Case-based Learning in a Virtual Professional Training – Collaborative Problem Solving Activities and Outcomes

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Abstract: This article deals with the analysis of the collaborative problem solving activities and the learning outcomes of five groups that had to solve two different complex cases. To measure the effects of the problem solving activities the learners' contributions were analysed in respect to four different problem solving activities. Results show that the learning process is dominated by two central activities. Furthermore the results prove that the groups show more overall problem solving activities within the more complex case than within the less complex case. The learning outcomes of the more complex case differ more between the groups than with the less complex case. At last it could also be shown that the overall problem-solving activities in most of the successful groups are higher than in the less successful groups. Additionally the more successful groups show more coordination-specific activities in the problem solving process than content-specific activities.

Objectives

Several studies have analyzed the problem solving activities in face-to-face groups. But this is not sufficiently investigated in virtual groups, yet. Therefore this article focuses on the analysis of the collaborative problem solving activities and the learning outcomes of five groups who participated in a virtual professional training while working on two different complex case tasks.

Theoretical Framework

Case-based learning as a problem-oriented learning method is more and more realized in professional trainings, particularly within virtual learning environments (Reinmann & Mandl, 2006). Case-based learning offers the possibility to work on authentic and complex problems (Heimerl & Loisel, 2005) and it has the intention to support the application and transfer of knowledge into real professional situations (Badke-Schaub & Frankenberger, 1999) which is especially emphasized by moderate constructivist approaches (Reinmann & Mandl, 2006). In our study, the problem-oriented learning method is characterized by two central aspects. Firstly, solving complex problems is crucial for acquiring knowledge in the collaborative learning situation as they have a large number of different cross-linked variables, and include novel situations as well as incomplete information. When solving such problems, learners are confronted with their daily professional practices which is motivating for their learning effort and thus for knowledge acquisition. Secondly, problem scenarios are presented as authentically and realistically as possible in order to depict the complexity of reality, to stimulate learners' prior knowledge, to acquire new knowledge with help of additional information needed to solve the problem, and to transfer this knowledge to new situations. The problem-oriented learning method was used to stimulate problem solving activities in collaboration.

Collaborative learning is a situation in which two or more persons learn or attempt to learn together (Dillenbourg, 1999). A virtual learning group is characterized by a computer supported communication which can take place synchronously or asynchronously. As an asynchronous medium the discussion forum allows small groups to work together more intensively on a certain task than within a synchronous medium (Gräsel, Bruhn, Mandl & Fischer, 1997). Additionally the asynchronous communication allows a time- and location-independent learning which is especially important for professional trainings. The term collaborative learning describes a variety of interactions between learners with the intention to achieve a common goal (Johnson & Johnson, 1996) defined by a task or problem that has to be solved together (Cohen, 1994).

As solving complex problems and working together in teams are part of our daily and professional life the way how to solve a problem collaboratively is of great interest. Different authors have proposed models for individual problem solving (e.g., Hayes, 1989; Putz-Osterloh, 1983). All these models contain a sequence of problem solving steps which should lead to successful problem solving. But how does problem solving turn out to be under collaborative conditions? Referring to the models of individual problem solving Wetzel (1995) has developed a model for problem solving in groups which considers apart from the problem solving activities for individuals certain collaborative activities for problem-solving in groups. According to Wetzel (1995) the following activities are of relevance for the collaborative problem solving process: The *content-specific problem solving activities* are important as an indication for content-relevant aspects. These are *"gathering information"* which means the collection and preparation of all information needed to solve a problem solving task (Mabry & Attridge, 1990) and *"developing a solution"* which includes the development of a problem solution on the basis

of the collected and prepared information (Resnick, Salomon, Zeitz, Wathen & Holowchak, 1993). Secondly the *coordination-specific problem solving activities* which are particular for problem solving in groups are of great importance to avoid process loss in coordination. These are *"planning the common proceeding"* (contributions concerning the distribution of tasks and the time planning) and *"steering the interaction process"* (contributions relevant for the whole proceeding during the problem solving task) (Wetzel, 1995).

Different studies in face-to-face groups could prove core-activities in a problem solving process (Stempfle & Badke-Schaub, 2002). The results show that content-specific as well as coordination-specific activities appear as definable steps in the problem solving process of groups. Accordingly, this study wants to answer the question how problem solving in groups turns out to be in a virtual learning environment while the groups were working on different complex case tasks.

Regarding the didactical design of case tasks different types of cases and different levels of complexity should be taken into consideration. There are two types of cases that are relevant for this study. One is the case-problem-method and the other is the real- or live-case-method (Heimerl & Loisel, 2005). Within the case-problem-method the problem and all relevant information are given. The focus lies on finding a problem solution. Within the live-case-method the learners have to bring in the problem as well as all information needed to solve the case themselves, e.g. out of their professional background. Another didactical aspect for designing cases is the degree of complexity (Grohmann, 1997). On the one hand there are "closed cases" which are characterized by detailed task instructions and concrete questions to structure the case tasks. On the other hand there are "open cases" where the learners have more freedom of action in solving the cases and the learning instructions are characterized by more open questions and less structured task descriptions.

To measure the success of the problem solving process, the results of the learning outcomes are of interest. For this study the following two qualities of knowledge are of relevance (De Jong, & Ferguson-Hessler, 1996): At first there is the "conceptual knowledge" which includes the knowledge and concepts referring to a certain domain, e.g. knowledge management. Secondly the "situative knowledge" refers to a specific problem situation. This kind of knowledge shows that the learner is able to identify the aspects which are necessary to solve a problem and which should finally help to apply the acquired knowledge in a similar problem situation.

The Virtual Professional Training

Object of the investigation was a virtual professional training on the topic of knowledge management for professionals in an automotive company. The intention of the virtual training was to impart theoretical concepts and models on the topic of knowledge management as well as practice-oriented knowledge by working on practical cases. The training was divided in four parts: two theoretical parts each composed of certain learning modules regarding the subject knowledge management and two collaborative parts in which the learners worked on their cases in their predefined virtual groups. The virtual training on the topic of knowledge management was didactically designed according to the principles of problem-oriented learning with the focus on the collaborative case tasks, namely authenticity and learning in a social context, multiple contexts and multiple perspectives, as well as instructional support.

The Cases in the Virtual Training

The first case "Metallina" was complied with the case-problem-method. This was a predetermined case taking place in the maintenance planning of a metal working company. Problem and information were given as well as detailed instructions for handling this case. The groups had the task to develop a solution to improve the knowledge management problem in the maintenance department of that company.

The second case was a real- or live-case-method. Real implies that the groups chose a case which presented a real knowledge management problem in their department or company, e.g. a knowledge sharing problem in a certain project. Information and problem of the cases were proposed by the group members themselves. Here the groups didn't get such a detailed instruction as for the first case. In comparison with the first case the task was less pre-structured and the learners got more open questions.

Technical Realization of the Virtual Training

The virtual training was realized on a web-based learning environment. On the learning platform the learners had access to the tutorials of the different learning modules and to protected working sections which were only accessible for the participants of a defined group. In this working section the groups got their case instructions and could work on their cases in their own discussion forums.

Research Questions

1. To what extent do problem solving activities exist in the two cases?
2. How do the problem solving activities differ in the two cases?
3. How successful were the two cases solved?
4. How do the groups' learning outcomes differ regarding the problem solving activities?

Method

Sample and Design

The investigation of this study refers to the 18 professionals of the virtual training on the topic of knowledge management. 14 participants were male and four were female. The average age was 38 years. The subjects formed three groups with three members, one with four and one with five members. One group dropped out after the first case "Metallina". So the data of that group couldn't be included for the analysis of the Real-Case.

Data Collection

For analysing the learning process the problem solving activities were divided in two categories "content-specific" and "coordination-specific" activities. The categories were analysed with a special coding scheme which included the two content-specific activities "*gathering information"* (e.g. „What do you exactly mean by that?") and "*developing a solution*" (e.g. "I agree with your suggestion to focus on the groups which are involved") as well as the two coordination-specific activities "*planning the common proceeding"* (e.g. „Who works on which part?") and "*steering the interaction process"* (e.g. „Please, look in the concept of our documentation"). The unit of analysis was one statement. The coding scheme was validated by a second evaluator who double-rated 20 per cent of all contributions. The interrater correlation was .84.

The learning outcomes were analysed according to the *conceptual* and *situative* knowledge with a specific analysis scheme and rating instrument. For the *conceptual knowledge* the experts evaluated the theoretical contributions in the case solutions. For every correct theoretical aspect the groups got one point. At the end all correct aspects were added. For the evaluation of the *situative knowledge* the degree of problem solving was rated by means of a six-scale between "not solved" and "exactly solved". Here the evaluator rated to what extent the offered solution was adequate to really solve the present case problem or not. The interrater correlations were .96 for measuring the conceptual knowledge and .98 for rating the situative knowledge.

Results

Research Question 1: Extent of Problem Solving Activities in the Two Cases

Regarding the problem solving activities during both cases, "developing a solution" and "steering the interaction process" were most important while "gathering information" and "planning the common proceeding" played a minor role in most of the groups.

Table 1. Problem solving activities of the case "Metallina" and the Real-Case in per cent.

	Gathering information		Developing a solution		Planning the common proceeding		Steering the interaction process	
Cases	Metallina	Real	Metallina	Real	Metallina	Real	Metallina	Real
Group 1	8.33	15.39	25.00	28.85	33.33	17.31	33.33	38.46
Group 2	23.53	28.85	29.41	40.00	23.53	20.00	23.53	25.00
Group 3	5.00	17.31	35.00	38.10	20.00	14.29	40.00	33.33
Group 4	11.77	38.46	47.06	36.36	11.77	18.18	29.41	40.91
Group 5	6.25		31.25	--	12.50	--	50.00	--

Research Question 2: Differences of Problem Solving Activities in the Two Cases

Looking at the absolute numbers of the problem solving activities the results in all groups apart from group 1 are almost similar in both cases (see table 2). Comparing the results of the two cases groups show more overall problem solving activities within the real-case than within the first case. This result confirms the assumption that a greater amount of problem solving activities is found within the second and more complex real-case due to the fact that a real problem situation has different and a larger amount of dependent variables.

Table 2. Content- and coordination-specific problem solving activities of the two cases in absolute numbers.

	Case "Metallina"		Real-Case	
	Content-specific	Coordination-specific	Content-specific	Coordination-specific
Group 1	12	24	23	29
Group 2	9	8	11	9
Group 3	8	12	11	10
Group 4	10	7	9	13
Group 5	6	10	--	--

Research Question 3: Outcomes of the Cases

Looking at the learning outcomes of the case "Metallina" (see table 3) all groups show similar results in respect to the conceptual and situative knowledge. Regarding the learning outcomes of the real-case the groups show a more heterogeneous picture concerning the conceptual and situative knowledge, which was assumed, because of e.g., a higher degree of complexity, and a less detailed instruction.

Table 3. Learning outcomes of the two cases in per cent.

	Case "Metallina"		Real-Case	
	Conceptual	Situative knowledge	Conceptual	Situative knowledge
Group 1	62.50	80.00	76.00	80.00
Group 2	52.50	60.00	24.00	40.00
Group 3	57.50	80.00	20.00	40.00
Group 4	47.50	60.00	52.00	60.00
Group 5	60.00	80.00	--	--

Research Question 4: Differences in Success and Problem Solving Activities

"Successful groups" are those groups which learning outcomes were over the groups' average in respect of the conceptual and the situative learning outcomes. For the first case these are groups 1, 3 and 5, for the Real-Cases these are the groups 1 and 4 (see table 4 and 5). The groups whose learning outcomes were below the groups' average are described as "less successful groups" (groups 2 and 4 for case "Metallina", groups 2 and 3 for Real-Cases). The successful groups show more problem-solving activities than the less successful groups in spite of group 5 for the case "Metallina". Furthermore, all successful groups in both cases show more coordination-specific activities than content-specific activities in comparison with the less successful groups.

Table 4. Problem solving activities for successful and less successful groups in absolute numbers ("Metallina").

	Successful groups			Less successful groups	
	Group 1	Group 3	Group 5	Group 2	Group 4
Content-specific	12	8	10	9	10
Coordination-specific	24	12	6	8	7

Table 5. Problem solving activities for successful and less successful groups in absolute numbers (Real-Case).

	Successful groups		Less successful groups	
	Group 1	Group 4	Group 2	Group 3
Content-specific	23	9	11	11
Coordination-specific	29	13	9	10

Summary of Results and Discussion

Overall this descriptive study could give an insight into the collaborative problem solving activities and learning outcomes of two different complex case tasks in a virtual learning environment. The main activities in both cases were *"developing a solution"* and *"steering the interaction process"*. The results show that also in virtual groups the core of certain problem solving activities can be found as it is already shown in face-to-face groups (Stempfle & Badke-Schaub, 2002). The importance of the activity *"developing a solution"* proves the relevance of the development of a common solution space within a collaborative task (Gruenfeld & Hollingshead, 1993). The importance of *"steering the interaction process"* could be due to the fact that the professional training took part in a virtual room that requires more coordination than face-to-face situations (Fischer & Waibel, 2002). This could be explained with the missing non-verbal and paraverbal signals in virtual learning environments (Kiesler, Siegel & McGuire, 1984). Furthermore according to the expectations the groups show a greater amount of problem solving activities within the real-case than within the first case which supports the thesis that a more complex real-case with many interdependent variables requires more activities to solve the problem.

Regarding the learning outcomes, the results were more heterogeneous within the real-case than within the case "Metallina" as assumed. That shows that a more complex case from the professional context of the participants is related with higher requirements for the learners (Gruenfeld & Hollingshead, 1993). Furthermore it has to be taken into consideration that the self-chosen real-cases differed in their level of complexity. This could be a reason why the learners within a less complex case did not refer to as much theoretical concepts.

The assumption that the successful groups show more problem solving activities than the less successful groups could be proven for most of the groups in both cases. Additionally a pattern was found that

the successful groups show more coordination-specific activities than content-specific activities. This result shows the relevance of coordination-specific activities for successful problem solving in virtual groups.

In terms of limitations of this investigation further studies with bigger samples could show if there can be found certain similarities regarding the problem solving activities in virtual groups as well as in other virtual settings. Additionally bigger samples would allow finding correlations between single problem solving activities and the learning outcomes. Limitations of this study can also be seen in the comparability of the real-cases the groups had to choose by themselves. Therefore in further studies there should be more focus on the level of complexity of the different real-cases giving more instructions regarding content, structure or size.

Furthermore on a didactical level the learners could be supported with scripts that could help them with strategies to solve the cases. Additionally with social scripts the coordination activities which were very high in both cases could be reduced in support of more content-related activities. Finally it could be recommended for virtual trainings of this kind to integrate classroom courses in terms of a blended learning concept. This would on the one hand allow the group members to get to know each other as well as to clarify certain questions, e.g. regarding content and responsibilities of the case tasks face-to-face. On the other hand the learners could get more instructional support during the classroom courses to help them solving the cases.

Importance of Study and Outlook

Case-based learning in virtual learning environments especially within professional trainings allows working on authentic and complex problems in a social context. Regarding the collaborative learning in virtual environments there is further research needed. This study is a contribution to the analysis of certain problem solving activities in virtual groups while they were working on different complex cases as well as to their learning outcomes. Furthermore the study could make a methodical contribution to the analysis of problem solving activities in virtual groups as it is already investigated in face-to-face groups. Additional studies should show if the results of this study can be transferred to other virtual settings and into other domains.

References

Badke-Schaub, P. & Frankenberger, E. (1999) Analysis of design projects, *Design Studies*, 20, 481-494.

Cohen, E. G. (1994). Restructuring the classroom: Conditions for productive small groups. *Review of Educational Research*, 64, 1-35.

Dillenbourg, P. (1999). Introduction: What do you mean by 'collaborative learning'? In P. Dillenbourg (Ed.), *Collaborative learning: Cognitive and computational appraoches* (pp. 1-15). Oxford: Elsevier.

De Jong, T. & Ferguson-Hessler, M. G. M. (1996). Types and qualities of knowledge. *Educational Psychologist*, 31 (2), 105-113.

Gräsel, C., Bruhn, J., Mandl, H. & Fischer, F. (1997). Lernen mit Computernetzen aus konstruktivistischer Perspektive. *Unterrichtswissenschaft*, 25 (1), 4-18.

Grohmann, S. (1997). Die Fallmethode. Theoretische Grundlagen. In J. Aff & M. Wagner (Hrsg.), *Methodische Bausteine der Wirtschaftsdidaktik*. Wien: Manz.

Gruenfeld, D. H. & Hollingshead, A. B. (1993). Sociocognition in work groups: The evolution of group integrative complexity and its relation to task performance. *Small Group Research*, 24, 383-405.

Hayes, J. R. (1989). *The complete problem solver*. Hillsdale: Erlbaum.

Heimerl, P. & Loisel, O. (2005). *Lernen mit Fallstudien in der Organisations- und Personalentwicklung: Anwendungen, Fälle und Lösungshinweise*. Wien: Linde.

Johnson, R. T. & Johnson, D. W. (1996). Cooperation and the use of technology. In D.H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 1017-1044). New York: Macmillan.

Kiesler, S., Siegel, J. & McGuire, T. W. (1984). Social psychological aspects of computer-mediated communication. *American Psychologist*, 39 (10), 1123-1134.

Mabry, E. A. & Attridge, M. D. (1990). Small group interaction and outcome correlates for structured and unstructured tasks. *Small Group Research*, 21, 315-332.

Putz-Osterloh, W. (1983). Über Determinanten komplexer Problemlöseleistungen und Möglichkeiten zu ihrer Erfassung. *Sprache und Kognition*, 2, 100-116.

Reinmann, G. & Mandl, H. (2006). Unterrichten und Lernumgebungen gestalten. In A. Krapp & B. Weidenmann (Hrsg.), *Pädagogische Psychologie* (S. 613-658). Weinheim: Beltz PVU.

Resnick, L. B., Salmon, M., Zeitz, C. M., Wathen, S. H. & Holowchak, M. (1993). Reasoning in conversation. *Cognition and Instruction*, 11, 347-364.

Stempfle, J. & Badke-Schaub, P. (2002). Kommunikation und Problemlösen in Gruppen: eine Prozessanalyse. *Gruppendynamik und Organisationsberatung*, 33 (1), 57-81.

Wetzel, J. (1995). *Problemlösen in Gruppen: Auswirkungen von psychologischen Trainingsmaßnahmen und Expertenbeteiligung unter kooperativen und kompetitiven Arbeitsbedingungen*. Dissertation. Technische Universität Carolo-Wilhelmina, Braunschweig.