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CHAPTER 4

Concept maps and integration of clinical and basic sciences: an approach to teacher learning

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Submitted
Abstract

Context  The explication of relations between clinical and basic sciences can help vertical integration in medical curricula. Concept mapping can be a useful technique for this explication, in particular when clinical and basic science teachers work in cooperation and instructions make them focus on integration. So far, cognitive views have dominated concept mapping research and have unveiled differences between expertise levels. Little is known about the learning process regarding the articulation of integration.

Objectives  In this study we examined which factors affect the learning process of groups of clinicians and basic scientists on different expertise levels who learn to articulate the integration of clinical and basic sciences in concept maps.

Methods  After a pilot for fine-tuning group size and instructions, seven groups of expert clinicians and basic scientists and seven groups of residents with a similar disciplinary composition constructed concept maps about a clinical problem that fit their specializations. Draft and final concepts maps were compared on elaborateness and articulated integration. Participants completed a questionnaire on motivation and their evaluation of the instructions. Cooperation in the groups was investigated qualitatively.

Results  Residents outshone experts as regards learning to articulate integration, but experts were more motivated and positive about the concept mapping procedure and instructions. The groups differed as to communication: residents interacted from the start (asking each other for clarification), whereas overall experts only started interaction when they had to make joint decisions.

Conclusions  Our results suggest that articulation of integration can be learned, but this learning is not related to participants’ motivation or their views on the instructions. Decision making and interaction, however, do relate to the articulation of integration. Expertise level turned out to be decisive not only for the level of articulation of integration, but also for the extent of learning and the cooperation pattern. Teacher learning programs in which co-construction tasks are used could further improve vertical integration.
4.1 Introduction

In publications on clinical reasoning, the roles of three kinds of knowledge have been delineated: experiential, clinical, and basic science knowledge (Charlin, Boshuizen, Custers, & Feltovich, 2007; Eva, 2005). An experienced clinician uses these three kinds in an integrated way, and it depends on the complexity of the patient case which kind of knowledge is crucial for the analysis. Familiar patient cases tap into clinicians’ experiential knowledge, whereas if clinicians are puzzled by patient cases, they revert to basic science knowledge (Charlin et al., 2007; Van de Wiel et al., 2000). Basic science knowledge helps to comprehend clinical signs and symptoms, but tends to remain tacit when experienced clinicians analyse patient cases that to them are not complicated (Boshuizen & Schmidt, 1992; Van de Wiel et al., 2000). Evidently, basic science knowledge is used unconsciously for the analysis of routine patient cases.

Medical curricula are intended to help students to relate clinical and basic science knowledge, and by curriculum innovations teachers try to improve this so-called vertical integration (Dahle et al., 2002; Wilkerson et al., 2009). Localizing underlying basic science mechanisms allows teacher and students to focus on relevant relations with clinical phenomena (Kinchin et al., 2008). Vertical integration requires the articulation of basic science mechanisms and their relations with clinical concepts, because educational programs rely on knowledge that can be made explicit and discussed in the classroom (Eraut, 2000). Teachers’ tacit knowledge is of little help to develop an instructive curriculum (Eraut, 2000; Kinchin et al., 2008). However, medical teachers, often experts in their domains, are not automatically able to articulate the basic science mechanisms that underlie clinical phenomena, due to the tacit nature of this knowledge (Boshuizen & Schmidt, 1992; Van de Wiel et al., 2000). It seems therefore worthwhile to support them in this task (Kinchin et al., 2008) and to investigate how they can learn to make their integrated clinical and basic science knowledge explicit.

Concept mapping is a technique by which to explicate and share knowledge (Novak, 2002, 2003). The resulting concept maps contain networks of hierarchically ordered concepts. They are recommended as a means to elicit expert knowledge (Hoffman & Lintern, 2006) and thus might help medical teachers to articulate relations between clinical and basic science knowledge (Daley & Torre, 2010; Kinchin et al., 2008). This makes the maps a promising instrument for the development of medical curricula (Weiss & Levison, 2000).
4.1.1 Teachers’ learning to articulate integration

Integration of clinical and basic sciences is not receiving much attention in faculty development programmes in the medical domain (Martimianakis, Hodges, & Wasylenki, 2009). In prevalent views on learning (Darling-Hammond & Bransford, 2005) three different focuses are distinguished in teacher learning (cf (Cochran-Smith & Lytle, 1999)): a cognitive view, emphasizing teachers’ knowledge as a source for improving teaching practice; a constructive view, stressing teachers’ learning process as an active interpretation process of new information based on teachers’ own knowledge and experiences; and a third view emphasizing the cooperative aspects of teacher learning, that is, teachers learning with and from other teachers. When it comes to teachers’ learning to explicate the integration of clinical and basic sciences by means of concept maps, these three views pertain to different aspects.

The cognitive view addresses the concept maps themselves, which reflect the teachers’ knowledge and knowledge organization. The maps reflect the integration of clinical and basic science concepts that teachers are able to explicate, and hence designate the integration they are likely to apply in their teaching practice. Here, the instructions guiding the teachers in constructing the concept map should be taken into account, because they influence what teachers articulate in the concept map (H. J. Schmidt, 2006). In previous studies we have taken this cognitive perspective by examining the articulation of clinical and basic sciences in concept maps (see Chapter 2 and Chapter 3).

From a constructivist point of view, it is not the concept maps, but the process of concept mapping that is vital (Novak, 2002). Examining this process helps us to understand how medical teachers apply the concept mapping instructions and how they learn to articulate the integration of clinical and basic sciences. Comparing draft and final versions of concept maps can shed light on the process of learning (Novak, 2002; Rendas et al., 2006; Torre, Durning, & Daley, 2013) and thus also on the learning process to articulate clinical and basic sciences.

The third view on teacher learning also focuses on the process of learning, but highlights the importance of cooperation. Although some studies recommend involving more than one constructor in the construction of concept maps for educational purposes, in none of these studies are concept maps constructed jointly (Cutrer et al., 2011; Edmondson, 1995; Rendas et al., 2006; Weiss & Levison, 2000). For the development of integrated curricula, communication between clinicians and basic scientists is deemed decisive (Harden, 2000). Thus, cooperative learning, with its strong emphasis on communication, could be helpful for the articulation of integration. Due to the information gaps in mixed groups (Slavin, 1996), establishing the relations between clinical and basic sciences is expected to be easier than when
teachers construct the maps individually. Research on the cooperation between teachers and their communication can illuminate how teachers learn (Weinberger & Fischer, 2006), and so could contribute to our understanding of how medical teachers learn to explicate the integration of clinical and basic sciences in concept maps.

4.1.2 Influence of context on teacher learning

Concept mapping with the aim to visualize integration of clinical and basic sciences is still in its infancy. Although the technique is recommended especially for this purpose (Daley & Torre, 2010; Edmondson, 1995; Kinchin et al., 2008), there are not so many examples of concept maps that show the relations between clinical and basic sciences. Evidently, the general instructions for concept mapping as proposed by Novak (Novak, 2002) do not automatically lead to concept maps that visualize vertical integration. Therefore, specific concept mapping instructions that help medical teachers to articulate the integration of clinical and basic sciences seem required.

Design-Based Research offers an approach to experiment with such concept mapping instructions. The objectives of Design-Based Research are twofold: to refine an intervention by iteratively conducting experiments in real life contexts, and to further theoretical insights (Barab & Squire, 2004). Context variables are mapped out to allow transfer to another learning context and to improve the theoretical framework in such a way that learning in these different contexts can be explained (Gravemeijer & Cobb, 2006). Because of the current explorative character of instructions intended to articulate the integration of clinical and basic sciences, it seems wise to set up different contexts to experiment with them.

In the study described in Chapter 3, we compared the concept maps constructed by groups of experts with those constructed by groups of residents, and found that residents were able to articulate the integration of clinical and basic sciences to a significantly greater extent than experts. A cognitive explanation for this could be that due to their clinical experience, experts’ basic science knowledge becomes encapsulated by clinical higher order concepts, whereas the basic science knowledge of residents plays a more overt role in the understanding of clinical problems, cf. (Boshuizen & Schmidt, 1992; Van de Wiel et al., 2000). However, not all the differences between experts’ and residents’ concept maps could be explained by theories about their different knowledge bases. It was suggested that group dynamics and their reflection in the communication could also account for the level to which expert groups and resident groups articulate their knowledge. If this is the case, the expertise level of the constructor groups could then be a context variable that accounts for differences in the concept mapping processes and, consequently, for differences between the concept maps. Hence, the dynamics of cooperation
(Weinberger & Fischer, 2006) could be a relevant context variable (Gravemeijer & Cobb, 2006).

4.2 Aims

The goal of medical education is to teach students to build an integrated knowledge base, which means that medical teaching should elaborate on the relations between clinical and basic science knowledge. Only if medical teachers are aware of these relations and competent in articulating them will they be able to discuss them with their students. Concept mapping has been put forward as a promising technique that could support medical teachers in their endeavours to articulate this integrated knowledge. In our study, groups of clinicians and basic scientists constructed concept maps guided by instructions focusing on the articulation of the integration of clinical and basic sciences. In line with Design-Based Research (Barab & Squire, 2004), we scrutinized the process of concept mapping and searched for the factors that account for the articulated integration in the concept maps. Insights into the factors that facilitate or hinder this process can be used to refine the concept mapping instructions, in order to instruct teachers how to effectively articulate the integration of clinical and basic sciences. So far, research has focused on the concept maps themselves, i.e., taking a cognitive point of view (McGaghie et al., 1996; Rendas et al., 2006). Our focus in this study was on the process of concept mapping, thereby exploring constructivist and cooperative learning approaches. We asked ourselves:

Which factors affect the learning process of interdisciplinary groups of clinicians and basic scientists at different expertise levels, if they jointly construct concept maps guided by instructions focusing on the articulation of the integration of clinical and basic sciences?

The answer to this question might give us insights into the explication of clinical and basic science knowledge in interdisciplinary groups.

4.3 Methods

4.3.1 Participants and procedure

Seventeen groups, all composed of both clinicians and basic scientists working at the Leiden University Medical Centre, participated in the experiments. Ten groups were designated as ‘experts’: the participants had at least five years’ experience and were involved in preclinical and/or clinical education. Two groups consisted of five, one
group of two, and seven groups of three experts. To examine the influence of expertise level, seven resident groups with a disciplinary composition equivalent to that of the seven groups of three experts were included. Each group constructed a concept map about a clinical problem that fitted the disciplinary composition of the group, e.g., a surgeon, a pathologist and a general practitioner constructed a concept map about blood in faeces, and a lung specialist, a specialist in infectious diseases and an immunologist constructed a map about coughing. In order to minimize the influence of content bias on the findings, concept maps of seven different clinical problems were constructed.

The concept maps were constructed in at least two sessions, as recommended by Novak (Novak & Gowin, 1984). We considered the draft made during the first session to be an intermediate state in learning to articulate integration, which was further developed during the second session (Kinchin et al., 2008). The groups were guided through concept mapping instructions that included directives intended to encourage them to articulate the integration of clinical and basic sciences, such as the instruction to contribute and discuss concepts that were particularly relevant from the perspective of participants’ own disciplines, the instruction to explore links between clinical and basic science concepts, and the instruction to use clinical concepts as higher order concepts that subsumed basic science concepts. As a final step, the participants had to explain two complex patient cases in order to check whether the concept map was comprehensive enough. The draft versions were constructed with the aid of post-it notes and large sheets of paper. We expected this “physical” way of constructing to enhance communication, particularly in groups in which participants met each other for the first time. This would thus contribute to the learning process (Slavin, 1996). After the first session, the first author digitized the draft concept maps by means of Inspiration®, a software tool for concept mapping. In the second session, participants checked whether any mistakes had been made during digitization and reviewed and refined the ordering and relations between the concepts along the same instructions as used in the first session.

Before the actual experiment started, we conducted pilots to find the optimal group size and instructions. In cooperative learning, group size has been associated with different interaction patterns and its effectiveness largely depends on the task that is carried out (Strijbos, Martens, & Jochems, 2004). We assumed that larger groups, with consequently more disciplines, would mean a greater challenge to bridge the gaps between the disciplines (McGaghie et al., 1994) and that this might be reflected in the communication patterns (Strijbos et al., 2004; Weinberger & Fischer, 2006). When group size and instructions had been optimized, leading to a
construction process that the participants experienced as feasible, we were able to investigate the context variable ‘expertise level’ (Gravemeijer & Cobb, 2006).

4.3.2 Data collection and analysis

Three data sources were used: the draft and final versions of the concept maps (to track learning during the concept mapping process), a questionnaire (for measuring the perceived usefulness of the instructions) and video tapes of the sessions combined with field notes (to analyse cooperation). After the sessions of the groups of five experts, the group of two experts and one group of three experts, we discussed the instructions with each group to check feasibility and clarity, so that we could adapt them to practical needs -an approach that fits into Design-Based Research- (Barab & Squire, 2004; Gravemeijer & Cobb, 2006).

Concept maps
Draft and final versions of the concept maps were compared to examine whether there was a learning effect regarding the articulation of integration. We measured both the elaborateness of the concept maps in terms of number of clinical and basic science concepts, and features that measured the articulated integration of clinical and basic sciences. When we applied this framework to the final concept maps, interrater reliability turned out to be sufficient (a mean Cohen’s kappa of .95, see Chapter 3) to justify having one researcher coding the draft versions. The concept maps of the groups consisting of two and five experts were left aside, because the instructions were modified after these sessions. The learning effect between the first and the second session was measured by performing a t-test for two related samples on the analysis of the draft and final versions.

Questionnaire
In order to incorporate participants’ points of view on what factors facilitated or hindered the articulation of clinical and basic science knowledge in concept maps, we asked them to fill in a questionnaire focusing on the usefulness of the instructions. The items were answered on a five-point Likert scale ranging from ‘I do not agree’ to ‘Agree’ or ‘Very low’ to ‘Very high’ in case of the questions on motivation. The reliability of the 20 items used in the analysis was satisfactory (Cronbach’s alpha .87). In the version filled in by the residents an additional six items were used to question the different ways of organizing the concept map in detail (Cronbach’s alpha .93). Because the integration as articulated in the expert concept maps differed significantly from that in the resident concept maps, ANOVAs were used to investigate whether these groups also differed regarding the perceived usefulness of the
instructions. In order to examine the impact of the sessions on motivation, t-tests were run on the questions concerning motivation.

**Video tapes and field notes**

We gathered data by means of video tapes and field notes of the pilot sessions, and 11 sessions of the three-participant groups to examine cooperation within the groups. A first rough analysis was conducted by means of a checklist matrix structured along the concept mapping instructions (Miles & Huberman, 1994). Per instruction and per participant, notes were made of questions, answers to questions, subjects of discussion, positive and negative remarks and motivations that participants gave for their contributions, in order to map out the communication in the group. Moreover, per instruction we wrote observations that pertained to the whole group, such as how much effort it took to apply the instruction and make decisions, and added quotes to illuminate the notes. One tape was analysed by two researchers in order to cross-check the interpretation and to fine-tune the checklist matrix. We felt one researcher was sufficient for video analysis, because this was triangulated by data from the questionnaires and the draft and final concept maps. A summary of the notes per instruction was briefly discussed with the groups of participants during the second session, to check whether they recognized the findings.

Initially, the data gathered in the checklist matrix were further analysed by means of communication patterns in cooperative learning as described by Weinberger (Weinberger & Fischer, 2006). However, these categories did not completely fit our data. They were more focused on obtaining consensus between different viewpoints, whereas in our data communication was also directed towards reconciliation and combining contributions. We decided to ground the categories in the data in different rounds of analysis, thus clustering the categories. Eventually, the data were clustered into (1) motivation, (2) exchange of information, (3) interaction and (4) the decision-making process. These categories combined some of the communication patterns as described by Weinberger & Fischer (Weinberger & Fischer, 2006) and some conditions for effective cooperative learning (Slavin, 1996), which we interpreted as a validation of the categories for analysis. In Box 4.1 the categories are presented in detail.
**Box 4.1** Overview of the coding categories used for the analysis of the video tapes and the field notes

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>Positive and negative drive to adopt concept mapping.</td>
<td>It is great fun, this way of working. (E)</td>
</tr>
<tr>
<td></td>
<td>Understanding of the goal of the cooperative learning task in order to stay on track.</td>
<td>My enthusiasm is reduced because I still do not understand the goal of concept mapping. (R)</td>
</tr>
<tr>
<td>Exchange of information</td>
<td>Explanations and explications without involvement from others, e.g., explications of the participant’s own contribution to the concept map.</td>
<td>The basic science categorization is good to know but you should not really apply it. (E) For me, the concept map is upside down. (E)</td>
</tr>
<tr>
<td>Interaction</td>
<td>Active involvement reflected in questions participants ask each other, asking for and giving clarifications</td>
<td>I do not know whether this results in blood in feces. You know that. (R)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Now I am completely confused: how do you use secretor and osmotic? Up to 2 hours ago, it was our main device. This distinction can’t be that weird? (R)</td>
</tr>
<tr>
<td>Decision making</td>
<td>Negotiations about how to structure the concept map, implying what to adopt in the map.</td>
<td>Let’s distinguish pathogenesis and pathophysiology. Okay, this categorization does not commit us to anything. (E)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Let’s stop with expanding the concept map. Every concept covers more detailed concepts. (E)</td>
</tr>
</tbody>
</table>

E=Expert, R= Resident

### 4.4 Results

#### 4.4.1 Learning expressed by draft and final concept maps

Table 4.1 presents the differences between the draft and final versions of the concept maps. In the second session, participants added more (especially clinical) concepts to the concept map, and articulated integration to a significantly higher extent via links between clinical and basic science concepts, and via basic science concepts subsuming clinical concepts. Additional analysis comparing resident and expert concept maps revealed that only the residents were responsible for the significant improvements in articulated integration.
Table 4.1. Differences between draft and final versions of the concept maps, measured by the number of clinical and basic science concepts and features describing articulation of integration

<table>
<thead>
<tr>
<th></th>
<th>Draft</th>
<th>Final</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=14</td>
<td>N=14</td>
<td></td>
</tr>
<tr>
<td>Clinical concepts</td>
<td>67.1 15.2</td>
<td>78.1 19.9</td>
<td>3.44**</td>
</tr>
<tr>
<td>Basic science concepts</td>
<td>18.6 8.5</td>
<td>23.7 16.1</td>
<td>1.34</td>
</tr>
<tr>
<td>Proportion of basic science/clinical concepts</td>
<td>21.7%</td>
<td>23.3%</td>
<td></td>
</tr>
<tr>
<td>Clinical concepts subsuming basic science concepts</td>
<td>0.6 1.2</td>
<td>1.8 3.0</td>
<td>1.4</td>
</tr>
<tr>
<td>Basic science concepts subsuming clinical concepts</td>
<td>4.3 4.8</td>
<td>6.0 5.3</td>
<td>3.07**</td>
</tr>
<tr>
<td>Links between clinical and basic science concepts</td>
<td>12.4 9.0</td>
<td>15.4 10.3</td>
<td>3.05**</td>
</tr>
</tbody>
</table>

* p<0.05    **p<0.01

4.4.2 Participants’ views on concept mapping

Regarding the views on procedure and instructions, we distinguished between experts and residents, for their concept maps differed significantly in the articulation of integration. Overall, experts were significantly more positive about the procedure and instructions of concept mapping than residents; seven out of twenty questions showed a significant difference between the two groups, as Table 4.2 shows. The experts really enjoyed the concept mapping sessions; their motivation increased significantly, whereas residents’ motivation grew no more than slightly. Additional t-tests revealed that residents were significantly more positive about the instruction to order the concepts along clinical concepts than about the instruction to order the concepts along basic science concepts (p<0.05).
Table 4.2 Differences between experts and residents concerning the value they attached to the concept mapping procedure and the instructions (rated on a 5-point Likert scale)

<table>
<thead>
<tr>
<th></th>
<th>Residents N=19</th>
<th>Experts N=21</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>Before this session, my motivation to participate was</td>
<td>3.4</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>After this session, my motivation to participate was</td>
<td>3.5</td>
<td>0.8</td>
<td>3.219</td>
</tr>
<tr>
<td>Procedure: making a concept map</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Is feasible</td>
<td>3.4</td>
<td>0.8</td>
<td>2.172</td>
</tr>
<tr>
<td>Is inspiring</td>
<td>3.9</td>
<td>0.7</td>
<td>3.853</td>
</tr>
<tr>
<td>Is a good way to assemble concepts of various disciplines</td>
<td>3.9</td>
<td>0.6</td>
<td>5.127</td>
</tr>
<tr>
<td>Enhanced my understanding of what knowledge should be incorporated in the educational program</td>
<td>3.6</td>
<td>0.8</td>
<td>0.303</td>
</tr>
<tr>
<td>Facilitates multidisciplinary cooperation</td>
<td>3.6</td>
<td>0.7</td>
<td>2.828</td>
</tr>
<tr>
<td>I enjoyed the multidisciplinary way of working</td>
<td>4.0</td>
<td>0.7</td>
<td>7.241</td>
</tr>
<tr>
<td>Consists of logical steps</td>
<td>3.3</td>
<td>0.8</td>
<td>1.086</td>
</tr>
<tr>
<td>Time investment and result are balanced</td>
<td>3.2</td>
<td>1.0</td>
<td>3.296</td>
</tr>
<tr>
<td>Total</td>
<td>3.6</td>
<td>0.4</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>4.0</td>
<td>0.4</td>
<td>7.302</td>
</tr>
<tr>
<td>Instructions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The introduction was understandable</td>
<td>3.9</td>
<td>0.8</td>
<td>1.984</td>
</tr>
<tr>
<td>Collecting concepts &amp; first categorization was useful</td>
<td>4.0</td>
<td>0.7</td>
<td>2.396</td>
</tr>
<tr>
<td>Collecting concepts &amp; first categorization was understandable</td>
<td>3.8</td>
<td>0.9</td>
<td>0.629</td>
</tr>
<tr>
<td>Ordering was useful</td>
<td>3.7</td>
<td>0.7</td>
<td>15.366</td>
</tr>
<tr>
<td>Ordering was understandable</td>
<td>3.7</td>
<td>0.9</td>
<td>5.372</td>
</tr>
<tr>
<td>Linking concepts was useful</td>
<td>3.4</td>
<td>1.1</td>
<td>3.008</td>
</tr>
<tr>
<td>Linking concepts was understandable</td>
<td>3.8</td>
<td>0.7</td>
<td>0.445</td>
</tr>
<tr>
<td>Using patient cases was useful</td>
<td>3.8</td>
<td>0.6</td>
<td>5.338</td>
</tr>
<tr>
<td>Using patient cases was understandable</td>
<td>3.9</td>
<td>0.8</td>
<td>2.069</td>
</tr>
<tr>
<td>Total</td>
<td>3.8</td>
<td>0.6</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>4.2</td>
<td>0.4</td>
<td>7.443</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am satisfied with this concept map</td>
<td>3.9</td>
<td>0.8</td>
<td>5.065</td>
</tr>
<tr>
<td>Ordering:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Along basic science concepts is useful</td>
<td>3.3</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>Along basic science concepts is understandable</td>
<td>3.6</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Along clinical science concepts is useful</td>
<td>4.1</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Along clinical science concepts is understandable</td>
<td>4.0</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>3.7</td>
<td>0.7</td>
<td></td>
</tr>
</tbody>
</table>

* p< 0.05    ** p< 0.01

4.4.3 Cooperative learning

After clustering the data from the video tapes and the field notes, four categories emerged: 1. motivation, 2. exchange of information within the group, 3. interaction between participants and 4. the decision-making process. Quotations below have been translated from Dutch to English, and expertise level is indicated by (E) for experts and (R) for residents in order to illustrate the impact of the context variable ‘expertise’.
1. Motivation
Regarding motivation, concept mapping cut two ways: enthusiasm about the activity of concept mapping itself and motivation that came from working towards a goal. The multidisciplinary approach obviously motivated the experts: they expressed their surprise about the input of the others, and the disciplinary differences that became apparent. One of the expert groups decided to meet a third time because the gynaecologist did not agree with the internist’s viewpoint about how to categorize diagnoses.

“As clinicians you always concentrate on this part of the concept map (points to the patient-related concepts) but the most important piece of clinical reasoning is this (points to basic science concepts).” (E)
“We, surgeons, are not so important.” (regarding diarrhoea) (E)

The pilot groups showed less motivation. Unlike the experts, the residents took the different viewpoints more for granted. They showed less motivation for the sessions. Although the target users (medical clerks) of the concept maps were described, it was especially the residents who remained uncertain about the level of knowledge of these target users.

“Who is the target group?” (R)
“My enthusiasm is reduced because I still don’t understand the goal.” (R)

Some groups expressed difficulties with the task to construct a concept map about all knowledge they considered absolutely relevant for understanding a clinical problem. This seemed to have to do with their previous experiences with schematizations. The experts were inclined to create a decision tree, and thus seemed to be guided by the question: what knowledge does one use for diagnosing a clinical problem?

“I have trouble knowing where to start the thinking process.” (E)

2. Exchange of information
Explanations and motivations of contributions were clustered as ‘exchange of information’ (see Box 4.1). Participants explained how their disciplines coloured their views on the concepts. Information was exchanged right from the start of the concept mapping process, when participants were collecting concepts. In the resident groups, these explanations already in this first stage often led to questions and hence interaction, which was the case in one expert group. There was only one resident group in which the emphasis in the communication was on exchange of information. In this group, one of the participants joined later.

“You think of the patient, as a first step, I think of the context.” (E)
“What does MALT mean?” (R)
3. Interaction
In the expert groups, interaction occurred in particular when the participants started to order concepts, requiring joint decisions. The pilot group of two experts exhibited hardly any interaction. For residents, decision making was not a prerequisite to interact; most resident groups started interaction while collecting concepts, triggered by the contributions of the others. These contributions entailed concepts they did not know, leading to interaction, that is, asking for explanations or joint consultations of the Internet and subsequently explorations of whether the concept maps should be adapted. There was much more interaction in the expert groups when joint decisions had to be taken, i.e., about links, the organization of the concepts and labelling the links. Although labelling the links was deemed unnecessary -most relations were causal or sequential- , it provoked discussions about what was cause and what consequence.

“This blood test, what information do you want to get from that?” (when trying to link concepts) (E)
“I have added these concepts with another meaning in mind. Now, I discover that when you replace them, their meaning is changed.” (E) (indicating that by relating a concept to other concepts, meanings change somewhat)

Most resident groups spent much time organizing the concepts along the two structures offered: clinical concepts subsuming basic science concepts or the other way around, basic science concepts subsuming clinical concepts. Although some resident groups expressed having difficulties categorizing clinical concepts within a framework of basic science concepts, they all maintained a basic science categorization. In most resident groups this categorization provoked interaction: residents expressed doubts about which category to place some of the clinical concepts in, asked each other and consulted the internet.

“Is there a third group of pathophysiological explanations of proteinuria?” (R)
“I should have studied proteinuria before I came to this meeting.” (R)
“I do not know whether this results in blood in faeces. You know that.” (R)

The instruction to analyse, summarize and explain the patient cases raised questions and therefore led to interaction. If a case did not belong to the domain of a particular participant, he/she tended to participate less in the discussion.

4. Decision-making process
The pilot groups of five participants had difficulties to reconcile five disciplinary viewpoints. Too many disciplinary viewpoints hindered the decision-making process
about the organization of the concept map. This resulted in a bunch of concepts that
to some extent were grouped, but not really organized or related.

“There are too many viewpoints. I don’t see how we can structure this.” (E)
“You seem to make a decision tree. But we are making a scientific
ordering.” (E)

The residents started to order the concepts before they were instructed to do so. For
them, an explicit instruction to consider different ways to order the concepts seemed
to hinder rather than help decision making. Six of the seven expert groups did not
start ordering until they received the instruction. They had frequently to be reminded
to organize the concept map. All groups started with an ordering of the concepts that
adhered closely to the phases of clinical reasoning (e.g., history, lab, diagnoses) and
subsequently added an ordering as instructed: clinical concepts subsuming basic
science concepts and basic science concepts subsuming clinical concepts. Basic
science ordering sometimes evoked doubts about whether clinical or basic science
concepts should be the organizational device, and slowed down decision making.

“In this schematization, you are trying to do two things at the same time:
from basic science to differential diagnosis and from patient case to basic
science knowledge. (R)
“The basic science categorization is good to know but you should not really
apply it.” (E)
“But how do students learn? First anatomy, embryology. No, that does
not work.” (E)

Decisions about linking concepts were based on considerations about complexity; too
many links would make the concept map chaotic. This practical viewpoint accelerated
decision making. In all groups, the instruction to analyse patient cases led to
adaptations and helped to decide about the final version of the map. When the
concept map was deemed not comprehensive, and therefore not a sufficient help to
explain the patient case, it was accepted as ‘temporarily definitive’. It was especially
the residents who used the concept map for their own analysis and explanation of the
case.

“Yes, I can reason along these lines” while pointing to a part of the
concept map (R)
“This concept map is unclear, complex.” After analysis of a patient case:
“Yes, our ordering is probably the best. You can exclude causes by using this
concept map.” (E)
“Let’s stop expanding. Every concept covers more detailed concepts. This is a
framework.” (E)
4.5 Conclusions and discussion

Our results indicate that interdisciplinary groups of medical teachers can learn to articulate the integration of clinical and basic sciences in concept maps if they are guided by specific instructions. In our study, this learning process was influenced by several factors. First, group size mattered: five disciplines in a group made decision making difficult. Optimal group size depends on the task (Strijbos et al., 2004), and for the task of constructing multidisciplinary concept maps three participants seems optimal. Second, the learning process of these groups of three were found to be highly influenced by expertise level. Residents not only articulate integration of clinical and basic sciences to a greater extent (cf. Chapter 3), they also learn to articulate integration via concept mapping to a greater extent, as the differences between draft and final versions showed.

Which other factors played a role in the articulation of integration in concept maps and could explain the differences between expert and resident concept maps? In the cooperation between residents interaction was vital, whereas experts relied more on an exchange-of-information pattern. Taking the viewpoint of the theory of cooperative learning, which underscores interaction as a factor that affects learning, we assume that this interaction is a facilitating factor for the articulation of integration in the concept maps (Weinberger & Fischer, 2006). The decision-making process is another factor that showed to be decisive for the articulated integration in concept maps. Decision making as an aspect of co-construction is considered to contribute to effective cooperative learning (Slavin, 1996; Weinberger & Fischer, 2006). In groups with too many participants decision making was rather difficult, probably due to too many gaps between disciplines that had to be bridged. Moreover, decision making generated interaction in the expert groups. Whereas joint decisions and interaction are reported as two different factors that account for learning in cooperative learning settings (Slavin, 1996; Weinberger & Fischer, 2006), our results suggest that decision making and interaction are related: decision making turned out to be a means to induce interaction.

The articulation of integration in concept maps did not correspond with motivation, nor with the value participants attached to the procedure and the instructions. Although the residents considered the instruction to order clinical concepts along the lines of basic science concepts less helpful, they not only used this ordering device more, but also learned to use it more frequently during the concept mapping sessions. Our data suggest that this learning was due to the interaction evoked by the instruction. Hence, participants’ views on the procedure and
instructions turned out to be irrelevant for the articulation of integration in concept maps.

Our understanding of the differences between expert and resident concept maps regarding the articulation of integration (see Chapter 3) fell short when we confined our view to a cognitive perspective only. It is the combination of the cognitive, constructive and cooperative learning perspectives that deepened our understanding of the use of concept mapping instructions on different expertise levels. The concept maps in our study not only disclosed characteristics of the shared knowledge of groups of clinicians and basic scientists on different expertise levels, as in cognitive psychological studies (Boshuizen & Schmidt, 1992; Van de Wiel et al., 1999). They also showed that the articulation of integration can be learned by discussing and improving concept maps constructed previously, an explanation from the constructivist viewpoint. Thus, the articulation of the integration of clinical and basic sciences is not a static reflection of cognitive structures but a dynamic phenomenon, subject to being influenced, as suggested elsewhere (H. J. Schmidt, 2006). Note that we did not measure the process of learning the articulation of integration during the first concept mapping session. The cooperative learning view helped to detect decision making and interaction as facilitating factors for learning to articulate integration in expert and resident groups. Cooperative learning is usually an approach for peer learning (Slavin, 1996). Both expert and resident groups were supposed to be peers: experts among experts and residents among residents. However, the definition of ‘peer’ might need to be differentiated. Experts might regard each other less as peers than residents do. Because of their specialized knowledge, the knowledge gap between experts might be larger than between residents. If this is the case, interaction might be a confounding variable for expertise level.

We placed this study in the tradition of Design-Based Research because we aimed to refine the concept mapping instructions, and to link the articulated integration in concept maps with theoretical insights. Decision making and interaction do not seem independent factors that correlate with the articulated integration in concept maps, but they seem to be correlated and are affected by group size and expertise level. However, Design-Based Research is usually conducted along experiment cycles exploring new context variables (Gravemeijer & Cobb, 2006). This explorative study should therefore be continued in new experiments, for further refinement of the instructions and procedure. We will here discuss three limitations of this study and their potential consequences for follow-up research.

First, our results allowed us to state only the relatedness of interaction and articulation of integration. Follow-up research should examine whether there is a causal relationship. This might be investigated by triggering interaction in the expert
groups by means of advancing decision making in the concept mapping session, and measuring the integration in the resulting concept maps. A next step is to quantify interaction and decision making, and correlate this to the integration articulated in the concept maps. Second, we conducted this study in one medical centre. Its specific organizational culture might have coloured the interaction between the experts and the way they have cooperated. This context variable should be taken into account in a follow-up study. Third, we endeavoured to detect patterns in the data from the video tapes and field notes, and decided to make a qualitative analysis with the risk of bias in the interpretation (Barab & Squire, 2004; Gravemeijer & Cobb, 2006; Miles & Huberman, 1994). Such an explorative approach should be followed by research intended to quantify this qualitative information (Raudenbush, 2010).

A practical implication of this study concerns teacher learning programs that aim to support vertical integration. It does not go without saying that medical specialists are able to explicate integration, which makes the challenge of vertical integrated programs even bigger, cf. (Eraut, 2000). The good news is that teachers are able to learn to articulate integration. For teacher learning programmes it seems wise to support this learning, in which interaction shows to be the key word. In line with cooperative learning research (Slavin, 1996), our study points to co-construction tasks as means to evoke interaction, in particular for groups that do not interact easily. The concept mapping procedure we proposed seems to fit this purpose. Another practical implication is that we should be more aware of the gaps between disciplinary points of view on clinical problems when developing vertical integrated programs. Integration on the level of clinical problems seems to be best established by three teachers with different disciplinary backgrounds. With more disciplines involved, we might run the risk that integration remains confined to discussing separate viewpoints instead of relating them, a phenomenon that is also reported in PBL classes (Prince & Boshuizen, 2004). Finally, we want to recommend involving residents in the development of educational programs, besides their role of teacher. They might be better able to pinpoint relevant relations between clinical and basic science concepts than experts. Often the concepts themselves are not a cognitive challenge for students, it is the basic science concept in different clinical contexts that challenges understanding (Feltovich et al., 1993). Residents have shown that they are able to articulate the relevance of basic science concepts for the understanding of clinical concepts, and it is this explication that constitutes an educational program (Eraut, 2000).
References


