Concept Mapping: Connecting Educators
Proc. of the Third Int. Conference on Concept Mapping
Tallinn, Estonia & Helsinki, Finland 2008

THE EFFECT OF DIFFERENT CONCEPT-MAPPING TECHNIQUES ON PROMOTING STUDENTS' LEARNING PROCESSES IN THE FIELD OF BUSINESS

Jeannine Ryssel, Sabine Sommer, Bärbel Fürstenau, Janet Kunath
Chair of Business Education and Management Training, Technische Universität Dresden, Germany

Abstract. This study reports about the effects of three concept-mapping techniques on promoting students' learning processes in the field of business sciences: expert map, fill-in-the-map and construct-a-map. The three techniques were used complementary to a management game and they differ in the degree of self-construction. Twenty-six ninth-grade students at a public high school took part in the study. The students were assigned to one of four groups: a control group and three concept-mapping groups (experimental groups). In order to measure the learning outcome, students of all groups were required to answer a knowledge test before and after the intervention. An increase in knowledge over time could be identified, but the groups did not differ significantly. However, interesting tendencies were identified: The groups who worked with fill-in-the-map and construct-a-map were superior to the expert map group. The expert map group showed the lowest increase in knowledge. Thus, one can assume that the requirement for self-construction (e. g. fill-in-the-map or construct-a-map) fosters learning better than working with pre-constructed maps (e. g. expert map). Furthermore, the control group, which did not use any of the mapping techniques as a complement to the management game, performed very well. Possibly, the management game itself fosters knowledge development so significantly that the effect of the mapping techniques is confounded. In light of these findings further research on the conditions under which it is useful to combine mapping techniques with complex tasks like management games is necessary.

1 Introduction

In the last decades concept-mapping techniques (Novak & Gowin, 1984) have often been used in order to support students' learning processes. Concept-mapping techniques are based on the assumption that knowledge has the structure of a semantic network (e. g. Collins & Quillian, 1969), and therefore concept-mapping helps students on the one hand to externalize and on the other hand to construct and elaborate their cognitive structure. Many research studies have been carried out with the aim of investigating concept maps as learning aids in science education (Nesbit & Adesope, 2006; O'Donnell, Dansereau & Hall, 2002). When concept-mapping is used in pedagogical contexts, the degree of pre-structuring can be varied. Learners are either required to construct the maps entirely by themselves (construct-a-map), to complete partly pre-constructed maps (fill-in-the-map) or to use completely pre-constructed maps (expert map). In a meta-analysis Nesbit and Adesope (2006) showed the advantage of construct-a-map over expert map. To date only little research has been done on the fill-in-the-map technique as a learning aid. One study conducted by Hardy and Stadelhofer (2006) shows that fill-in-the map supports the understanding of science contents better than construct-a-map. Since there are only few and diverse findings with regard to the fill-in-the-map technique, it is not possible to draw a general conclusion as to which concept-mapping technique is the most appropriate to support learning processes. Moreover, most studies focus on the well-structured domain of science, whereas research in the domain of business, which in many cases is more complex and abstract, has not yet been taken into account.

Thus, the aim of our study was to investigate the effects of three different concept-mapping techniques on promoting students' learning processes in the field of business sciences. The concept-mapping techniques were used complementary to the management game "Easy Business™". The study is part of a cooperation between the Technische Universität Dresden, the Robert Bosch Limited Liability Company and a public high school.

2 Research Methodology

2.1 Aim and Sample

The following research question guided our study: Which concept-mapping technique is the most effective for promoting students' learning processes in the field of business sciences?

Twenty-six ninth-grade students at a public high school located near Dresden took part in our study during the school year 2007/2008.

2.2 Design

The students played the management game "Easy Business™" in groups. The individual phases of the management game were complemented by classroom instruction. After finishing the management game, the class was divided into three different experimental groups and a control group. The respective concept-mapping technique was introduced to the experimental groups in order to support the students in consolidating the newly acquired knowledge. Assistance was provided when problems using the techniques arose. The control group did not learn any of the concept-mapping techniques. Before and after the treatment (management game +/- concept-mapping technique) a knowledge test was provided in the parallel forms A and B to all students (see **Figure 1**).

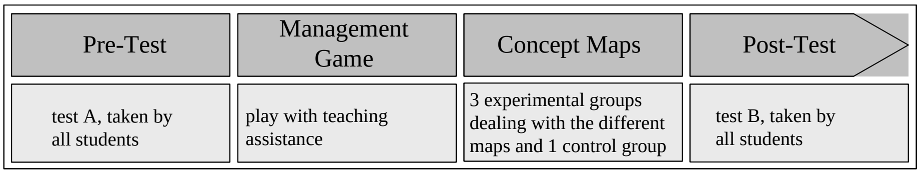

Figure 1: Research Design

2.2.1 Management Game "Easy Business™"

The management game used in this study aims at providing students with knowledge about the supply chain in an industrial company. It was designed as board game, which provides the opportunity to internalize the supply chain and the decisions involved. Moreover, students experience the effects of their decisions in the annual accounting.

2.2.2 Construct-A-Map, Fill-In-The-Map and Expert Map

The students in the experimental groups were requested to use mapping techniques to structure the knowledge acquired in the course of the management game.

The *expert map* group (M1) worked with a totally pre-constructed map showing the structure of the supply chain implemented in the management game. The *fill-in-the-map* group (M2) was given a map with some missing concepts and relations. These concepts and relations had to be put into the right position. The expert map is illustrated in **Figure 2**. The concepts and relations which had to be added in the fill-in-the-map are marked in this figure with dashed lines. A list of missing terms was provided as additional assistance.

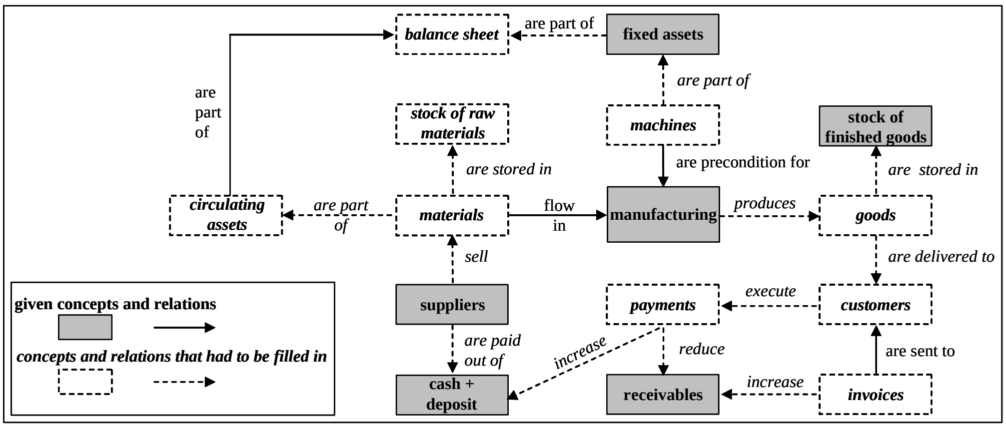

Figure 2: Expert Map

The *construct-a-map* group received only a list of concepts and relations, and the students had to construct the map completely by themselves. As a result, the self-construction requirement increases from expert map to construct-a-map (see **Figure 3**). Precise operation guidelines support all groups in working with the maps.

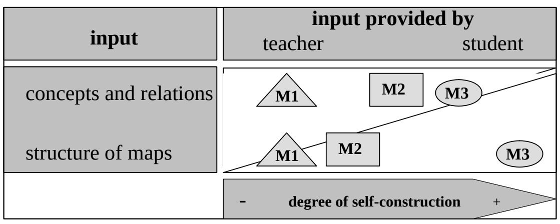

Figure 3: Concept-Mapping Techniques and the Requirement of Self-Construction

2.3 Data Gathering

The students took a knowledge test in parallel forms A and B. The two forms of parallel tests can be substituted so that they are homogeneous forms of one test. In this context the authors decided not to modify the surface structure of the questions but instead to develop two different questions on the same content area and at the same level of difficulty for A and B. This construction ensures that the results can be explained by the intervention and not by learning from the pre-test.

Following the taxonomy of Anderson and Krathwohl (2001), the cognitive process categories “remember” and “understand” in particular were combined with the knowledge dimensions “factual knowledge” and “conceptual knowledge”. Eight questions (two for each combination) were developed both for the pre-test and post-test. The tests were designed in a constructed response format including short answer and essay tasks. Questions in multiple-choice format were not included.

2.4 Data Analysis

Content analysis: The students’ answers were analyzed using a qualitative content analysis. A qualitative content analysis is a systematic, replicable technique for assigning words or phrases of a text to content categories based on explicit rules of coding. The coefficient of intersection measured 81%, indicating a high degree of inter-coder-reliability and underscoring the reliability of the category system. On the basis of the qualitative content analysis a test score could be calculated for each student.

ANOVA and t-test: To determine whether differences in knowledge increase between the pre-test and the post-test could be explained by the concept-mapping techniques, a two-way mixed analysis of variance was carried out with “group” as between-subjects factor and “time” as within-subjects factor. In addition, two one-way ANOVAs were carried out to compare the groups in the pre-test and post-test. Since neither the Kolmogorov-Smirnov-Tests of goodness and fit nor the Levene-Tests showed significant results, the prerequisites for conducting the ANOVA were given. In addition, t-tests were conducted.

3 Results

The students in all groups showed an increase in knowledge from pre-test to post-test. The construct-a-map group, the fill-in-the-map group and the control group showed a similar development. The fill-in-the-map group had the lowest prior knowledge, but also the highest increase in knowledge. The expert map group had the lowest increase in knowledge. Clearly, using a construct-a-map is superior to working with an expert map. In the pre-test the construct-a-map and the expert map groups achieved comparable scores, whereas in the post-test the construct-a-map group exceeded the expert map group. Thus, it seems that a completely pre-constructed map does not support the learning process as well as the other mapping techniques. However, the comparatively good results of the control group were surprising in this context (see **Figure 4**).

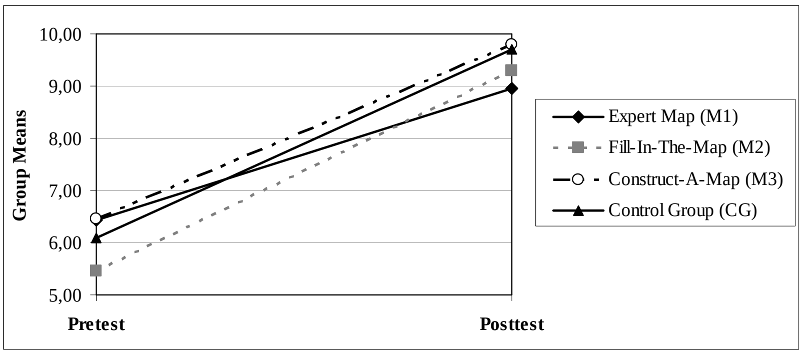

Figure 4: Results of Pre- and Post-Test

The two-way mixed ANOVA showed a main effect for the factor time (F= 227,516; p= .000). That means that a significant increase in knowledge over time was given for all groups. However no significant correlation between time and group could be identified. In other words, the groups did not significantly differ in their knowledge increase from pre-test to post-test. Further t-tests were conducted, contrasting the increase in knowledge of the groups pairwise. The means comparison of the fill-in-the-map group and the expert map group showed a nearly significant result (p= .057). The other pairwise comparisons as well as the comparison of the control group and all concept-mapping groups were not significant. The one-way ANOVAs, which compared the groups in regard to their test scores, showed no significant result for the pre-test and the post-test. Consequently, it could be assumed that the groups did not differ in knowledge in either their pre-test or their post-test scores.

4 Conclusions

On the whole, a difference between the groups could not be proved statistically. Our results do not allow conclusions as to which degree of structure in concept maps is the most effective for fostering the understanding of the supply chain in industrial companies. However, the numerical analysis shows that the fill-in-the map group had the highest increase in knowledge, and that the construct-a-map group was superior to the expert map group. These results are in line with findings of other studies: Nesbit and Adesope (2006), for example, also underscore the superiority of construct-a-map over expert maps. Likewise, Hardy and Stadelhofer (2006) emphasize the positive effect of fill-in-the-maps.

In particular the good results of the control group lead us to believe that possibly the management game itself distorts the effect of the mapping techniques. “Easy Business™” is a complex but comparatively well-structured management game. Thus, it may support students in structuring knowledge so that no additional mapping techniques are needed for understanding. This might be an explanation for the good results of the construct-a-map group in the post-test compared with the expert map group. To explain this phenomenon one may assume that the students’ active involvement in self-construction strengthens the cognitive structure, whereas completely pre-structured maps may induce confoundations with the students’ individually generated cognitive structure. In this case, students would be more challenged to match their own structure with the given pre-structure than to strengthen their cognitive structure by working through the contents a second time. Another explanation might be that the students may examine the expert map only superficially because the map seems plausible and students mistake plausibility for understanding the contents.

To sum up, our results confirm those of former studies which show that the construct-a-map technique and the fill-in-the-map technique are superior to expert maps. This seems to be true across domains. But, especially with regard to the fill-in-the-map technique more research is necessary. Our study gives some hints that fill-in-the-map provides both an adequate degree of structure and a sufficient potential for self-construction.

In our follow-up study we will increase the sample size in order to obtain statistically firmed results. Furthermore, with regard to the expert map we will develop special instructions in order to determine how to challenge the students to deal with the maps intensively rather than superficially. If possible, a fourth experimental group will be given material other than a concept map (e. g. a text) in order to work through the contents a second time. Thus, we hope to show whether the results can be explained by repeated work on the contents or by the mapping techniques. Future research will focus on the question of whether the supplementary application of mapping-techniques is more useful in the case of less highly structured management games than in the case of highly structured management games.

References

Anderson, L. W. & Krathwohl, D. R. (2001). A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives. New York: Longman.

Collins, A. M. & Quillian, M. R. (1969). Retrieval Time From Semantic Memory. Journal of Verbal Learning and Verbal Behavior, 8(2), 240-247.

Hardy, I. & Stadelhofer, B. (2006). Concept Maps wirkungsvoll als Strukturierungshilfen einsetzen – Welche Rolle spielt die Selbstkonstruktion? Zeitschrift für Pädagogische Psychologie, 20(3), 175-187.

Nesbit, J. C. & Adesope, O. O. (2006). Learning with Concept and Knowledge Maps: A Meta-Analysis. Review of Educational Research, 76(3), 413-448.

Novak, J. D. & Gowin, D. B. (1984). Learning How to Learn. New York: Cambridge University Press.

O’Donnell, A. M., Dansereau, D. F. & Hall, R. H. (2002). Knowledge Maps as Scaffolds for Cognitive Processing. Educational Psychology Review, 14(1), 71-86.