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CONCEPT MAPPING AS A TOOL TO FACILITATE GOAL-ORIENTED COMMUNICATION AND COOPERATION AMONG TEACHERS

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Abstract: In this study concept mapping will be used as a tool to facilitate goal-oriented communication and cooperation among chemistry teachers in German schools. A teacher training programme has been developed to affect not only the individual professional development of the participating teachers but also the instruction-oriented cooperation and learning culture in schools. The content of the teacher training is a context based science curriculum. In a one-factorial field experiment three groups of 24 chemistry teachers each will be assigned to either one condition. One group only participates in the training. In the two other groups cooperation on the training contents will be anchored in the chemistry departments of the participants through an intervention of the project team. Additionally in the third group a cooperation task will be provided which will be a mapping task, based on theoretical considerations. It is expected that between chemistry department members of this group the largest amount of cooperation will be observed. The teacher training will begin in autumn 2004.

1 Introduction

Teachers are continuously confronted with new duties and responsibilities. Cooperation among them could be very helpful and even necessary to deal with these challenges – but reality shows that teachers in (German) schools do not cooperate much (Terhart, 1998). Teachers seem to be "lone fighters". If there is cooperation at all, it is often limited to an exchange of teaching-material. But substantial instruction-oriented cooperation, such as collaborative reflection and planning of instruction is seldom found, especially in upper secondary schools. It is an open research question, how teachers can be activated for more team work. Our study will investigate the possibilities of enhancing cooperation through in-service training workshops, where cooperative concept mapping will be used as a task to start and support discussion and reflection processes among teachers.

2 Goal and research questions

The goal of the project is to develop and to evaluate a teacher training programme that does not only focus on the professional development of single teachers and the improvement of their instructional quality. We also intend to stimulate cooperative processes within the science departments of schools.

Research questions focus on the effects of the teacher training programme and the usefulness of different tasks to support processes of professional development, to improve teaching and learning activities and to enhance cooperation between teachers. Therefore, we are particularly interested in the effectiveness of tasks to start and support such cooperation processes. Our own results as well as findings from literature indicate that mapping tools might meet these expectations. Therefore, Concept Maps will be developed and analysed as one main part of the study. Besides, we will collect data with questionnaires and interviews concerning the development of teacher competencies, the quality of instruction (assessment by teachers as well as pupils) and the development of team work in chemistry departments at schools. The following influencing factors are taken into account: characteristics of the teachers, such as attitudes, competencies and motivation as well as characteristics of the schools, such as support from head-teachers and previous cooperation of teachers. Additionally, learning outcomes will be measured.

3 The teacher training programme

3.1 Background and content

Background and content of the teacher training programme is the project "ChiK" – Chemie im Kontext (Chemistry in Context) (Parchmann & Ralle, 1998; Parchmann, Ralle & Demuth, 2000; Parchmann, Demuth, Ralle, Paschmann & Huntemann, 2001), a conceptual framework for chemistry teaching in grades 8-13 in German schools. Goal of the programme is the development of basic chemical concepts from authentic contexts. The course provides teachers with a collection of material (such as guidelines, examples and suggestions) for them to adapt to their own needs in class and to construct their own lessons within the framework of "ChiK". Classroom activities can be characterised as inquiry-oriented, self directed and cooperative; a great variety of teaching methods is used. Teaching units start with a question or an issue of relevance for the pupils either

individually, for their community or for society; for example: “Which cleaning agent is the best to buy?” or “Is the hydrogen car the car for the future?” These issues are then elaborated in questions by using chemical knowledge. Thus, basic chemical concepts are developed such as the concept of chemical equilibrium (subject of our teacher training) or the concept of energy.

For the in-service training course, exemplary units are presented, as well as different tools to support teaching and learning processes in class. Again, mapping tools are used to plan the elaboration of a context on the one hand and to structure and develop basic chemical concepts on the other.

3.2 Structure of the in-service training programme

Our teacher training can be described as a “sandwich course”: In the first workshop (1,5 days) the participants are introduced to the framework and examples of context-based teaching units of “ChiK”. They get the opportunity to get to know different methods and try chemical experiments by themselves. After this first workshop there is a practical phase of about 5 months, where they try different examples and tools in their classrooms. Afterwards follows a second workshop (1 day) with the chance to reflect the teaching and cooperation experiences in group discussions and another example of a new context is shown and tried out. This workshop is succeeded by the second practical phase in the schools of about 4 month.

Using an experimental design, some groups also get special cooperation tasks to enhance and support their work back at their schools.

4 First results and consequences

One cycle of this teacher training programme has already been organised. During the first workshops in autumn 2002, a total of 76 teachers took part. In these workshops the participants were introduced to the mind mapping programme “Mind Manager Smart” as a tool to structure information from internet inquiries with pupils or to collect previous knowledge and ideas of pupils. This programme was frequently used in classes.

The extra cooperation-task was limited to a written guideline which included the demand to discuss the information from the teacher training with at least one colleague at school. Both partners were supposed to choose one main focus for the collaborative planning of instruction. As our first results show, this cooperation task only had effects in those departments, that already cooperated very well.

Two consequences were drawn for the second run of the programme: A) the new cooperation task will be intensified and based on mapping activities (see below). B) Visits of the project team (again, using an experimental design, see below) will assure a structural anchorage of cooperation in the chemistry department of the school before the next course of the teacher training programme takes place.

5 The new study

5.1 Theoretical background

5.1.1 Characteristics of effective cooperation tasks

Intervention arrangements in order to stimulate cooperative work need to consider findings about the effectiveness of cooperation tasks:

First, a subject based task (in our case chemistry) provides a common knowledge- and experience-background for the communication and cooperation (Clark & Brennan, 1991). Second, teachers have to estimate the cooperative approach as helpful and attractive and as coherent with other initiatives (Garet, Porter, Desimone, Birman & Yoon, 2001).

One main obstacle for cooperation at schools might be the intervening “autonomy principle” (Lortie, 1975; Altrichter, 2000). It is assumed that the wish for autonomy in the case of instruction is particularly high, because in this case the core of the professional activities is affected (Altrichter, 1996; Ulich, 1996). Also the self-perception of the teacher might be affected (Bauer, 1998) as an exchange of personal instructions concepts allows insights into the quality of the instruction.

5.1.2 Related research on cooperative concept mapping

Especially in the framework of pre-service training for teachers and to a lesser extent in the field of in-service training, there are some empirical studies and experiences available with cooperative concept mapping, e.g. for curriculum development.

Ferry, Hedberg and Harper (1997) worked with 69 pre-service teachers in their third year. They used a computer-based concept-mapping programme to create and modify Concept Maps about science related curriculum content knowledge. The tool was used to plan science lessons for a class of an elementary school. There were several sessions over several weeks, where the Concept Maps have been revised several times. During the task, the students were free to collaborate with their peers. The collected data (the Concept Maps being supplemented by interviews) showed, that the students used the concept-mapping task to build up their curriculum content knowledge in the form of "more powerful integrated patterns". Furthermore it could be found, that the construction of the Maps enhanced the students skills to plan instruction.

Beyerbach and Smith (1990) carried out an investigation with 17 pre-service teachers, who created Concept Maps on the topic of effective teaching. The initial Concept Maps were revised several times over the time of one year, while the students worked together with a partner. Beyerbach and Smith investigated content and organisation of all Maps. They could show that the cognitive processes of the students about effective teaching could be improved with the help of the mapping task. The work with partners proved to be especially helpful as an opportunity for reflection.

Starr and Krajcik (1990) used the concept-mapping technique for curriculum development with middle school teachers. The participating teachers worked in teams of two or three and developed and revised their Maps over a period of 4 sessions, 3,5 hours each. On the basis of the changes made in the Maps (like additions and deletions), an increasing clarification of the concepts as well as of the relations between them could be seen.

5.2 Concept Mapping tasks as a tool to support cooperation

Regarding the literature and principles of mapping activities, concept-mapping tasks fulfil the fundamental criteria of effective cooperation tasks as specified:

1) They can be used to visualise ideas and goals of basic chemical concepts and therefore build up on the common background and knowledge of teachers.
2) The task receives special relevance in the light of current discussions about the introduction of "standards" in Germany, which are also based on chemical concepts. The task can therefore be regarded as highly coherent.
3) Mapping of basic chemical concepts to visualise central goals of cumulative chemistry teaching does not interfere with pedagogical beliefs of how something should be taught. The "autonomy principle" is less touched than it would be in discussions about teaching methods, for example.

Following these arguments, mapping techniques will not only be introduced as tools to support teaching and learning in class in the second run of the course. They will also be used as a tool to raise and support discussion and cooperation processes among teachers, also in the workshops and at their departments in school, following the experimental design.

5.3 Design

Three groups of 24 teachers each – two teachers from one school at a time – take part in the training sessions.

During the training, all teachers will be introduced to concept mapping as a tool to structure and to discuss contents and goals of basic concepts in chemistry. Following an experimental design, one group will additionally be asked to use this task in their chemistry department of their schools to discuss and visualise contents and goals of the same basic chemical concept with their colleagues.

To support cooperation at school, teachers from two groups will additionally be contacted. Their schools will be visited by members of the project team during a department meeting to present and discuss the ideas of the in-service training workshop and to point out the objectives of cooperation during the course.

Teachers from the last group will only participate in the teacher training workshops and will neither get extra visits nor special tasks to use mapping activities at their schools.
The treatments can be classified as following:

1) No structural anchorage and no extra activities
2) Structural anchorage of cooperation in the chemistry department of the school (through

visits of the project team)

3) Structural anchorage plus additional placement of an adequate cooperative mapping task during the teacher training

The study will be completed by a control group of 24 teachers, who do not take part in the teacher training programme.

6 Outlook

In this project we want to combine our experiences during the first run of the teacher training programme and the results of the related concept mapping research studies (see section 5.1.1) and make it useful for school practice: concept mapping will be used as a tool for cooperative discussion and reflection of basic chemical concepts, which represent one element of new standards of goals for understanding and explaining chemical phenomena. We will introduce the teachers to this tool – and after trying it and getting used to it themselves, the teachers may use it in their classes in various ways.

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8 References

Altrichter, H. (1996). Der Lehrerberuf: Qualifikationen, strukturelle Bedingungen und Professionalität. In W. Specht & J. Thonhauser (Hrsg.), *Schulqualität. Entwicklungen, Befunde, Perspektiven* (S. 96-172). Innsbruck: Studienverlag.

Altrichter, H. (2000). Schulentwicklung und Professionalität. Bildungspolitische Entwicklungen und neue Anforderungen an Lehrerinnen. In J. Bastian, W. Helsper, S. Reh & C. Schelle (Hrsg.), *Professionalisierung im Lehrerberuf* (S. 145-163). Opladen: Leske + Buderich.

Bauer, K.-O. (1998). Pädagogisches Handlungsrepertoire und professionelles Selbst von Lehrerinnen und Lehrern. *Zeitschrift für Pädagogik*, 44, 343-359.

Beyerbach, B.A. & Smith, J.M. (1990). Using a computerized concept mapping program to assess preservice teachers` thinking about effective teaching. *Journal of Research in Science Teaching*, 27 (10), 961 – 971.

Clark, H.H. & Brennan, S. E. (1991). Grounding in communication. In L. B. Resnick, J. M. Levine & S. D. Teasley (Eds.), *Perspectives on socially shared cognition* (S. 127-149). Washington: American Psychological Association.

Ferry, B., Hedberg, J. & Harper, B. (1997). How do Preservice Teachers use Concept Maps to Organize Their Curriculum Content Knowledge? Paper presented at ASCILITE Conference, Perth, Australia. http://www.ascilite.org.au/conferences/perth97/papers/Ferry/Ferry.html; 16.09.03.

Garet, M. S., Porter, A.C., Desimone, L., Birman, B. F. & Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal*, 38, 915-945.

Lortie, D. (1975). *Schoolteacher. A sociological study*. Chicago: University of Chicago Press.

Parchmann, I., Demuth, R., Ralle, B., Paschmann, A. & Huntemann, H. (2001). Chemie im Kontext – Begründung und Realisierung eines Lernens in sinnstiftenden Kontexten. *Praxis der Naturwissenschaften – Chemie*, 50, 2-7.

Parchmann, I. & Ralle, B. (1998). Chemie im Kontext – ein Konzept zur Verbesserung der Akzeptanz von Chemieunterricht. In: A. Kometz (Hrsg.), *Chemieuntericht im Spannungsfeld Gesellschaft – Chemie – Umwelt*. Berlin: Cornelsen.

Parchmann, I., Ralle, B. & Demuth, R. (2000). Chemie im Kontext – eine Konzeption zum Aufbau und zur Aktivierung fachsystematischer Strukturen in lebensweltlichen Kontexten. *MNU*, 53 (3), 132-136.

Starr, M. L. & Krajcik, J. S. (1990). Concept Maps as a Heuristic for Science Curriculum Development: Toward Improvement in Process and Product. *Journal of Research in Science Teaching*, 27 (10). 987 – 1000.

Terhart, E. (1998). Lehrerberuf: Arbeitsplatz, Biographie, Profession. In: H. Altrichter, W. Schley & M. Schratz (Hrsg.), *Handbuch zur Schulentwicklung* (S. 560-585). Innsbruck: Studienverlag.

Ulich, K. (1996). Beruf: Lehrer/in. Arbeitsbelastungen, Beziehungskonflikte, Zufriedenheit. Weinheim: Beltz.