

## Symposium: Fostering the Acquisition and Application of Domain-Specific Knowledge through Concept Mapping

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**Abstract:** This symposium centers on the concern about the acquisition and application of conceptual knowledge in the domain of business and economics, both important and yet demanding educational goals. The contributions are aimed at studying whether concept mapping can be helpful in reaching these goals. Moreover, we intend to provide preliminary guidelines for using concept maps (CMs) as a learning tool in this specific field. For this purpose, we adopt an instructional design perspective that focuses on the issues as (1) what kinds of learning tasks can be successfully promoted by using CMs, (2) what kinds of learning activities need to be stimulated in order to accomplish these learning tasks, (3) how concept mapping supports students in performing the required learning activities, and (4) which additional instructional means can be helpful to increase its effectiveness.

### Symposium Overview

*Overall focus and potential significance:* Issues in the field of business and economics dramatically affect peoples' lives in an increasingly globalized world. Thus, the ability to acquire knowledge in this specific domain and to apply this knowledge to public and private concerns is not only essential with respect to professional business and economics training but may be deemed as an overarching educational goal. However, due to the diversity in (1) concepts, (2) possibilities of relating these concepts, and (3) representing the domain (i.e., causally, mathematically), knowledge in business and economics may be regarded as highly complex (e.g., Miller & VanFossen, 2008). As a consequence, acquiring a well-developed knowledge base and/or applying this knowledge to business and economics problems are anything but easy ventures. Empirical studies (e.g., Marangos & Alleys, 2007) suggest that even major business and economics students at an university level still encounter difficulties when trying to reach these educational goals. It is in the context of this unsatisfactory situation that concept maps (CMs) attract the interest of researchers and educators in the field. However, while most of the research done here uses CMs as a teacher-provided text adjunct or as an assessment device (e.g., Lawless, Smee, & O'Shea, 1998), scholars in business and economics education have more recently begun to study concept mapping as a learning tool for supporting the processes of acquiring and/or applying domain-specific knowledge. Against this background, the main purpose of the symposium is to scrutinize this latter application of concept mapping in the field of business and economics education, which includes pinpointing potential benefits and pitfalls. Based on the results of the research studies presented, we also provide preliminary guidelines for using CMs as a learning tool in this particular field. In spite of being derived from domain-specific research, we suppose these guidelines to be adaptable to other complex knowledge domains. Thus, the symposium may be of interest to all researchers and educators who wish to understand and effectively cope with the challenges and predicaments of learning about complex knowledge domains.

*Major issues addressed:* In order to obtain the goals mentioned above, we adopt an instructional design perspective (e.g., Van Merriënboer & Kirschner, 2007), that integrates the views of CMs (1) as a mean of supporting certain kinds of learning activities (i.e., as a process), and (2) as a learning goal (i.e., as a product) in itself. Within this frame of reference, we particularly focus on the following issues:

- (1) What kinds of *learning tasks* in the field of business and economics education can be successfully promoted by using concept mapping as a learning tool?

- (2) What kinds of *learning activities* need to be stimulated in order to accomplish these learning tasks?
- (3) How does *concept mapping* support students in performing the required learning activities?
- (4) Which additional *instructional means* might be helpful to increase the effectiveness of concept mapping as a learning tool?

*Summaries of the contributions:*

*Paper 1* focuses on concept mapping and summary writing as learning tools for fostering students' understanding of the knowledge domain after playing a management game. The findings indicate that both construction tasks lead to more learning gains in comparison to a control condition. However, in contrast to the expectation, the summary writing task was superior to the concept mapping task.

*Paper 2* suggests that collaborative problem-solving in the field of business economics is facilitated when the different part-tasks are made explicit, are properly sequenced, and foreseen with ontologically part-task congruent support in the representational tools. Collaboratively constructing different representations (i.e., concept maps) of the knowledge domain with the aid of representational tools increases students' understanding which beneficially affects their problem-solving performance.

*Paper 3* addresses the issue of students' difficulties with concept mapping and how these may be overcome by directly (i.e., training) and indirectly (i.e., collaboration) scaffolding the construction of concept maps. The results indicate that collaboratively constructing concept maps fosters students' understanding of the domain, but the effects of scaffolding should be carefully matched to students' characteristics (e.g., prior knowledge) and the intended learning outcome (i.e., factual or conceptual knowledge).

## **Paper 1: Concept Mapping versus Summary Writing as Instructional Devices for Understanding Complex Business Problems**

Baerbel Fuerstenau, Jeannine Ryssel, & Janet Kunath

### **Background and Aim**

Preparing students to work with complex cases and procedures is one of the central goals of business and economics education. Traditional instruction is meeting this goal with only limited success. Thus, researchers as well as educational politicians recommend solving the problems mentioned by relating instruction more closely to workplace assignments and business processes. Using management games has been advocated to meet this educational goal by supporting students in understanding complex interrelationships and applying knowledge in new situations and to new tasks. However, 20 years of research indicates that management games alone are not sufficient and additional instruction aimed at stimulating students to actively rethink the management game contents is required. For that purpose – among other forms – concept mapping or summary writing can be applied. In a meta-analysis Nesbit and Adesope (2006) showed a slight advantage of concept mapping over alternative construction tasks like summary writing. This may be explained by the diagram format which corresponds with the notion of knowledge as a semantic network. Thus, the similarity of knowledge and concept maps (as learning media) may support students in externalizing their cognitive structure and in using concept maps as learning aids. In addition, a concept map represents every concept only once, and by that directly shows the interaction of one concept with other concepts, i.e. the structure. In contrast, a text is linear and constructed according to a specific grammar (Larkin & Simon, 1987). Similar or same concepts can be used several times, and it is difficult to directly articulate a structure or macrostructure. However, since there are diverse findings, more research is needed with respect to the effectiveness of concept mapping in contrast to summary writing. In addition, 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), whereas research in the domain of business and economics has rarely been taken into account.

In light of these considerations, the aim of our study is to investigate the effects of concept-mapping and summary writing on promoting students' learning processes in the field of business sciences. Both techniques are used as a complement to the management game "Easy Business<sup>TM</sup>" and should support students in understanding complex business interrelationships.

### **Method**

*Research Question:* Is concept mapping more effective than summary writing for promoting students' learning processes in the field of business?

*Participants and intervention:* Forty-four ninth grade students at a public high school took part in our study during the school year 2008/2009. On average they were 14.5 years old. All students played the management game "Easy Business<sup>TM</sup>" in groups. It was designed as a board game that provides the opportunity to learn the supply chain of a company and the decisions involved by visualizing the departments of a company. Moreover, students have the opportunity to experience the effects of their decisions in the annual accounting. After finishing the management game, the students were randomly assigned to one of two experimental groups (either

concept mapping or summary writing) or to a control group. The students of the experimental groups were asked to construct a concept map of the most important interrelationships of the management game. As an aid they received a list of concepts and relations. We trained the respective technique with the students about one month before starting the study. The text group was requested to write a summary on the most important interrelationships of the management game. They received a list of concepts as an aid. Both techniques aimed at supporting the students in consolidating the newly acquired knowledge. The students of the control group just played the management game and did neither additional concept mapping nor additional summary writing.

*Hypotheses:* 1. Concept mapping and summary writing are superior to the control condition; 2. Concept mapping is superior to summary writing.

*Data gathering:* Before and after the treatment a knowledge test consisting of 9 open-ended questions was administered. The test is constructed in parallel forms A and B, so that the results can be accounted for 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”. In addition, we included a question aiming at the cognitive process category “applying” and the knowledge dimension “procedural knowledge”. The tests were designed in a constructed response format including short answer and essay tasks.

*Data analysis:* The students’ answers were analyzed using a qualitative content analysis. This is a systematic, replicable technique for assigning words or phrases of a text to content categories based on explicit rules of coding. The intercoder reliability measured 93% (Holsti coefficient) underscoring the reliability of the category system. On the basis of the qualitative content analysis a test score was calculated for each student. To determine whether differences in knowledge increase between the pre-test and the post-test could be explained by concept mapping or summary writing, a two-way mixed analysis of variance was carried out with “group” as between-subjects factor and “time” as within-subjects factor. 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, effect sizes (measure  $d_{int}$ ) were determined. In case of pretest-posttest designs the effect size can be determined by:  $d_{int} (= interaction) = d_{posttest} - d_{pretest}$ . The pooled standard deviation from the respective groups was used as standard deviation.

## Results

The two-way mixed ANOVA showed a main effect for the factor time ( $F(1,41)=128.244$ ;  $p=.000$ ), indicating a significant increase in knowledge over time for all groups. The main effect for the factor group showed that the groups significantly differ in their level of knowledge in the post-test, but not in the pre-test ( $F(2,41)=4.289$ ,  $p=.02$ ). In the post-test the summary group exceeded the two other groups. The concept mapping group was second best, and the control group reached the lowest level of knowledge in the post-test. In addition, a significant interaction effect (time x group) could be identified ( $F(2,41)=6.131$ ;  $p=.005$ ). In other words, the groups differ significantly in their knowledge increase from pre-test to post-test. The effect sizes with regard to both experimental groups versus control group ( $d=0.867$ ) and summary group versus concept mapping group ( $d=0.841$ ) are remarkable. The data indicate that the summary group outperformed both the concept mapping group and the control group, whereas the concept mapping group and the control group did not differ significantly in knowledge increase.

## Conclusions

As assumed in hypothesis 1, the summary writing group and the concept mapping group are superior to the control group that did not work on a construction task after the management game. This is especially indicated by the effect size which contrasted both experimental groups vs. control group, though the concept mapping group is not significantly but only by trend better than the control group. This result is consistent with other studies according to which active involvement in knowledge construction (e.g., by concept mapping or summary writing) is fostering learning. Though the management game in this case supports the learning process significantly (significant main effect time ANOVA), the additional construction activity is significantly better. This seems to be true across domains. Contrary to our second hypothesis, the summary group outperformed the concept mapping group. The following reasons might explain this result: 1. Concept mapping is a comparatively new format for knowledge explication and the students are not familiar enough with the technique so that they cannot apply it confidently. Instead, the students are much more used to summary writing. Continuous training in concept mapping previous to the study might lead to other results. 2. The format of active knowledge explication does not matter that much compared to the active involvement itself. Thus, summary writing is as effective as concept mapping or some other alternative. This is in line with many studies that report only marginal differences between concept mapping and alternative construction techniques. More research is needed here. 3. A closer look at the test shows that the difference between concept map group and summary group mainly results from items concerning procedural knowledge. By excluding these items from data analysis, the difference between the experimental groups is no longer significant. Therefore, it still has to be proven whether

summary writing better supports students in the development of procedural knowledge than concept mapping or whether this is only true for remembering and understanding.

In a replication study planned for the school year 2009/2010 we will use exactly the same design except that we will train the students in constructing concept maps a number of times before starting the management game. Thus we will be able to determine whether results can be explained by familiarity with a special technique. Furthermore, we will apply the design to another topic in the field of business in order to exclude the possibility of the results depend on a specific business topic. Finally, we are going to examine whether concept mapping can foster the development of procedural knowledge and higher cognitive process dimensions, e.g., applying or analyzing.

## **Paper 2: Matching Representational Tools' Ontology to Part-task Demands to Foster Problem-solving in Business Economics**

Bert Slof, Gijsbert Erkens, & Paul A. Kirschner

### **Background and Aim**

Collaborative problem-solving is often regarded as an effective pedagogical method beneficial for both group and individual learning. The premise underlying this approach is that through a dynamic process of eliciting one's own knowledge, discussing this with peers, and establishing and refining the group's shared understanding of the knowledge domain, students acquire new knowledge and skills and process them more deeply (e.g., O'Donnell, Hmelo-Silver, & Erkens, 2006). However, due to its complexity (i.e., diversity in concepts, principles and procedures, see Miller & VanFossen, 2008) students in business economics encounter difficulties with acquiring a well-developed understanding of the knowledge domain (e.g., Marangos & Alleys, 2007). When solving problems, students, therefore, rely primarily on surface features such as using objects referred to in the problem instead of the underlying principles of the knowledge domain, and employ weak problem-solving strategies such as working via a means-ends strategy towards a solution (e.g., Jonassen & Ionas, 2008). This hinders students in effectively and efficiently coping with their problem-solving task because the ease with which a problem can be solved often depends on the quality of the available problem representations (e.g., Ploetzner, Fehse, Kneser, & Spada, 1999). To this end, it would be beneficial if students are supported in acquiring and applying suitable representations (e.g., Ainsworth, 2006). Research on concept mapping (Nesbit & Adesope, 2006; Roth & Roychoudhury, 1993) has shown that the collaborative construction of external representations (i.e., concept maps) can guide students' collaborative cognitive activities and beneficially affect learning. Due to its ontology (i.e., objects, relations, and rules for combining them, see Van Bruggen, Boshuizen, & Kirschner, 2003) a representational tool enables students to co-construct a domain-specific content scheme fostering students' understanding of the knowledge domain in question. Problem-solving tasks, however, are usually composed of fundamentally different part-tasks (i.e., problem orientation, problem solution, solution evaluation), that each requires a different perspective on the knowledge domain and, thus, another representational tool with a different ontology. To be supportive for problem-solving, the ontology provided in a representational tool must be matched to the part-task demands and activities of a specific problem phase. Otherwise, effective problem-solving may be hindered (e.g., Van Bruggen et al.).

The goal of the study presented in this paper is to determine whether an instructional design aimed at providing ontologically part-task congruent support in the representational tools leads to more successful problem-solving performance in the field of business economics.

### **Method**

*Participants and intervention:* Students from six business-economics classes in from two secondary education schools in the Netherlands participated in this study. The total sample consisted of 93 students (60 male, 33 female). The mean age of the students was 16.74 years ( $SD=.77$ ,  $Min=15$ ,  $Max=18$ ). Working in a Computer Supported Collaborative Learning (CSCL) environment, all groups had to solve a case-based problem in business-economics in which they had to advise an entrepreneur about changing the business strategy to increase profits (i.e., company result). To come up with a suitable advice, students had to carry out three different part-tasks in a predefined order, namely (1) finding out the main factors that affects the company's results and relate them to the problem (problem orientation), (2) evaluate how certain interventions such as changing the business strategy affect company results (problem solution), and (3) calculate and compare the financial effects of these interventions and formulate a final advice based on this comparison (solution evaluation). To study the effects on problem-solving performance, the ontology in the representational tool was either matched or mismatched to the part-tasks (see Table 1). The students were randomly assigned to 31 triads divided between the four experimental conditions; seven triads in the match condition and eight triads in each of the mismatch conditions (i.e., conceptual, causal, and simulation condition).

Table 1: Overview of the Experimental Conditions

Condition	Part-tasks and provided ontology			Match / mismatch
	Problem orientation	Problem solution	Solution evaluation	
Conceptual	Conceptual	Conceptual	Conceptual	Match for the orientation phase
Causal	Causal	Causal	Causal	Match for the solution phase
Simulation	Simulation	Simulation	Simulation	Match for the evaluation phase
Match	Conceptual	Causal	Simulation	Complete match

*Hypothesis:* It was hypothesized an instruction design aimed at providing ontologically part-task congruent support in the representational tools leads to more successful problem-solving performance in the field of business economics than not receiving it.

*Data gathering:* All student groups spent six 45-minute lessons solving the problem during which each student worked on a separate computer connected by a network to enable synchronous communication (i.e., chat-tool and the sharing of the representational tool(s)). Before the first lesson, students received an instruction about the CSCL-environment, the group composition, and the problem-solving task. Students worked on the problem in the computer classroom where all chat-discussions and answers to the part-tasks were logged.

*Data analysis:* To measure the effect of condition on problem-solving performance, an assessment rubric for all criteria of the problem-solving task was developed (see Table 2). The problem-solving task consisted of three part-tasks in which the groups each had to answer three questions. All nine answers were evaluated based on their ‘suitability’, ‘elaboration’, ‘justification’, and ‘correctness’, resulting in 36 items (9 answers \* 4 criteria). It was also evaluated whether groups used answers from a subsequent phase and altered their way of reasoning when they had to answer the questions asked in a following phase (i.e., ‘continuity’). There were two phase transitions (i.e., transition from problem orientation to problem solution and transition from problem solution to solution evaluation) and therefore two items (2 items). Finally, the ‘quality of the final advice’ was evaluated by three items; number of concepts incorporated in the advice, financial consequence of the advice, and whether the final answer was in line with the guidelines provided in the original task description. All 41 items were coded as 0, 1 or 2; a ‘2’ was coded when the answer given was of high quality. Groups could, thus, achieve a maximum score of 82 points (41 \* 2 points). One-way MANOVA with Bonferroni post hoc analyses was used to analyze the effect of condition. Since there were specific directions of the results expected (see hypothesis) all analyses are one sided.

Table 2: Items and reliability for problem-solving performance ( $N = 31$ ).

Criteria	Description	Items	$\alpha$
Suitability	Whether the groups’ answers were suited to the different part-tasks.	9	.81
Elaboration	Number of different business-economics concepts or financial consequences incorporated in the answers to the different part-tasks.	9	.56
Justification	Whether the groups justified their answers to the different part-tasks.	9	.71
Correctness	Whether the groups used the business-economics concepts and their interrelationships correctly in their answers to the different part-tasks.	9	.68
Continuity	Whether the groups made proper use of the answers from a prior problem phase.	2	.67
Quality advice	Whether the groups gave a proper final advice.	3	.76
	- Number of business-economics concepts incorporated in the advice.		
	- Number of financial consequences incorporated in the advice.		
	- Whether the final answer conformed to the guidelines provided.		
Total	Overall score on the collaborative problem performance	41	.92

## Results and Conclusions

One-way MANOVA on the total score of the problem solving performance showed a significant difference for condition ( $F(3,27)=4.38$ ,  $p=.01$ ). Bonferroni post hoc analyses revealed that groups in the match condition scored significantly higher than groups in both the conceptual ( $p=.01$ ;  $d=1.46$ ) and the simulation condition ( $p=.01$ ;  $d=1.48$ ). When the results for the dependent variables were considered separately, using one-way ANOVAs with Bonferroni post hoc analyses, condition effects were found for ‘justification’ ( $F(3,27)=4.85$ ,  $p=.01$ ) and ‘correctness’ ( $F(3,27)=3.97$ ,  $p=.01$ ). The mean scores indicate that there were two significant differences between conditions. First, groups in the match condition scored significantly higher on ‘justification’ than groups in both the conceptual condition ( $p=.01$ ;  $d=1.56$ ) and the simulation condition ( $p=.01$ ;  $d=1.56$ ). Second, groups in the match condition scored significantly higher on ‘correctness’ than groups in both the conceptual condition ( $p=.01$ ;  $d=3.97$ ) and the simulation condition ( $p=.03$ ;  $d=2.52$ ). Although expected, no significant differences were found between the match and the causal condition. Students in both conditions received the causal ontology (relevant concepts, solutions and their causal interrelationships), providing students the means to co-construct multiple qualitative perspectives on the knowledge domain. It seems, therefore,

important to recognize that causal reasoning is beneficial for collaborative problem-solving (e.g., Jonassen & Ionas, 2008).

Collaborative problem-solving in business economics is facilitated by an instructional design aimed at making the different part-tasks explicit, sequencing them properly, and foreseeing them with ontologically part-task congruent support in the representational tools. The complementary function of those different perspectives can gradually increase students understanding and, therefore, support them in solving a complex problem (see Ainsworth, 2006). That is, groups receiving ontologically congruent support for each part-task (i.e., match condition) gave more correct and justified answers to the part-tasks and came up with better final solutions to the problem than groups in the non-matched conditions. Future work is aimed at analyzing the chat-discussions and the constructed representations (i.e., concept maps) to gain more insight in the learning process itself and the lack of difference between the match condition and the causal condition. During the conference insight into students' discussions about the knowledge domain (i.e., concepts, principles, and procedures) will be presented.

### **Paper 3: Direct and Indirect Means of Scaffolding the Effective Use of Student-generated CMs in Economics Education**

Carmela Aprea, & Hermann G. Ebner

#### **Background and Aim**

Not only does the adjunctive presentation of diagrams, drawings, pictures and other forms of visualizations play a prominent role in everyday classroom practice, it is also a long-running issue in educational research (e.g., Ainsworth, 2006). With the growing popularity of cognitive and constructivist learning approaches, many scholars in the learning sciences have begun to suggest that the benefits of these adjuncts can be further intensified if students are prompted to generate their own graphical representations (e.g., concept maps). This conjecture seems to be corroborated by empirical findings in various content domains (e.g., science learning, teacher education, foreign language acquisition) and with different types of students such as primary school children and high school students (e.g., Nesbit & Adesope, 2006). However, besides the fact that only few studies address the question whether the benefits of student-constructed concept maps are transferable to the domain of economics education, the research literature is not conclusive, and in some studies even severe difficulties in using concept mapping as a learning tool are reported (e.g., Reader & Hammond, 1994). As the results of these studies suggest, one reason that might have caused these difficulties is students' (and teachers') lack of familiarity with these learning tools. Thus, beginners are easily overwhelmed by the demands of the concept mapping task. Against the background of these findings, it can be concluded that there is no such thing as a 'concept mapping finger-tip effect', but that some form of scaffolding might be required to ensure adequate tool use. One way of addressing this need is to provide students with a mapping training. Yet, the results of training studies (e.g., Chang, Sung, & Cheng, 2002) suggest that the success of this direct scaffolding method seems to be limited. At least in short time interventions, it proved helpful only for students with sufficient domain and strategic knowledge. However, students lacking such a level of prior knowledge seem to need additional support. Given the current debate on the social construction of cognition and learning (e.g., O'Donnell, Hmelo-Silver, & Erkens, 2006), a promising candidate for such an additional support is to embed the concept mapping task within a collaborative learning environment. For example, Roth and Roychoudhury (1993) assume that collaboratively constructed maps may provide an ideal context for overt negotiation of meaning and construction of knowledge, because they require individuals to externalize their propositional frameworks. Others (e.g., Jones & Issroff, 2005) have highlighted the motivational and affective support of collaborative learning. Congruently with De Simone, Schmid, and McEwan (2001), this adaptation of the learning environment is classified as an indirect form of scaffolding.

Given these suggestions, the aim of the research study to be presented in this paper was twofold, namely exploring (1) the impact of student-generated maps as tools for fostering conceptual knowledge acquisition and application in the domain of economics education, and (2) whether effective tool use can be facilitated by direct means (i.e., training) and/or indirect means (i.e., collaboration) of scaffolding.

#### **Method**

*Participants and intervention:* 169 students from two urban secondary level business schools participated in this study. Fifty percent of the students in the sample were female, and the mean age was 20 years. In order to address the research issues mentioned above, students were randomly assigned to one of three treatment groups: (1) Subjects of the first group (*text plus experimenter-provided graphic group*;  $n = 52$ ) received a text passage in combination with an already elaborated expert map. The text passage deals with the topic of environmental economics and contains about 1000 words. This treatment group was included to control for the general dual-coding effect of verbal and visual information provision. (2) Subjects of the second group (*individually mapping group*;  $n = 59$ ) firstly received a mapping training unit. This training unit was inspired by a cognitive

apprenticeship approach and consisted of three components: (a) a list of steps how to construct a concept map; (b) a short text passage to model map development; (c) a training text passage for coaching purposes. The content of these text passages was unrelated to the experimental text on environmental economics. After the training, the experimental text passage was handed out and students were asked to individually read the text, to identify the main ideas of the text and then to re-construct its content in a diagram. (3) As in the individually mapping group, subjects in the third group (*collaboratively mapping group*;  $n = 58$ ) received the mapping training and the environmental economics text passage without any visual adjunct. They were then asked to first read the text alone and make a preliminary sketch. After that, they were requested to discuss their sketches with a learning partner and to subsequently draw up a shared concept map.

**Hypotheses:** We hypothesized that the collaborative mapping treatment might lead to the best results in terms of cognitive learning outcomes, followed by the results of the individually mapping group and the results of the text plus experimenter-provided diagram group. Moreover, we supposed that collaborative mappers outperform the individual mapping group with respect to concept map quality.

**Data gathering:** An achievement test and a free recall test were used for assessing the cognitive learning outcomes. The achievement test (*Knowledge Acquisition Test*; KAT) included six mixed-format questions (multiple choice and open-ended). These questions mainly addressed detailed understanding and transfer of conceptual knowledge and encompassed content from the whole text passage. The KAT was administered twice, namely immediately after the instructional treatments (subsequently referred to as KAT1) and approximately three weeks later (subsequently referred to as KAT2). Likewise, about three weeks later, students were asked to write down all they could remember about the text. This *free recall test* (FRT) was intended to assess whether and to what extent students were able to remember the overall conceptual structure of the text. To account for map quality (MQ), we moreover evaluated accuracy, elaboration and organization of students' representations. In addition, we included students' general economic knowledge as a covariate by using several items from the Test of Economic Literacy (TEL) (Soper & Walstad, 1987).

**Data analysis:** All dependant measures (i.e. KAT1; KAT2; FRT, MQ) were submitted to one-way ANOVAs and post-hoc tests. These statistical procedures were conducted for (1) the whole sample as well as (2) for students with extremely high or low general economic knowledge as indicated by the TEL items.

## Results and Conclusions

Analyses of the *whole sample* showed that subjects from the collaborative mapping group significantly outperformed the text plus provided graphic group with respect to the FRT ( $F(2,142)=3.545, p<.05$ ). Moreover, these subjects constructed more accurate and elaborated concept maps than their individual mapping counterparts. On the other hand, individual mappers demonstrated a significantly better knowledge organization. None of the other outcome measures proved to be significant at the  $\alpha=.05$  level. Students with *low general economic knowledge* mirror the whole sample results with respect to the FRT and the MQ measures. Furthermore, collaborative mappers within this subgroup showed significantly better results on the KAT 1 than individual mappers ( $F(2,78)=3.841, p<.05$ ). With respect to this latter learning outcome measure the reverse holds for the subgroup of students with *high general economic knowledge* ( $F(2,25)= 3.231, p<.05$ ).

Since the data only partly reflect the expected effects, it cannot be concluded that concept mapping generally enhances students' knowledge acquisition and application in the domain of economics education. However, the results seem to reveal an important relationship between the means of scaffolding the mapping task on the one hand and learning outcomes as well as prior knowledge on the other. Thus, a more refined perspective on the operating conditions of concept mapping within our field of application might be needed. On the basis of the data, at least three directions for such refinements seem to be evident:

- (a) Firstly, the results give rise to the assumption that students who can be considered as high-achievers in terms of general economic knowledge seem to profit most from an individually concept mapping task in combination with a training. In contrast, collaboration seems to be particularly helpful with regard to supporting students with low economic knowledge scores. However, since the current design did not entail a non-trained control condition, a cautious interpretation of the findings is of course imperative. With this admonition in mind, it can be tentatively recommended to differentiate the means of scaffolding with respect to the prevailing learner characteristics.
- (b) Secondly, the results indicate that concept mapping in economics education seems to be of specific use for promoting long-term retention of overall conceptual knowledge structures, whereas no such long-term effect for the retention of text details could be found. In accordance with researchers of learner-generated graphical representations in other domains (e.g., Van Meter et al. 2006), we therefore deem it necessary to differentiate the effectiveness of concept mapping tasks with respect to intended learning outcomes.
- (c) Finally, along with De Simone, Schmid and McEwen (2001), we feel that in order to gain a deeper understanding of the specific benefits of concept mapping and the respective means of scaffolding we need to study in more depth the learning processes that are associated with the various treatment conditions as well as the interactions of students in the collaborative mapping group.

## Conclusions and further work

The contributions indicate that a learning tool as concept mapping enables students to represent their conceptual understanding of the knowledge domain and to discuss it with their peers. Actively engaging in such learning activities can foster the acquisition/retention and the application of domain knowledge (i.e., during problem-solving). Its effect are, however, not straightforward, what students can represent in the concept map should be carefully match with (1) the intended/desired learning process and learning outcome, (2) and students' prior knowledge. Future research is, therefore, required to gain more insight in how specific learning activities, leading to intended learning outcome, can be evoked and what role instruction exactly plays in supporting those kinds of learning activities.

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