Concept Mapping: Connecting Educators
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LEARNING, PEDAGOGICAL THINKING AND COLLABORATIVE KNOWLEDGE BUILDING BY CMAPTOOLS

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Abstract. We are reporting research on collaborative knowledge building compared to individual conceptual change during a professional study unit in Laurea University of Applied Sciences. As educational research that is a design experiment, a multi-case, multi-method study. We used both individual and collaborative concept mapping in the same design experiment. The theme of the design experiment was 'Coping at Home'. In the competence based curriculum it was a research project as a learning environment. The core concept of the research project and study unit Physiotherapy of the elderly was 'successful ageing'. The subjects were Bachelor of Health Care students in Laurea University of Applied Sciences in Finland. We monitored both individual and collaborative learning and knowledge building related to this concept. The focus of the study was professional and generic competence, especially the reflective competence of physiotherapy students. Students' conceptions developed greatly. Collaborative knowledge building was meaningful for the individual conceptual change. There were seen both cognitive and socio-cultural perspectives. The discussion during the concept mapping process was like a shared thinking process. Students continued each others talking and thinking very fluently like they had had "common brains". It took lot of conversations and many speech acts before the common understanding was created. After collaborative interactions, multidisciplinary concrete links were made between all concepts almost in all individual concept maps and interconnectedness of concepts in different subject areas was understood. Concepts in these individual concept maps were also more at the same time more theoretical and practical than in previous concept maps of these subjects. Also the wider context of the concepts was recognized in many individual concept maps. Students' conceptual frameworks developed from novice level to more advanced expert level. According to students the research project as a learning environment was interesting and useful. They attained new knowledge, skills and attitude and new perspective to their professional knowledge.

1 Introduction

The purpose of the study is to monitor and promote quality of learning and development of the professional and generic competences of physiotherapy students. The generic competence focused in this study is reflective metacognitive competence which means students ability to evaluate their own learning and competence, to identify development challenges and problems, to develop her/his competence independently and with others, to share what she/he has learnt and to assume a role in a group/team and acquire and analyze information systematically. The learning environment - the research project - is based on real needs of elderly people (over 75 years) who still live at home and wish to stay home. The physiotherapy students are going to design programs for an interactive TV – Caring TV-project in aim to support the functional ability, activity, social and mental welfare of the elderly and also to give possibilities to the elderly to discuss with other elderly people in similar positions with the help of different counseling, teaching and instruction methods. The aim of the project is to support successful ageing and sustainable welfare. The needs and expectations of the elderly exist in four themes: welfare, safety, functional activity and possibility to take part in activities. Students try to find out these themes in their professional basis and to plan evidence based interactions as programs of that interactive television. To plan the programs they need to understand and learn more about the main concept of project: successful ageing. The teaching and learning method is Learning by Developing (LbD), which is a concept developed in Laurea University of Applied Sciences, Finland (Raij 2007). In this study learning is understood as a meaningful conceptual change. Physiotherapy students' learning is monitored and evaluated by the quality tools of high quality learning: improved concept maps (1) as an individual conceptual change and (2) as collaborative and social learning and knowledge building of two student groups.

2 Backgroud

Sinatra & Pintrich (2003, 6) characterize intentional conceptual learning with few dimensions: intentional conceptual learning is goal-directed, the goal is to change conceptual understanding; intentional conceptual change is characterized by conscious initiation and regulation of cognitive, metacognitive and motivational processes to bring about a change in knowledge. According to Vosniadou & Kollias (2003, 2) the conceptual change is the outcome of a complex cognitive as well social process. An initial naïve theory is restructured in order to agree with currently accepted scientific and expert views. Studies of conceptual change have shown that this is a slow and gradual process. Dillon (1993, 229) describes the relationship between conceptual development, context and characteristic models of learning for a given issue. He creates a theoretical model for how people develop an understanding of environmental issues. The first exploratory, stage is characterized by developing an awareness of key concepts in a limited contextual framework. In the second stage, often

involving some rudimentary work across disciplines, tentative links are made between concepts. In the third stage, usually characterized by extensive subject- based study, concrete links between related subjects are made, the contextual framework is broadened and there is some recognition of the interconnectedness of concepts in different subject areas. In the final, multidisciplinary, stage, concrete links are made between all concepts, interconnectedness is understood and the wider context dependency of the concepts is recognized.

Concept mapping is a way to describe and visualize the conceptual understanding and its change. According to Novak and Cañas (2008) concept maps are graphical tools for organizing and representing knowledge. Åhlberg (2004) discusses varieties of concept mapping. In this paper his improved concept mapping is applied. Concept mapping is one of the quality tools to monitor and promote high quality learning. According to Åhlberg (2005) high quality learning is divided into individual and social learning, learning from personal level to organizational and the humankind levels. Concept mapping enhances integration of learning and thinking.

In the late 1990s, Laurea University of Applied Sciences chose as its strategic approach the integration of education, research and development, and regional development. While implementing the pedagogical strategy, Laurea's practical developers refined this principle into the Learning by Developing (LbD) model. Competence development in the LbD- model and its values like authenticity, partnership and creativity etc. are described in figure 1. Learning by Developing combines two of the major orientations of polytechnic universities: professional education (learning) and research-oriented higher education (developing). (Rauhala 2007)

An initiative is now under way to develop methods to aid the user during concept map construction. These aids are designed in response to observations of snags which may arise during concept mapping. During concept mapping, users often stop and wonder what other concepts they should add to the concept map they are working on, frequently spending time looking for the right word to use in a concept or linking phrase; they search for other concept maps that may be relevant to the one they are constructing, and they search through the Web looking for additional material that could help them enhance their maps. The following sections describe three methods developed to address these issues.

3 Methods

The purpose of the study is to monitor and promote quality of learning and the growth of the professional and generic competence of the physiotherapy students (Laurea 2006). The teaching and learning method was learning by developing. In this study learning is understood as a meaningful conceptual change. Physiotherapy students' learning is monitored and evaluated by the quality tools of high quality learning: improved concept maps: (1) as an individual conceptual change and (2) as collaborative and social learning and knowledge building of two student groups. The core concept of the course and developmental project is 'successful ageing'. The research questions are:

1. What kind of individual conceptions do the students build on the concept of successful ageing? What kind of concepts and propositions they have a) before the project, b) after the project and c) after they have built together a summarising concept map?
2. What happens in collaborative learning as social knowledge building? a) What happens when a concept map of the same theme is built by group of students? What kinds of differences (if any) are in collaborative learning processes and products when the two groups are compared? c) What kind of socially built conceptions (concepts and propositions) do the students have after the project?
3. What kind of individual conceptions do the students build on the concept of successful ageing after they have built together a summarising concept map?

As educational research this is a design experiment, a multi-case, multi-method study. The subjects are Bachelor of Health Care students in Laurea University of Applied Sciences in Finland. They are third year Physiotherapy students and they all are female. They are studying their professional study unit **Physiotherapy of the elderly** in the Coping at Home research project and in its Caring TV- project. In the two study groups there are 22 students. The individual chance of conceptual change is evaluated by 9 research persons who have a different knowledge level in baccalaureate qualification, in the matriculation examination of Finnish language test. Three research persons are chosen by random choice in each group: high achieving, average achieving and low achieving group.

In September 2006, before the study unit of Physiotherapy of elderly starts, the students built their **first individual** concept maps of the concept of successful ageing based on their own common sense knowledge and

after study unit their **second** concept maps. Because of practical scheduling reasons the students were divided into two groups: group A had 15 members and group B had 7 members. In January both group A and B created collaboratively a **group level concept map** of the theme' successful ageing' These face- to – face interaction sessions were both videotaped and recorded by Cmap Recorder. In February 2007 the students built **third** individual concept maps, individual professional concept map based on shared knowledge creation.

Both individually and socially built concept maps were evaluated and analysed by content analysis; content maps also by simply statistical analysis. Collaborative group level concept mapping processes, videotaped sessions, were analyzed by dialogue analysis. Before dialogue process analysis, the dialogue was divided into dialogue turns. A turn is an interval of expression by a single participant. The units were either turns or parts of turns, such as sentences or single words. The categories in analysis were developed applying Aarnio & Enqvist (2001).

4 Results

Before the study unit, in first concept maps of a concept of "successful ageing" the research persons (N=9) created 48 concepts and 32 propositions. (Figure 1.)

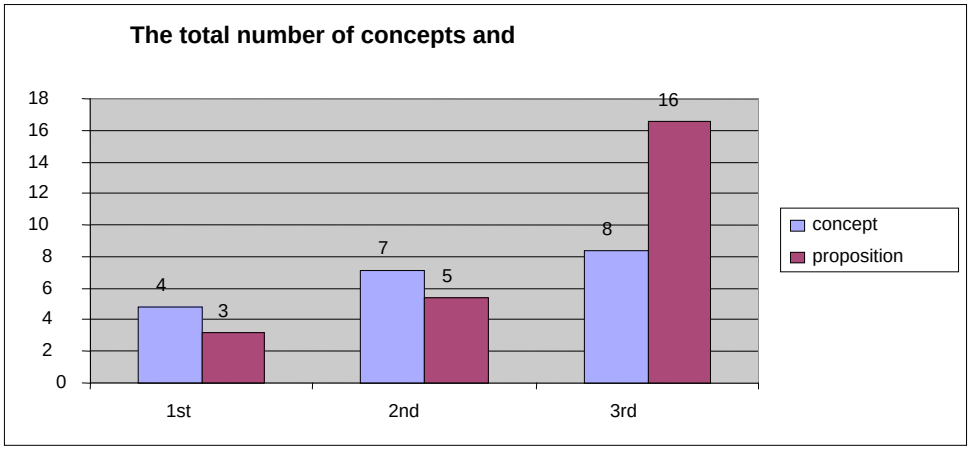

Figure 1. The total number of concepts and propositions in improved concept maps.

Immediately after the study unit, in the second individual concept maps the total number of concepts increased from 48 to 71 and the total number of propositions from 32 to 54. After the social concept mapping, in the third individual concept maps, the total number of concept increased from 71 to 84 and the total number of propositions increased from 54 to 166.

There were no qualitative differences between students who had different knowledge level in baccalaureate qualification, in the matriculation examination of Finnish language test. There were only few differences between numbers of concept but more differences in numbers of propositions in individually build concept maps. In first concept maps the following kinds of abstract concepts were used: 'life' (good life, quality of life, life satisfaction) 'health' (physical and mental health), 'welfare', 'functional ability', 'human relationships', 'economical situation', and concrete concepts like 'home' and 'environment'. In Figures 2, 3 and 4 is an example of conceptual change according high achieving student.

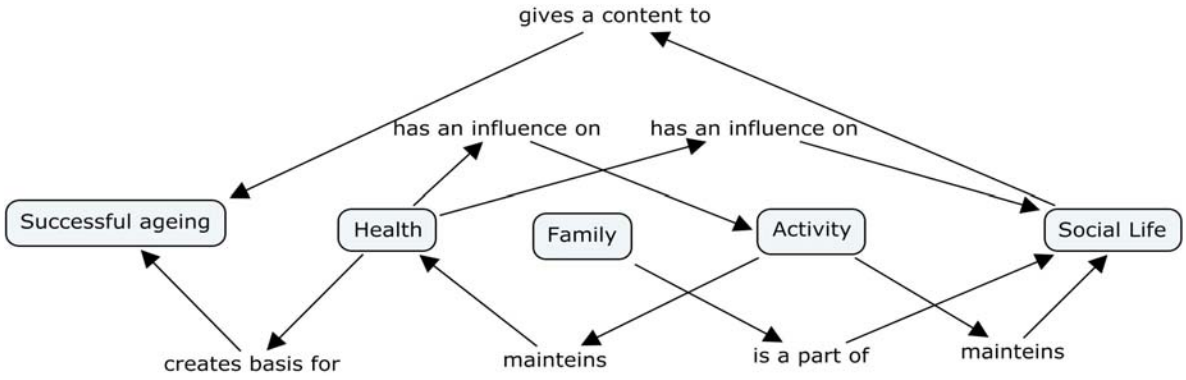

Figure 2. "Successful ageing" according a high achieving student before study unit.

In second concept maps the content categories remained similar as earlier. Professional, active functional aspect was very prominent and concepts of 'independency' and 'activity' were mentioned many times. In propositions there was found five themes: "supporting the health", "physical -", "social -", "environmental -" and "psychological existent".

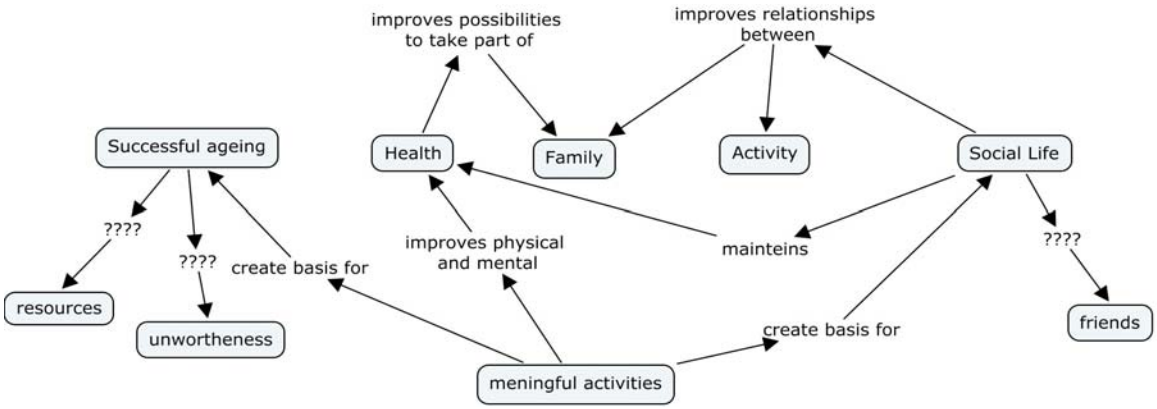

Figure 3. "Successful ageing" according a high achieving student immediately after study unit.

After the social concept mapping in third individual concept maps, there were lot of new propositions and concepts like "optimistic attitude", "sexuality", "good physical condition" "social support" and "pets" which did not exists in first or second individual concept maps. In propositions there were found very similar themes like before and a new theme "safety". Themes in third concept maps had changed to become more concrete compared with second maps like "environmental existent" which had changed to "stimulating environment". Even those students who didn't participate orally in social concept mapping used socially build concepts in their third concept maps.

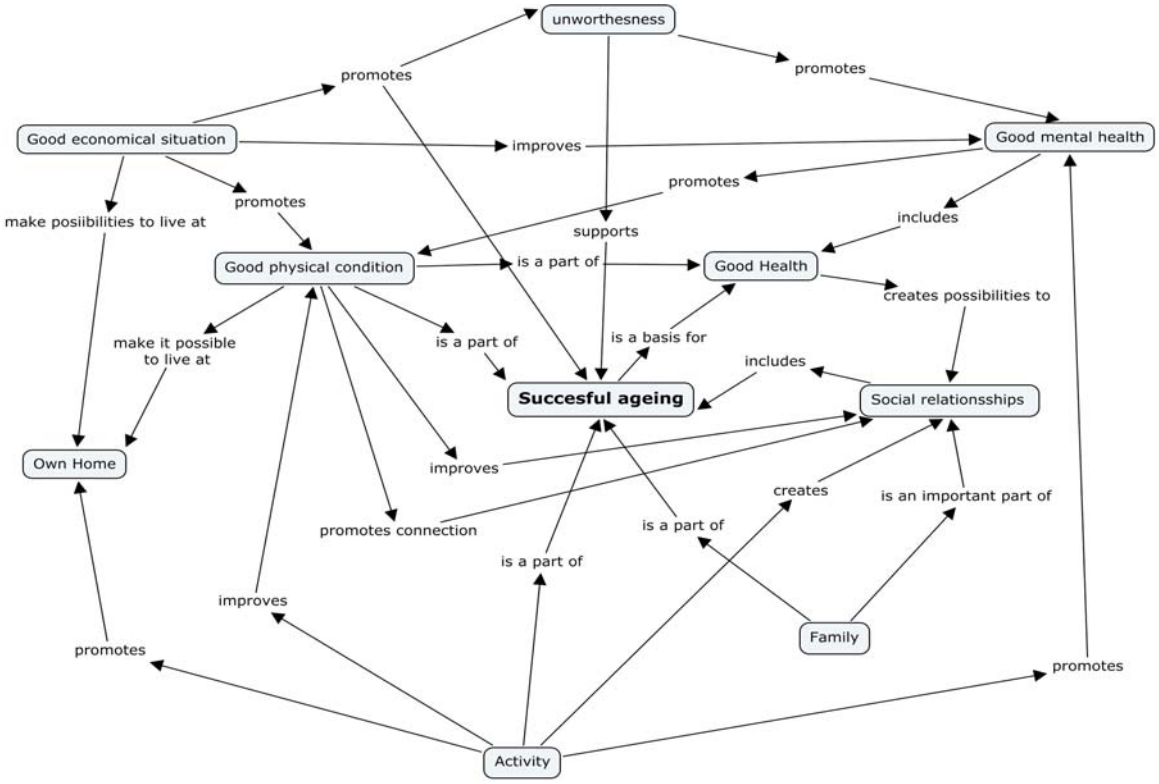

Figure 4. "Successful ageing" according a high achieving student after social concept mapping.

There were differences in processes of student groups. After the second concept mapping the number of concepts increased in the "high achieving" group from 18 to 26; in the "average achieving" group from 12 to 23 and in the "low achieving" group from 18 to 22. The number of propositions increased in the "high achieving" students from 12 to 28, in "average achieving" students from 12 to 22 and decreased in "low achieving" students from 8 to 4. The increase of relevant propositions indicates increase in meaningful learning.

After the social concept mapping, in the third individual concept maps the "high achieving" students increased their total number of propositions only from 28 to 49 and the "average achieving" students from 22 to 61. The "low achieving" students' group increased the number of propositions from 4 to 56. The number of relevant concepts increased only a little. (Figure 5. and 6.) The increase of relevant propositions indicates increase in meaningful learning. Like Dillon (1993) presents, in the final third individual concept maps, multidisciplinary, stage, concrete links are made between all concepts, interconnectedness is understood and the wider context dependency of the concepts is recognized.

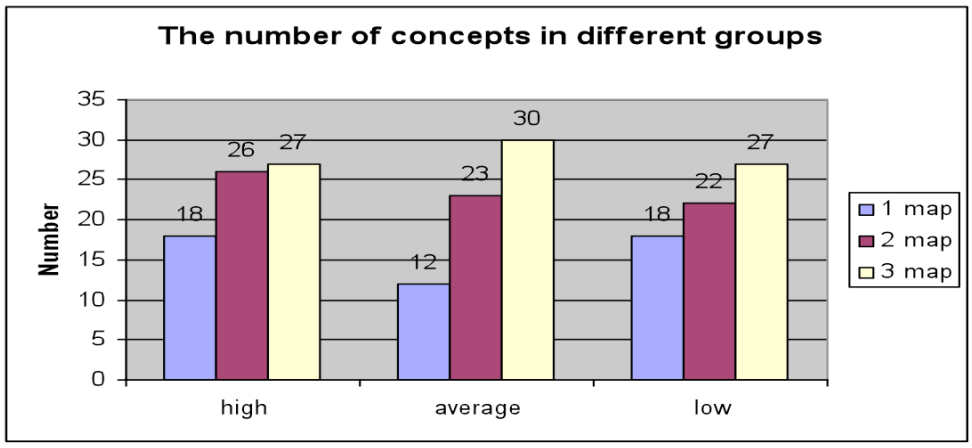

Figure 5. The number of concepts in different groups.

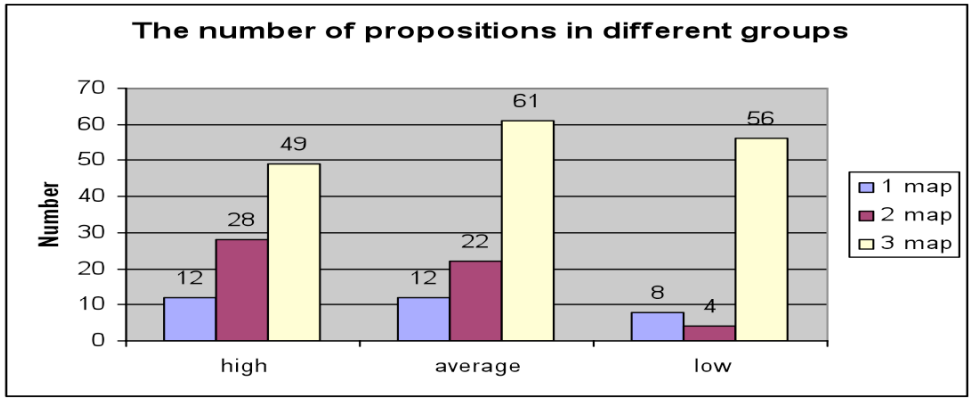

Figure 6. The number of propositions in different groups.

Between the second and third individual concept maps a group level collaborative concept map was created in both groups; 22 students in two groups. The first group (15 members) created its collaborative concept map in January 2007. The whole process took one 45 minutes session. Students of this group created 262 speech acts. The variance of speech act was from 0 to 82. In that bigger group five of the 15 students did not say anything during the process. The most active speaker was the student, who acted as a secretary in social concept mapping. The second group (7 members) created its collaborative concept map also in January 2007. The whole process was over in one 45 minutes session. Students of that smaller group created 384 speech acts and the variance was from 17 to 101, so in that group all seven students participated also orally. The most active student was, like in first group, the secretary of that social concept mapping. The discussion during the concept mapping process was like a shared thinking process. Students continued each others talking and thinking very fluently like they had had "common brains".

The videotaped conversations speech acts were divided into dialogue turns as a part of building group level concept maps. These dialogue turns were **classified by the category system (socio-cultural aspect) developed by applying Aarnio & Enqvist** (2001). In both groups the category used mostly was to support others opinion to connect or to agree. Almost a half of all dialogical turns were classified in that category. There were only a few unnecessary opinions. In the group #1 it took 379 and in the group #2 totally 464 dialogical turns before the synthesis of concepts or propositions had determined.

The dialogue turns were also classified by cognitive point of view. There were found peer-teaching, peer-counselling, evaluating, arguing as a pedagogical thinking and knowledge creating. There were 32 % pedagogical activities and 68 % knowledge creating activities in these knowledge building interventions.

In the collaborative improved concept mapping of the second group, they produced 11 concept synthesis and 22 proposition synthesis. So it means lot of discussion and conversation before the synthesis had existed. (Figure 7.)

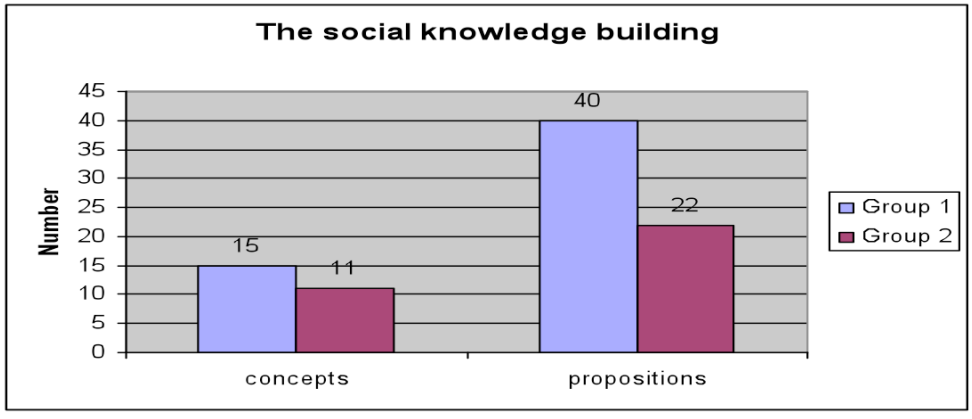

Figure 7. The number of concepts and propositions in socially built concept maps.

In the socially built concept map, there were few concepts, which did not exist in first or second individually built concept maps, like “supporting network”, “accepting the death”, “free environment” and few concepts, which was so meaningful, that students had them in their third individual concept maps created after social concept mapping, like “safety”, “social network” and “good economical resources”. The safety – theme was also mentioned in many propositions.

The process and content of collaborative concept mapping of two groups was quite similar according to data from Cmap recorder. Both groups started by the concept of “successful ageing” and continued by themes like health (good health, comprehensive health), home (home of own), independency (to make own decisions), environment, services (good services) and social network (supportive social network). In the first group the important concepts were connected to mental, social and environmental area like “accepting to become old and to die” or “good economical situation”. There were no mentions of specific physical aspect (Table 2.) In the second group the free living environment was important, but there were no mentions of specific physical or mental aspects. (Table 3)

Successful ageing	INNER RESOURCES			ENVIRONMENTAL RESOURCES
Common level	Physical aspect	Mental aspect	Social aspect	
Good health	**0**	**Good mental health**	**Social network**	**Active environment**
Independency		**To accept becoming old**	**Good economical balance**	**Own environment**
Activity of own		**To accept dying**		**Home of own**
Functional ability		**Safety**		**Good services**

Table 2. **Concepts (N= 15)** in the collaborative concept mapping of the first group.

Successful ageing	INNER RESOURCES			ENVIRONMENTAL RESOURCES
Common level	Physical aspect	Mental aspect	Social aspect	
Comprehensive health	**0**	**0**	**Supportive social network**	**Living environment**
Possibility to make own decisions			**Family,**	**Free environment**
Active life style			**Society**	**Home**
				Services

Table 3. **Concepts (N=11)** in the collaborative concept mapping of the second group.

5 Conclusion

The focus of the study was professional and generic competence, especially the reflective competence of physiotherapy students. Students’ conceptions developed greatly althought the change between first and second individual concept map was small. Collaborative knowledge building was meaningful for the individual conceptual change. Even those students who didn’t participate orally in social concept mapping used socially build concepts in their third concept maps. Difference between high, average and low achieving students in group level had almost disappeared.

The social concept mapping process was very similar in both two groups. There were seen both cognitive and socio-cultural perspectives. Student asked and answered on each others questions, they explained meanings of concepts, they supported each others opinions and created the social conception of the concept "successful ageing" together. There were found peer-teaching, peer-counselling, evaluating, arguing as a pedagogical thinking and knowledge creating. The discussion during the concept mapping process was like a shared thinking process. Students continued each others talking and thinking very fluently like they had had "common brains". It took lot of conversations and many speech acts before the common understanding had existed. After collaborative interactions, multidisciplinary concrete links were made between all concepts almost in all individual concept maps and interconnectedness of concepts in different subject areas was understood. Concepts in these individual concept maps were also more at the same time more theoretical and practical than in previous concept maps of these subjects. Also the wider context of the concepts was recognized in many individual concept maps. Students' conceptual frameworks developed from novice level to more advanced expert level. According to students the research project as a learning environment was interesting and useful. They attained new knowledge, skills and attitude and new perspective to their professional knowledge.

The social atmosphere was excellent in both groups and there were plenty of informal qualitative positive evidence for collaborative learning and thinking. The concept mapping centred teaching, studying and learning process was a success in these university level groups. Students discussed much more than in traditional teacher centred teaching of the earlier years. The Cmap Recorder data gave a lot of new information of the process. For scientific purposes it is important to replicate these kinds of design experiments. For us this was an optimal way to monitor and promote quality of learning in this kind of course.

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