compared to the real-time functions, which enable users to get quicker responses. Moreover, compared to other asynchronous applications, subjects chose e-mail instead.

9. Do you agree that threaded discussion is important for knowledge sharing during construction group map?

| | | Response Percent | Response Total |
|---|---|---|---|
| Strongly agree | | 0% | 0 |
| Agree | | 0% | 0 |
| Neutral | | 33.3% | 1 |
| **Disagree** | | **66.7%** | **2** |

If no, what are the problems?

| | |
|---|---|
| 1. | I prefer email for non real-time communications |
| 2. | I didn't use it. It could be useful, but I think real-time collaboration and chatting are much better, since you can react quicker and come to better ideas. Also Email can be used instead of this. |

**Figure 20: Threaded discussion**

The subjects were asked to make a rank of effective and efficiency facilitation of using concept mapping for knowledge sharing (Figure 21). All subjects consider face-to-face meeting to have the first position. Real-time collaboration and chatting have the second and third place respectively. Threaded discussion is on the fourth place, and one subject chose e-mail as the fourth, which confirms the findings from the previous question.

Please make a rank for the most effective and efficiency facilitation of using concept mapping for nowledge sharing (1 is the highest scare, 2 is the second, etc)

| | | | | | | | | Response Average |
|---|---|---|---|---|---|---|---|---|
| Face to face | **100% (3)** | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | **1.00** |
| Chatting | **33% (1)** | **33% (1)** | **33% (1)** | 0% (0) | 0% (0) | 0% (0) | 0% (0) | **2.00** |
| Real-time collaboration | **67% (2)** | 33% (1) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | **1.33** |
| Threaded discussion | 0% (0) | **50% (1)** | **50% (1)** | 0% (0) | 0% (0) | 0% (0) | 0% (0) | **2.50** |
| Other (Please specify) | 0% (0) | 0% (0) | 0% (0) | **100% (1)** | 0% (0) | 0% (0) | 0% (0) | **4.00** |
| ... | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | 0% (0) | **0.00** |
| | | | | | | | **Total Respondents** | **3** |

**Figure 21: Facilitation function rank**

All subjects have a positive attitude about using concept mapping for knowledge sharing (see Figure 22). The most important factors are exchanging resources and helping pin down tacit knowledge. Other factors as “capture new knowledge” and “foster thinking” are also considered to be important. These results shows that subjects confirm the positive effects of using concept mapping for tacit knowledge transfer.

Do you think building a group concept map is useful for knowledge sharing?

| | | Response Percent | Response Total |
|---|---|---|---|
| Strongly agree | | 33.3% | 1 |
| **Agree** | | **66.7%** | **2** |
| Neutral | | 0% | 0 |
| Disagree | | 0% | 0 |
| Strongly disagree | | 0% | 0 |

3. If yes, in which ways? (Multiple choices)

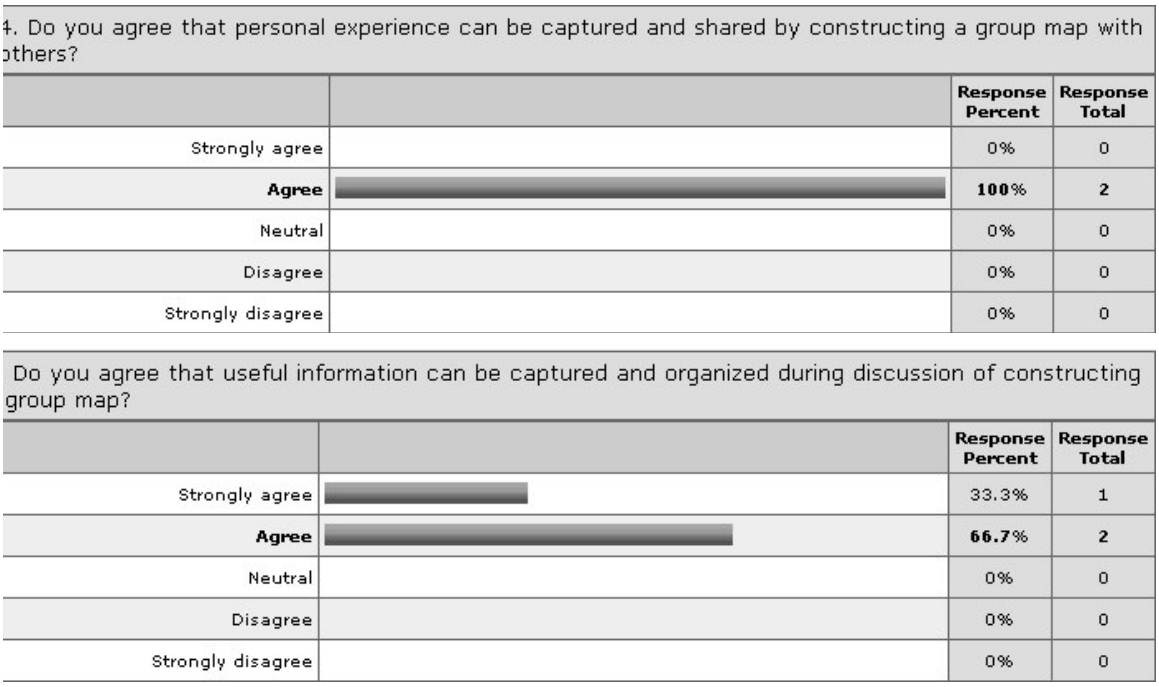
| | Response Percent | Response Total |
|---|---|---|
| **Exchanging recourses** | **100%** | **3** |
| Capturing new knowledge (by obtaining new concepts from other group members) | 66.7% | 2 |
| Foster creativity thinking (by generating new ideas during constructing a group map) | 66.7% | 2 |
| **Pinning down the tacit knowledge (ideas, experience are captured and formatted by a concept map)** | **100%** | **3** |
| View Other (please specify) | 33.3% | 1 |

If yes, in which ways? (Multiple choices)

| | |
|---|---|
| 1. | bring motivation too |

**Figure 22: Attitude for concept mapping**

The following questions further discuss details of the tacit knowledge sharing during the second experiment. All subjects agree that personal experience can be captured and shared by constructing a group map with others. 66.7% subjects agree that useful information can be captured and organized during discussion of construction a group map.



4. Do you agree that personal experience can be captured and shared by constructing a group map with others?

| | Response Percent | Response Total |
|---|---|---|
| Strongly agree | 0% | 0 |
| **Agree** | **100%** | **2** |
| Neutral | 0% | 0 |
| Disagree | 0% | 0 |
| Strongly disagree | 0% | 0 |

Do you agree that useful information can be captured and organized during discussion of constructing group map?

| | Response Percent | Response Total |
|---|---|---|
| Strongly agree | 33.3% | 1 |
| **Agree** | **66.7%** | **2** |
| Neutral | 0% | 0 |
| Disagree | 0% | 0 |
| Strongly disagree | 0% | 0 |

**Figure 23: Tacit knowledge transfer**

The next question is intended to find out the subjects' opinions about the proposed stepwise methods. This methodology has been adjusted according to the experience learned from the pilot experiment. The response (see Figure 24) shows a positive attitude from all subjects.

Do you think the designed steps to construct concept maps are suitable for knowledge sharing?

| | | Response Percent | Response Total |
|---|---|---|---|
| Strongly agree | | 0% | 0 |
| **Agree** | | **100%** | **3** |
| Neutral | | 0% | 0 |
| Disagree | | 0% | 0 |
| Strongly disagree | | 0% | 0 |

**Figure 24: Attitude about the methodology**

The subjects all consider the Cmap tool to be easy to use (Figure 25). This may be due to the fact that more effort was made for tool instruction. However, because of some bugs that exist in the tool, some functionality is hard to use. These bugs were reported to the Cmap development team.

Is Cmap tool easy to use?

| | | Response Percent | Response Total |
|---|---|---|---|
| Yes, very easy | | 0% | 0 |
| **Easy** | | **100%** | **3** |
| Not easy | | 0% | 0 |
| Very hard | | 0% | 0 |

Which functions are difficult for you? (multiple choice)

| | | Response Percent | Response Total |
|---|---|---|---|
| **No** | | **33.3%** | **1** |
| Adding concepts | | 0% | 0 |
| **Adding links (relationships) between concepts** | | **33.3%** | **1** |
| **Add recourses** | | **33.3%** | **1** |
| **Add Url Links** | | **33.3%** | **1** |
| Chatting | | 0% | 0 |
| Collaboration | | 0% | 0 |
| Other (please specify) | | 0% | 0 |

**Figure 25: About Cmap tool**

The subjects also gave some open comments about the methodology and the tool (Figure 26). They think the methodology they applied during the experiment has a logic of flow, the time and

sequence for activities are good; the process promotes knowledge sharing among group members. However, some adjustments may be needed for different situations. The subjects also report the bugs and problems from the tool during the second experiment, which have been sent to the Cmap development team by researcher of this study.

| Final remarks Please give some suggestions or remarks of using concept mapping for knowledge sharing purposes: | |
|---|---|
| 1. | In general, it's a good methodology. |
| 2. | The designed steps promote knowledge sharing. however, some steps may need to be adjusted in pratice. |
| 3. | logic step, sutiable for the knowledge sharing. The consquences and time scheduel are good |

| Final remarks Please give some suggestions or remarks of using concept mapping for knowledge sharing purposes: | |
|---|---|
| 1. | the link url function is not so easy to use. |
| 2. | it's bit diffucult to use adding resouces fuction.. |
| 3. | It's not hard to use, but I saw some bugs in this tool. |

**Figure 26: Final remark**

## 5.3 Summary for the second experiment

The second experiment was conducted based on the experience learned from the pilot experiment. The second experiment applied the proposed methodology from this study, followed designed activities and their sequence, some time issues were taken into account to achieve better performance. Some solutions were addressed due to problems found in the pilot experiment, which focus on the face-to-face meeting, tool instruction and time issues for collecting resources. The evaluation data analysis shows a positive result for the second experiment. Further conclusions about two experiments and other aspects of this study are given in the next chapter.

# 6 Conclusion

This chapter concludes the thesis. It gives an overview of the research questions and concluding comments. This chapter reflects the major conclusions of these research questions and gives the references to the sections.

- Section 6.1 will discuss the limitation of the study.
- Section 6.2 will review the research questions based on the results from the thesis.
- Section 6.1 will represent the consequence for Myself project.
- Section 6.2 discusses some issues for future work.

## 6.1 Limitation of the study

There are several limitations of this study that need to be noticed. The goal of this study is to build a methodology for professionals. However, it is hard to conduct the experiment within a real company. Instead, graduate Master's students were chose for the experiment, because of the similarity between them and professionals. In addition, the experiment inside Twente University brings a close observation to subjects. Moreover, this study more focuses on the procedure of building a concept map for knowledge sharing. The tacit knowledge measurement issues have not been deeply studied because of the time and resource limitation.

## 6.2 Review of the research questions

As was mentioned in Section 1.2, the following questions need to be answered:

- What methodology can be used to implement the use of concept mapping in knowledge management at the individual level as well as in knowledge sharing in groups?

In section 3.4, a stepwise methodology is presented, which proposed individual and group stages for knowledge sharing activities. Each of them contains detailed activities, the sequence for the activities was defined as well. In addition, a checklist for completing a concept map was developed. This methodology was tested by two experiments with Master students, who had to apply this methodology to share knowledge about a master project. The evaluation data analysis

was based on the concept maps, questionnaires and observation notes. The evaluation results from sections 4.2 and 5.2 show a positive effect of this methodology.

- How can tacit knowledge be captured and made explicit when for knowledge sharing purposes?

In the section literature study part (Chapter 2), two types of knowledge, tacit and explicit knowledge was introduced. A comparison was made. Further, it identified the difficulty to capture tacit knowledge. The SECI modes could be used to promote knowledge transfer. In addition, from literature study, it is recommended that the tacit knowledge can be transferred by:

- acquiring and sharing someone else's knowledge through observation, imitation and practice,
- conversion of acquired tacit knowledge into specifications.

- How can the capturing process of tacit knowledge be instrumentalized by means of tools based on concept mapping principles? What are the necessary activities and fasciations from tools?

The literature study about the concept mapping principle was given in section 2.3. The possibility of using concept mapping to share knowledge was identified. Special interests were paid to using concept mapping to promote tacit knowledge capture and transfer. Further, in chapter 3, the methodology of using concept mapping was defined, which contains a set of group activities. These group activities promote communication and collaboration between group members, which involves a lot of practice and conversation while constructing a group concept map. The evaluation results from the questionnaire and concept map show a positive effect of using the proposed methodology to capture tacit knowledge.

## 6.3 Consequence for Myself

This study was carried out in a university setting. The graduate Master's student applied proposed methodology to share knowledge for Master's project. This methodology was tested and refined during this study. The experience can be used for the Myself project. Most of the small and medium enterprises (SMEs) are isolated from strong research support, the external knowledge source are relatively low. The results from this study provide an general methodology of using

concept mapping for knowledge sharing with professionals among SMEs. It would be also good if the method can be evaluated in a pilot within the MySelf project, preferably within SME's participating in the project.

## 6.4 Recommendation and future work

The designed methodology and checklist can be used as the general stepwise method for knowledge sharing among professions. However, time allocated for each activity may need to be adjusted according to different situations. For instance, the face-to-face sessions should be planned more flexibly.

During this study, it is hard to precisely measure how tacit knowledge is transferred into explicit knowledge. It is interesting to know more about it in the future. Questions like what standards and metrics can be used for measurement need to be answered. Some bugs have been found in the Cmap tool. Although the development of this tool is out of the scope of this study, it is still interesting to see more powerful and useful technology connecting the concept mapping principle and knowledge sharing together.

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# Appendix 1: Questionnaire version 1

Dear Sir/Madam,

In order to refine our methodology of using Concept mapping principle to share knowledge among high educated people, we need your help to complete the following questionnaire. Your experience and remarks is valuable for our research.
Please use the word processor to tick the most appropriate box(es) with an **X** or delete the options that are not applicable to your situation and fill in your opinion in the blank spaces provided.

Thank you in advance!

Do you agree that building your own concept map is useful step for preparing a group map?

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Do you agree that a face-to-face discussion session is important for building a group map later?

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

If yes, which issues do you consider to be the most important ones? (multiple answers)

- Decide the main focus
- Decide the top concepts and their relationships
- Decide the second level concepts and their relationships
- Decide the third level concepts and relationships
- Other (Please specify):……..

If no, what are the problems?

……..……
……..……..……
……

Do you agree that a threaded discussion is useful for building a group map later?

- Strongly agree

Agree
Neutral
Disagree
Strongly disagree

If no, what are the problems?

……..……
……

Do you agree that the chatting function is useful for building a group map later?

Strongly agree
Agree
Neutral
Disagree
Strongly disagree

If no, what are the problems?

……..……
……

Do you agree that the collaboration function is useful to build a group map later?

Strongly agree
Agree
Neutral
Disagree
Strongly disagree

If no, what are the problems?

……..……
……

Please make a rank for the most effective and efficiency communication ways for using concept mapping for knowledge sharing (from 1 to 4 or more)

| | |
|---|---|
| Face to face | |
| Threaded discussion | |
| Chatting | |
| Real-time collaboration | |
| Other (Please specify) | |
| Other (Please specify) | |
| … | |
| … | |

Do you think building a group concept map is useful for knowledge sharing?

Yes, very useful
Useful

Neutral
Not really
Not useful at all

If yes, in which ways? (multiple choice)

Exchanging recourses (by adding resources to each particular concept)
Capturing new knowledge (by learning new concepts from group members)
Foster creativity thinking (new ideas are generated during group session)
Pinning down the tacit knowledge (discussions, ideas, experience are captured and formatted by a concept map)
Other (Please specify)……

Do you think more face-to-face sessions are needed and when? (multiple choice)

During remote session
During finalizing session
Not necessary

Is Cmap tool easy to use?

Yes, very easy
Easy
Not easy
Very hard

Which functions are difficult for you? (multiple choice)

Adding concepts
Adding links between concepts
Add recourses
Add Url Links
Thread discussion
Chatting
Collaboration
Other (Please specify)

**Final remarks**

Please give some suggestions or remarks for using concept mapping for knowledge sharing purposes:

About building a group map:

……
…
……
…

……
…
About the tool:
……
…
……
…
……
…

**Thank you for completing the questionnaire!**

# Appendix 2: Questionnaire version 2

Dear Sir/Madam,

In order to refine our methodology of using Concept mapping principle to share knowledge among high educated people, we need your help to complete the following questionnaire. Your experience and remarks is valuable for our research.
Please use the word processor to tick the most appropriate box(es) with an **X** or delete the options that are not applicable to your situation and fill in your opinion in the blank spaces provided.

Thank you in advance!

Do you agree that building your own concept map is a useful step of preparing a group map for knowledge sharing purpose?

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Do you agree that the face-to-face discussion before constructing a group is important?

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Do you agree that the face-to-face discussion during construction group map is important?

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Do you agree that the face-to-face meeting is important for finalizing a group map?

- Agree
- Neutral
- Disagree

Strongly disagree

Do you agree that chatting is useful for knowledge sharing during construction group map?

Strongly agree
Agree
Neutral
Disagree
Strongly disagree

If no, what are the problems?

……..……
……

Do you agree that real –time collaboration is useful for knowledge sharing during construction group map?

Strongly agree
Agree
Neutral
Disagree
Strongly disagree

If no, what are the problems?

……..……
……

Do you agree that threaded discussion is important for knowledge sharing during construction group map?

Strongly agree
Agree
Neutral
Disagree
Strongly disagree

If no, what are the problems?

……..……
……

Please make a rank for the most effective and efficiency facilitation of using concept mapping for knowledge sharing (1 is the highest scare, 2 is the second, etc)

| | |
|---|---|
| Face to face | |
| Chatting | |
| Real-time collaboration | |

| | |
|---|---|
| Threaded discussion | |
| Other (Please specify) | |
| Other (Please specify) | |
| … | |
| … | |

Do you think building a group concept map is useful for knowledge sharing?

Yes, very useful
Useful
Neutral
Not really
Not useful at all

If yes, in which ways? (Multiple choices)

Exchanging recourses
Capturing new knowledge (by obtaining new concepts from group members)
Foster creativity thinking (by generating new ideas during constructing a group map)
Pinning down the tacit knowledge ( ideas, experience are captured and formatted by a concept map)
Other (Please specify)……

Do you agree that personal experience can be captured and shared by constructing a group map with others?

Strongly agree
Agree
Neutral
Disagree
Strongly disagree

If no, what are the problems?

……..……
……

Do you agree that useful information can be captured and organized during discussion of constructing a group map?

Strongly agree
Agree
Neutral
Disagree
Strongly disagree

If no, what are the problems?

……..……
……

Do you agree that constructing a group map helps transfer individual experience and ideas to other group members?

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

If no, what are the problems?

……..……
……

Do you think the designed steps to construct concept maps are suitable for knowledge sharing?

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

If no, what are the problems?

……..……
……

Is Cmap tool easy to use?

- Yes, very easy
- Easy
- Not easy
- Very hard

Which functions are difficult for you? (multiple choice)

- No
- Adding concepts
- Adding links (relationships) between concepts
- Add recourses
- Add Url Links
- Chatting
- Collaboration
- Other (Please specify)

**Final remarks**

Please give some suggestions or remarks of using concept mapping for knowledge sharing purposes:

About the steps you followed during the experiment

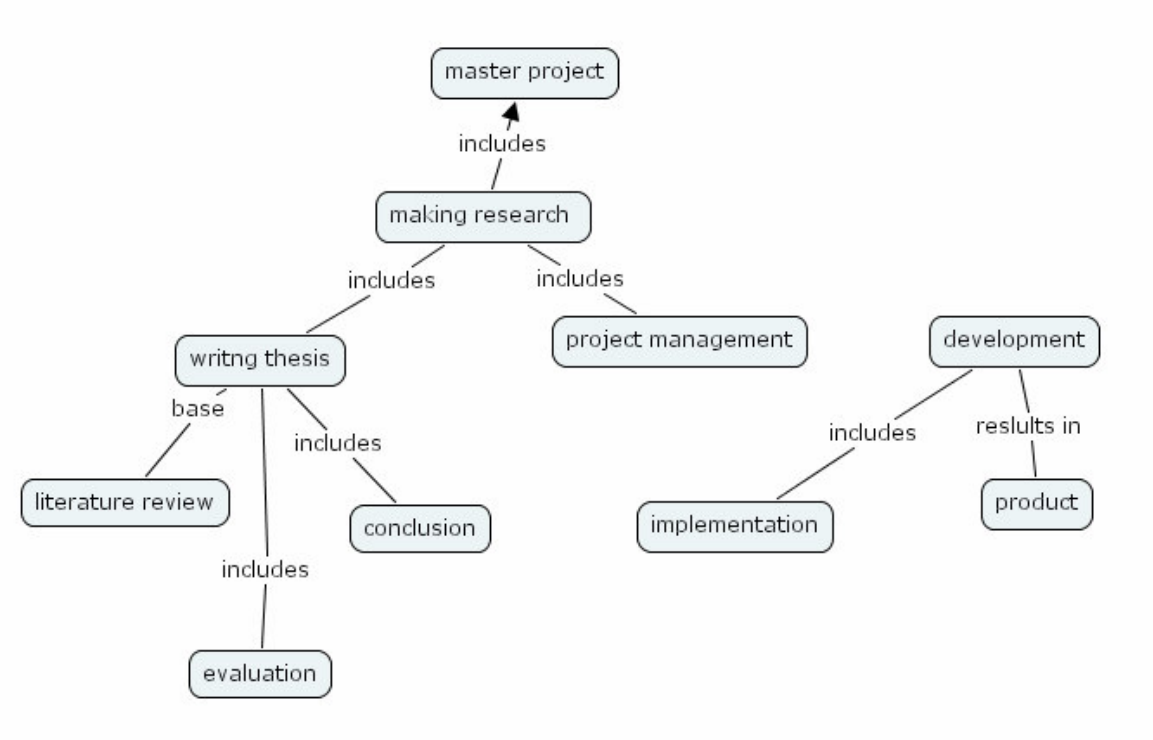
……
…
……
…
……
…

About the tool:

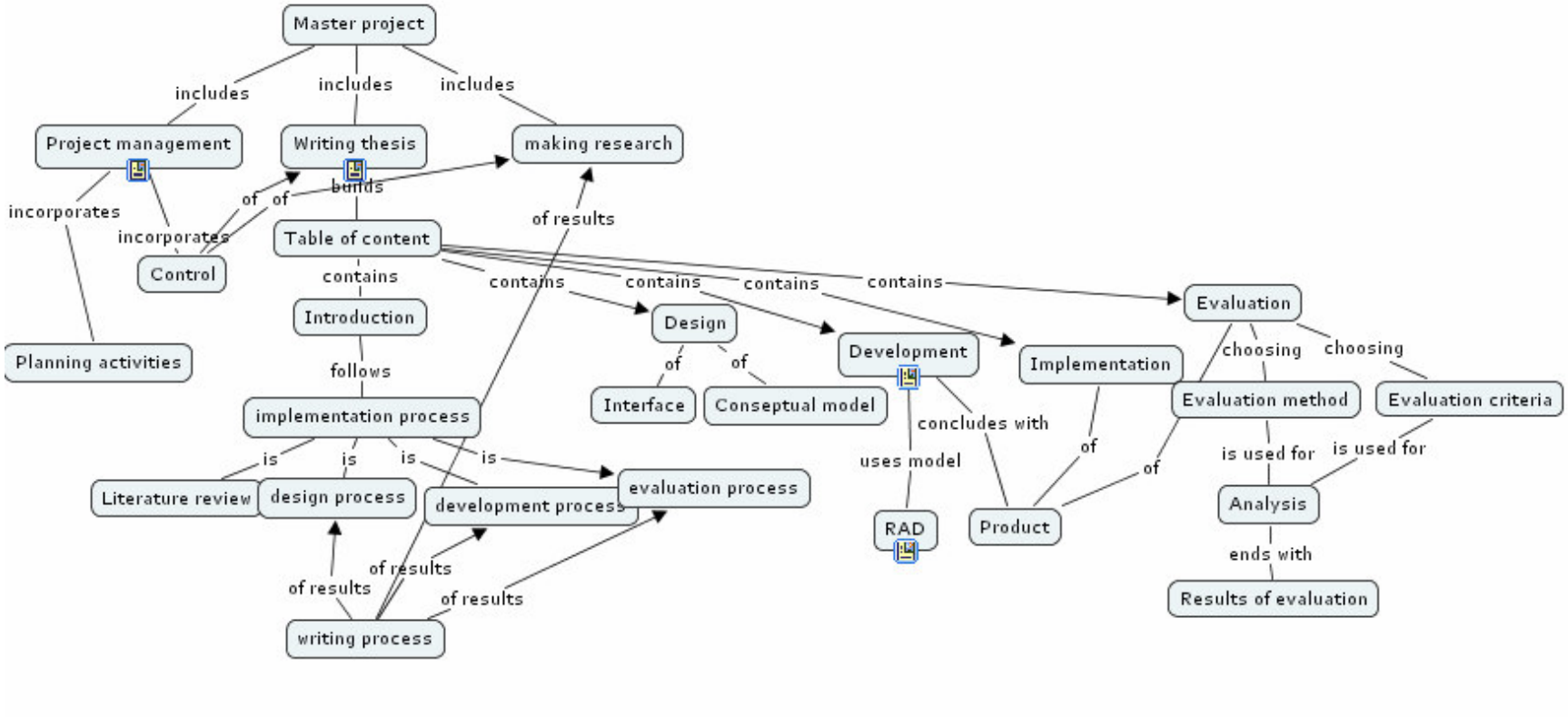
……
…
……
…
……
…

**Thank you for completing the questionnaire!**

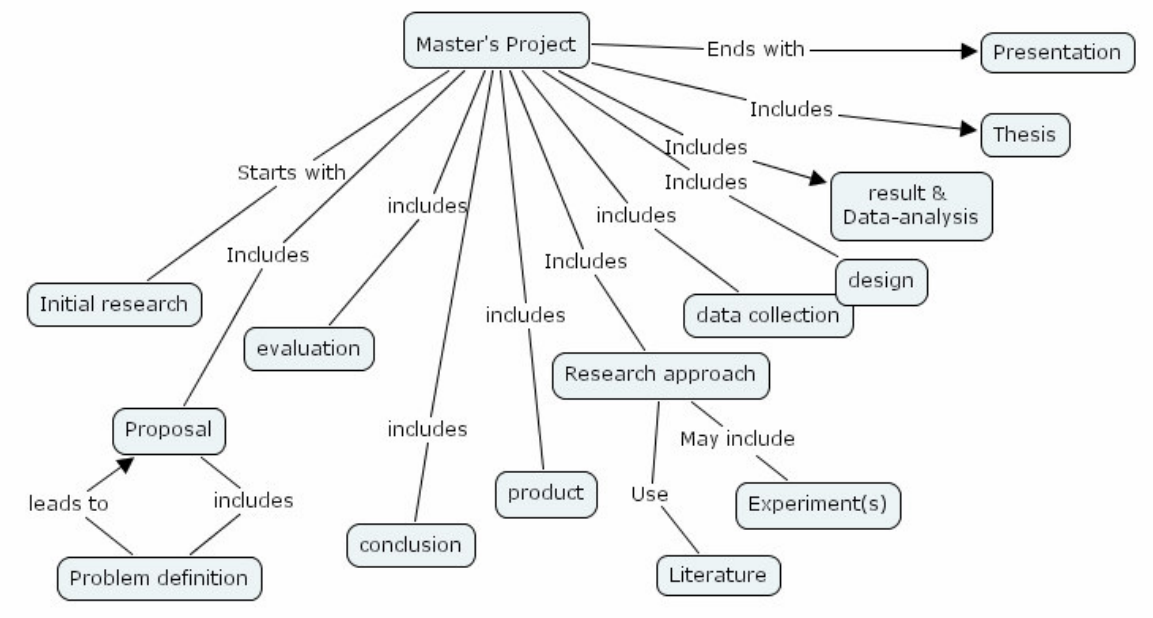
# Appendix 3: Individual map 1 (pilot experiment)



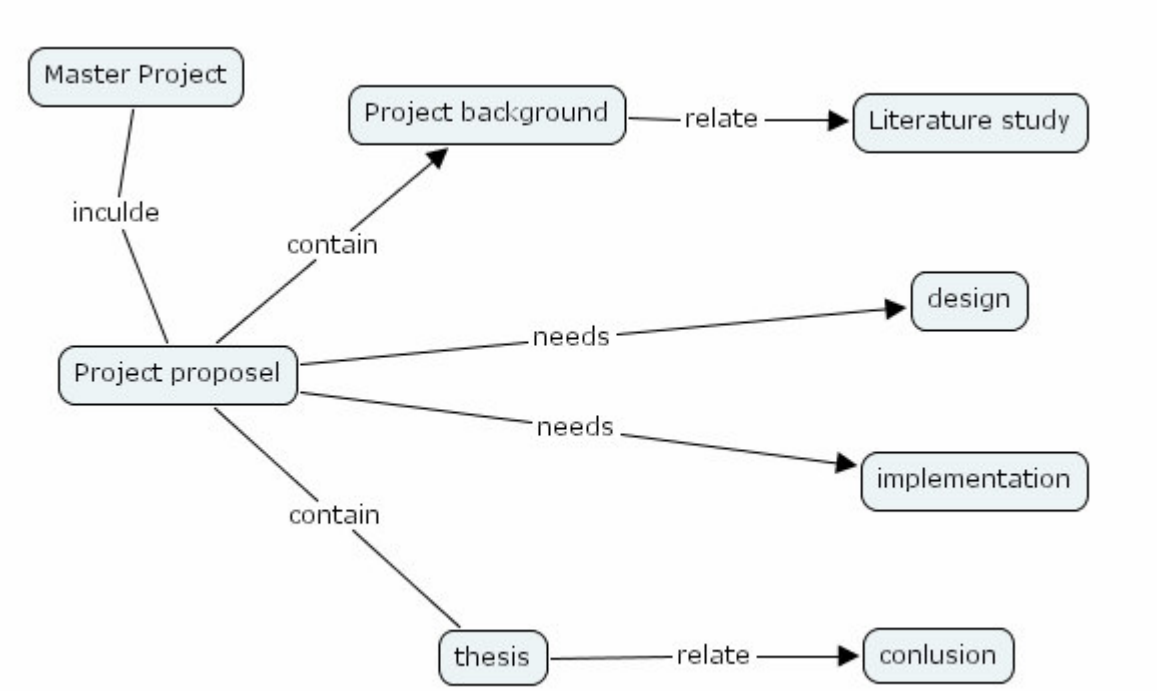
# Appendix 4: Individual map 2 (pilot experiment)



# Appendix 4: Individual map 1 (second experiment)



## Appendix 5: Individual map 2 (second experiment)



# Appendix 6: Individual map 3 (second experiment)