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SYNTHESIZING SOCIAL CONSTRUCTION OF KNOWLEDGE IN ONLINE CONFERENCES USING CONCEPT MAPS

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Abstract. By using content analysis techniques to compare social construction of knowledge in online dialogues to concept maps generated to synthesize this knowledge construction, this study showed that concept maps are an effective tool to synthesize knowledge construction in online conferences. This finding was also supported by self-reported data in a moderator survey. Concept maps were also considered an effective tool for organizing information which indicates that they can be utilized as a knowledge management and preservation tool in online conferences. All students perceived that the Cmap tool software could be used as a tool to foster online collaborative learning in distance education. While it is possible to use concept maps as a collaborative tool, it is important to provide training not only in the use of the software but also on how to collaborate using concept maps in an online environment. In this study, participants were able to generate, save, and post concept maps in the online environment. We also found that students with low technology experience and no previous knowledge of concept maps can learn how to use the tool with a few hours of training and ongoing support during the semester.

1 Introduction

Networked learning facilitated by computer-mediated communication (CMC) using the Internet and the World Wide Web has shown a dramatic increase during the last five years. Research has begun to investigate the effects of CMC on learning and communication among students and between instructors and students. Recently, a number of studies have examined how to design effective online distance learning environments that encourage collaborative learning (Barab & Duffy, 2000; Palincsar & Herrenkohl, 2002; Gunawardena, Jennings, Ortegano-Layne, Frechette, Carabajal, Lindemann & Mummert, 2004). These studies have pointed out the challenges of designing and facilitating collaborative learning which Dillenbourg (1999) defined as learning that takes place in a group setting, where members work together at the same time to construct knowledge, without division of labor. One of the challenges pointed out by research indicates the need to develop instructional strategies and methods that can effectively map and synthesize the vast number and diversity of ideas that are generated during online collaborative learning activities so that groups can engage in the social construction of knowledge.

Coffey and Cañas (2000) affirm that in online distance education, interactive concept maps might be used as learning tools to produce effective learning, especially in learning activities where students in groups can promote the co-construction of knowledge using mapping techniques. Constructivist theory argues that new knowledge should be integrated into existing structures in order to be remembered and be meaningful (Jonassen, 1993). Concept maps simulate this knowledge integration process by making knowledge explicit and by requiring the learner to pay attention to the relationship between concepts (Plotnick, 1997; Gaines & Shaw, 1995). However, only a limited number of studies have looked at concept maps in online collaborative learning environments, and examined the use of concept mapping techniques to solve problems in the distance education context (Kremer & Gaines, 1997; Cañas, et al., 1997; Cañas et al., in press; Stoyanov & Kommers, 1999). Studies have yet to investigate how concept maps can be used to synthesize knowledge construction that occurs in an online collaborative learning environment.

2 The Purpose of This Study and Research Questions

The purpose of this study was to determine whether concept maps can be used to synthesize knowledge construction in online conferences and to determine if the moderators who lead online discussions and use concept maps find them to be a worthwhile tool. Two research questions guided the study: 1) How did the concept maps generated by the moderators to synthesize knowledge construction that occurred in an online text-based conference relate to the actual social construction of knowledge that occurred?; 2) How did the moderators perceive the usefulness of concept maps for: a) synthesizing ideas, b) organizing the group contributions, c) communicating ideas, d) working in collaboration, and e) enhancing collaborative learning in a distance education context.

3 Methods

The study design was predominantly qualitative using in-depth transcript and concept map analysis. We examined online conferences during a semester in order to identify and describe how collaborative concept maps generated by student moderators synthesized the knowledge construction that occurred among class participants in the online text-based conferences. Three sources of data were analyzed: a) computer transcripts generated by the online community while participating in discussions moderated by small groups of students, b) concept maps generated by the student moderators to synthesize knowledge construction that occurred in the discussions, and c) an online moderator survey soliciting student moderator opinions on the use of concept maps.

3.1 Participants

The subjects for this study were fourteen students enrolled in a graduate course on the theory and practice of distance education at a Southwestern University in the United States, during the Fall 2003 semester. The majority of the group (71%) did not have previous experience in concept maps and they were not familiar with software that generates concept maps. Twenty six percent knew what a concept map was but had never generated one. Those same 26% knew about Inspiration software but only one (6%) knew how to use it.

3.2 Instruments and Data Analysis

In order to answer the first research question, text transcripts of three two-week long computer conferences were compared with concept maps generated by moderators of these three conferences . The text-based computer transcripts were analyzed using the Gunawardena, Lowe and Anderson (1997) five phase model of content analysis that describes steps in the social construction of knowledge. The phases are: I. Sharing/Comparing of Information; II. The discovery and exploration of dissonance or inconsistency among ideas, concepts or statements; III. Negotiation of meaning/co-construction of knowledge; IV. Testing and modification of proposed synthesis or co-construction; and V. Agreement statement(s)/applications of newly constructed meaning. The unit of analysis was the message. Sometimes one message was assigned two codes, because we observed that one unit contains more than one meaning that contributes to the co-construction of knowledge. Three codes were added to the five phase model to reflect a) socio-affective statements that seemed to offer the motivation for knowledge construction that predominantly occurred in Phase I, b) statements based on authors' ideas paraphrasing and/or using citations coded in Phase I, and c) elaborations and reflections based on participants' own or authors' ideas that occurred predominantly in Phase II. The content analysis method identified strategies that the group used during the social construction of knowledge, and examined the negotiation of meaning that occurred in the online conferences. Concept map propositions were compared with the categories that emerged from the transcript analysis to determine how the maps generated showed the social construction of knowledge that occurred. Trustworthiness and confirmability were established through a verification process with participants using the responses to a moderator survey. Thus, data was triangulated using the categories that emerged from the transcript analysis, the concept map propositions, and the moderator survey.

In order to answer the second research question, data was gathered from an online moderator survey administered after the groups had finished their roles as moderators. Content validity of the survey was determined by using an expert's judgment on each survey item. The expert was a researcher with more than 12 years of experience in distance education. The online survey administered via the WebCT platform consisted of five open-ended questions. Its purpose was to obtain self-reported information about students' experiences using concept maps to organize, communicate, and work collaboratively in summarizing the knowledge construction that occurred in the online discussion that they moderated. Content analysis using the qualitative analysis software package ATLASti v.4.2 was used to derive categories and codes from the moderator self reports. The results obtained from research questions one and two were triangulated to identify correspondence between transcript analyses, concept maps and the moderators' survey results. The triangulation method would identify the usefulness of using concept maps to synthesize group ideas as well as allow us to determine if students were able to develop concept maps in a group to organize and communicate ideas, work in collaboration, and enhance collaborative learning in distance education.

3.3 Procedures

Before beginning the study, the online course was designed using the WebCT learning management system based on a community of practice instructional design model called the Final Outcome Centered Around Learner (FOCAL) model (Gunawardena et al., 2004). FOCAL is a model based on constructivist and socio-

constructivist paradigms and distance education principles for the design of online wisdom communities. FOCAL focuses on the process of learning as well as the product. This instructional design model supports the idea that all learners will socially construct their knowledge by interaction with each other in an online social context. In two face-to-face classes at the beginning of the semester, all students were trained on concept mapping techniques using CmapTools v.3 software (Cañas *et al*., 2003). The software was created and developed by the Institute for Human and Machine Cognition (IHMC). This software has been licensed by IHMC UWF in a free Beta version and was provided for educational and non-profit use only. CmapTools empowers users to construct, navigate, share, and criticize knowledge models represented as concept maps. The tools are platform-independent and network-enabled, allowing the users to build and collaborate during the construction of concept maps with colleagues anywhere on the network, and share and navigate through others' models distributed on servers throughout the Internet (IHMC, 2003). Student moderators who were responsible for conducting the discussions were required to post a narrative summary of the discussion and a concept map synthesizing the knowledge construction that occurred during the discussion that they moderated.

4 Results and Discussion

4.1 Research Question 1

The first research question examined how the concept maps generated by student moderators to synthesize knowledge construction related to the actual social construction of knowledge that occurred. A total of five computer conferences were moderated by groups of students. From those, three conferences were selected and analyzed. The computer conferences selected were: 1) Transactional Distance, because it was the first computer conference moderated by students; 2) Social Presence, because it was conducted at the middle term of the semester; and 3) Learner Support, because it was the final conference in the semester. The decision to choose conferences based on the time they occurred during the course of the semester was because we theorized that the social construction of knowledge was different at different times during the semester. We hypothesized that because time must be a variable that influences the groups' cohesion, close relationships and familiarity between group members would increase over time and affect the co-construction of knowledge.

4.1.1 Computer conference: Transactional Distance

Transactional Distance was the first conference moderated by a group of three students. Table 1 indicates the results from the analysis of the computer transcript to determine knowledge construction. It can be seen that the majority of messages during the two weeks are located in Phase I, the sharing and comparing of information. It was observed that the moderators used questioning techniques which caused the whole group to 'ask and answer questions' in a pattern of interaction. Table 1 shows the presence of many socio-affective behaviors during the first week and a decline of these in the second week (from 28 to 12). It appears as though there was a need for the group to build the appropriate social environment before they could begin discussing issues related to the topic and engage in knowledge construction. During the second week students questioned less and demonstrated more negotiation skills. Table I also indicates that there were a considerable number of messages in Phase III, the negotiation of meaning and co-construction of knowledge.

Phases	**Codes**	**Week 1**	**Week 2**	**Totals**
I. Sharing/ Comparing of	PhI/A	8	10	18
Information	PhI/B	10	4	14
	PhI/C	0	1	1
	PhI/D	30	18	48
	PhI/E	6	0	6
* Socio affective/share personal experiences	PhI/F	28	12	40
* Statements based on authors' ideas	PhI/G	4	1	5
II. The discovery and exploration	PhII/A	1	1	2
of dissonance or inconsistency among	PhII/B	0	0	0
Ideas	PhII/C	0	2	2
* Elaborations based on participants or authors ideas	PhII/D	0	2	3
III. Negotiation of meaning/co-	PhIII/A	0	7	7
construction of knowledge	PhIII/B	1	3	4
	PhIII/C	0	3	3
	PhIII/D	5	3	8
	PhIII/E	3	4	7
IV. Testing and modification of	PhIV/A	0	0	0

Proposed synthesis or co-construction	PhIV/B	4	2	6
	PhIV/C	6	12	18
	PhIV/D	0	0	0
	PhIV/E	0	2	2
V. Agreement statements(s)/ application of newly constructed meaning	PhV/A	6	10	16
	PhV/B	1	1	2
	PhV/C	0	10	10
Totals		113	108	222

Table 1: Social construction of knowledge on Transactional Distance

In order to compare if the moderators were able to summarize the social construction of knowledge that occurred in a computer conference, all messages that fell into phases III, IV and V of the model were identified and extracted. Correspondence between the knowledge socially constructed in the computer conference and the concepts and propositions used by the moderators to summarize the knowledge construction that occurred using a concept map are shown in Table 2. The correspondence between the concepts and propositions in the transcript, and the concepts and propositions generated in the concept map are indicated by numbers in the concept map see Figure 1.

Phase	**Concepts and propositions in the text-based transcript**		**Concepts and propositions in the concept map**
Ph4/C	Transactional distance (TD) could be decreased when learners and instructors look for the balance between dialogue and structure	1 & 2	TD in a DE community of learners involves a balance of: Structure and Dialogue
Ph4/C	The course design imposes some structure in term of assignments to complete but the learners have some flexibility to choose what to learn	3	Structure includes Flexibility
Ph4/C	Time is an important determining factor in the relationship between structure and dialogue. While time is passing the learner will increase dialogue and the course structure should be perceived as less rigid	4	Structure includes time
Ph3/A	TD depends on the familiarly with the medium, once the learner becomes familiar with the interface and the medium it will lead to a decrease in the perceived course structure.	5	Structure includes Medium

Table 2: Example of correspondence between concepts and propositions used in the concept map to summarize the text-based discussion on: Transactional distance and control

Figure 1 shows the concept map generated by this group. The analysis of this concept map indicated that all nodes represented were conceptually emphasized and generated by the online group. This group classified their concepts using color to facilitate the visualization of the diverse concepts that emerged from the main concepts discussed. As observed in the map, these main concepts were bolded and represented in various shapes to easily differentiate them from the sub-concepts derived from the main ones. As observed from the map and from the content analysis of the transcript, four main concepts were discussed: structure (1), dialogue (2), autonomy (11) and control (15). Throughout the discussion it was noted that the main emphasis was on the negotiation about how these issues needed to be balanced and planned in order to decrease or lessen the transactional distance. However, this group did not use the necessary links and linkwords to represent the complexity of the knowledge socially constructed by the group. As a result, the map appeared very simplistic in comparison with the propositions found in the transcripts. It appeared that the group put the most effort in representing the main concepts and grouping ideas under each main concept represented.

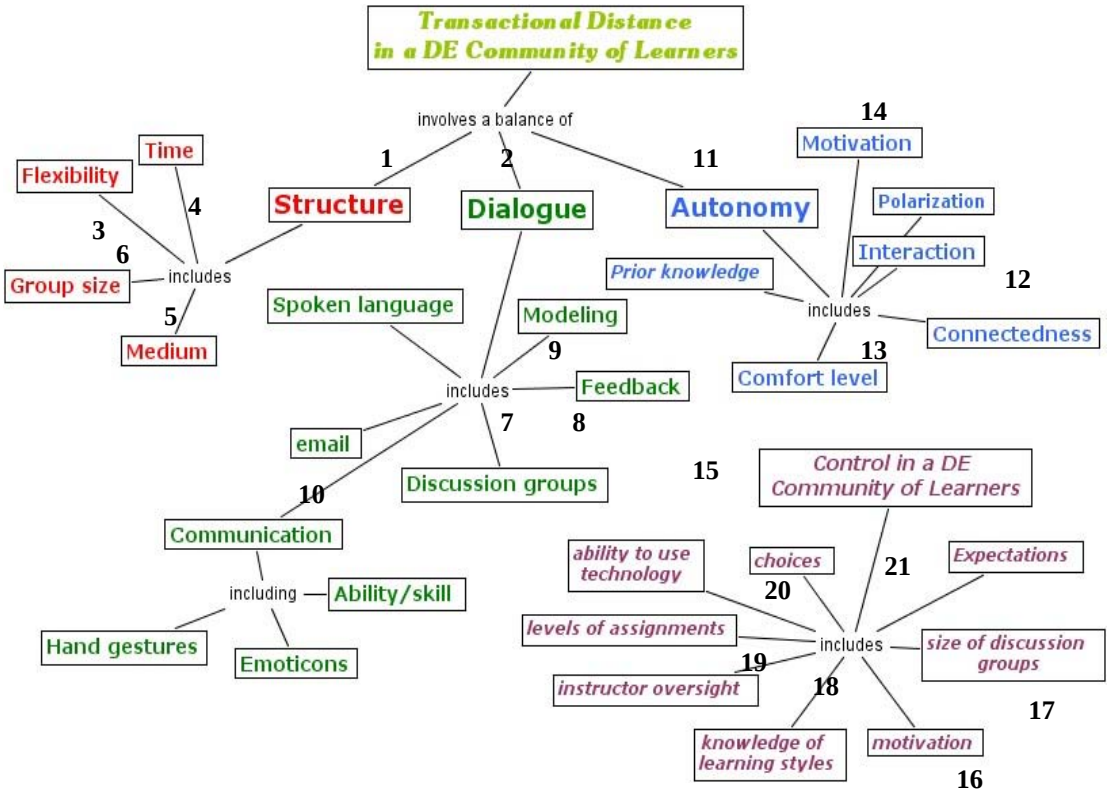

Figure 1. Concept map synthesizing social construction of knowledge in the Transactional Distance computer conference

4.1.2 Computer conference: Social Presence

The conference entitled "Social Presence" was moderated by three students. This group decided to implement a different format for the computer discussion. They divided the group into three subgroups of four participants randomly assigning students to each group. Each member of the moderating group took the responsibility of moderating a small group under the same conditions, i.e., using the same set of questions and communication strategies. A total of 141 messages were generated in the three groups. In order to determine if the moderators summarized the social construction of knowledge that occurred using a concept map, results from the content analysis of the computer transcript were compared with the propositions generated in the concept map. The lists of concepts and propositions that were generated in phases III to V, and the propositions in the concept maps that corresponded to these propositions, are contained in Table 3. Proposition numbers in Table 3 correspond to those numbers found in the concept map in Figure 2, and both the table and figure should be read together.

The collaborative generation of the concept map allowed this group to extend the social construction of knowledge to the importance of using an icebreaker to create social presence, and its close relationship with cultural issues in an online environment. This extension was incorporated into their concept map, suggesting that cultural issues that cross cultural boundaries could be used as icebreakers, e.g. using sounds, food, recipe exchanges, family, last vacation, among others already mentioned. Another extension was the connection made by relating cultural issues with what is considered personal; a normal degree of self-disclosure. The final extension showed that cultural issues need to be considered when using use icebreakers and that certain topics such as social status, religion, politics, and sports, must be avoided.

In general, the map summarized and synthesized the knowledge constructed by the three subgroups. The construction of this concept map was a more complex activity than the first concept map as three discussions were synthesized in one concept map. Group 2 also showed the extension of ideas related to culture while creating the concept map, thereby sharing that the collaborative construction of a concept map can extend knowledge construction in computer conferences.

Phase	Concepts and propositions in the transcripts	Concepts and propositions in the concept map	
Ph4/C			
	4.2 Strategies to generate social presence	1	Social presence attempted to create with an icebreaker
	Icebreakers are important at the beginning and through the course to generate social presence	2	Icebreaker created SP? Yes, especially at the beginning
		3	But also throughout the course
Ph4/C	Types of icebreakers		
		4	Icebreaker brought up cultural issues (extension)
		5	Moderators provided suggestions for icebreakers that cross-cultural boundaries: (extension)
Ph5/B			
	Pet/animals stories	6	Pet/animals stories
	Sound	7	Sound
	Food (favorites, recipes)	8	Food (favorites, recipes)
	Photos	9	Photos
	Family	10	Family
	Last vacation	11	Last vacation
	Jokes	12	Jokes
	Special moment	13	Special moment
	backgrounds	14	backgrounds

Table 3: Example of correspondence between concepts and propositions used in the concept map to summarize the computer conference: Social presence

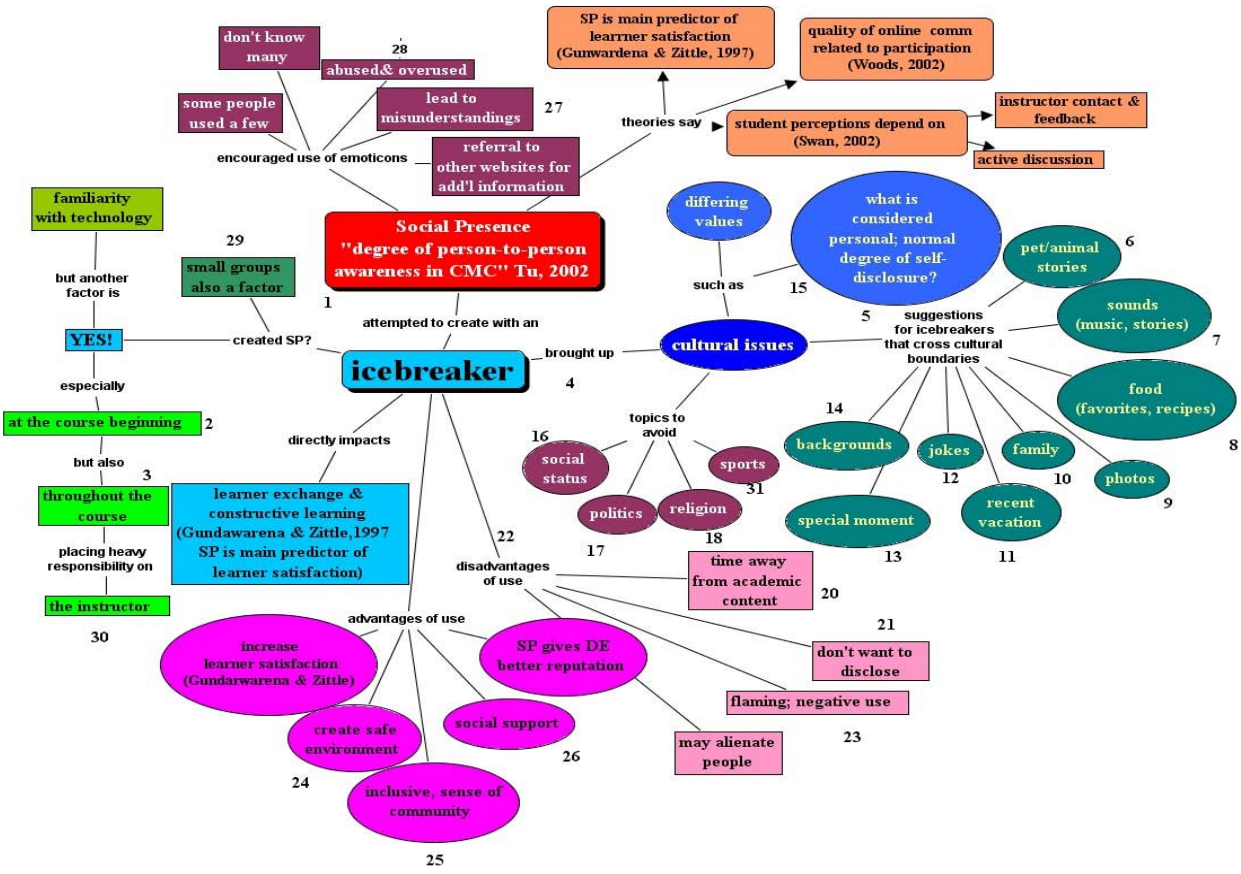

Figure 2. Concept map synthesizing social construction of knowledge in the Social Presence computer conference

4.2.1 Computer Conference: Learner Support

The four moderators divided the whole group into two subgroups with two moderators per subgroup. The moderators proposed a role playing scenario to solve learner support issues in a distance education context. The scenario was focused on creating an online disease prevention program for a rural community. They assigned a role to each participant, to wit: designers, administrators, instructors, and students. A total of 145 messages were generated. Group A generated 37 messages during the first week, while Group B generated 50 messages. During the second week all groups met together to respond to a common question in a common space. They generated 58 messages together. All discussions in Groups A and B ended the first week discussion with very detailed summaries (written and concept maps) that synthesized the main ideas proposed by each group. All groups agreed that these summaries helped them to go further in the activities proposed for the discussion in the second week.

During the second week both groups were back together in the same discussion environment to solve a common problem. The second week's discussion was characterized as moving toward phases III and IV. Conference participants also posted many new ideas, supported by the reading and instructional materials. By the end of the second week, the group was starting to summarize their agreements, moving toward phase V. The transcript analysis provided evidence that the groups socially constructed knowledge and approached the higher phases of the Gunawardena, et. al. model. The concept maps generated synthesized the social construction of knowledge that occurred in the group discussion. Overall, the learner support discussion indicated that the group was cohesive and created a sense of online community. This group's transcript analysis results and concept map are not presented in this paper because of space limitations.

4.3 Research Question 2

This question examined how moderators perceived the usefulness of concept maps for: synthesizing ideas; organizing the group contributions; communicating ideas; working in collaboration; and enhancing collaborative learning in a distance education context. After analyzing the responses provided by the students in the moderators' survey, it was observed that all groups perceived the usefulness of using concept maps for two main areas: 1) synthesizing and 2) organizing online computer conferences. All students agreed that the use of concept maps was an important information management tool, especially given the considerable amount of information generated (between 80 to 145 messages). It was also evident that the groups did not use CmapTools v3. software as a communication tool nor a collaboration tool in the online environment. Only the group that discussed social presence, showed one attempt to collaborate using the facilities of the CmapTools software, opening a discussion thread in the concept map created, although they recognized that they agreed about their ideas in previous face-to-face meetings. This group preference could suggest that they must be trained not only on how to use concept maps, but on how to communicate and collaborate using a concept map as a base.

This analysis served as a source of information to determine to what degree groups used CmapTools to communicate and to collaborate. However, it should be emphasized here that the use of Cmap to communicate and collaborate was not a mandatory task. Reasons given by the groups for not using the software in this way were first and foremost because of the complexity of using concept maps as a base for online group communication. They recognized that it was time consuming to try to interact using a concept map as the main communication tool, and also found that they were most comfortable interacting in face-to-face meetings. Another reason the groups gave for not using Cmap in this manner was the technology, which they argued necessitated their computer having specific hardware characteristics to support the use of the software. Students also felt overwhelmed with simultaneously learning content, dealing with technology, and working with concept maps all. It is argued that the generation of online communication based on concept maps is a complex process that takes time to develop and assimilate. All groups were asked for opinions about the use of web-based concept maps to enhance collaborative learning in distance education. Despite the difficulties cited above, a majority of the groups agreed Cmaps could be useful for enhancing collaborative learning (79%).

5 Conclusions

By comparing social construction of knowledge in text based dialogues to concept maps generated to synthesize this knowledge construction, this study showed that concept maps are an effective tool to synthesize knowledge construction in online conferences. This finding was also supported by self-reported data in a moderator survey. Concept maps were also considered an effective tool for organizing information which indicates that concept maps can be utilized as a knowledge management and preservation tool in online conferences. However, most of the students who participated in this study used concept maps to communicate ideas and collaborate among

their small groups in the face-to-face situation, instead of in the online environment. Even though students did not explore the CmapTools facilities in the online environment, they acknowledged that Cmap would be a powerful tool to encourage and foster collaborative learning in online distance education courses. One main finding was that collaborative construction of a concept map could extend knowledge construction in computer conferences, as observed in the group that moderated and summarized the social presence computer conference. We observed that collaboration using concept maps requires individuals to integrate each other's ideas using a higher level of thinking. That process is complex, requiring skill and time which may not be readily available in a semester long course. While it is possible to use concept maps as a collaborative tool, it is important to provide training not only in the use of the software but also on how to collaborate using concept maps in an online environment. In this study, participants were able to generate, save, and post concept maps in the online discussion environment, but they used them as a collaborative communicative tool in face-to-face situation. It is recommended to replicate similar studies where face-to-face is not an option, to better understand the usefulness of the web-based concept maps in foster collaborative learning in online setting. We also found that students with low technology experience and no previous knowledge about concept maps can learn how to use the tool with a few hours of training and ongoing support during the semester. The future bodes well for continued investigation of the use of web-based concept mapping techniques to support many forms of online collaborative learning, especially when those techniques are used in a collaborative problem solving situation.

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