The Use of Concept Maps in Knowledge Organization: An Analysis of Conference Papers†*

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Alon Friedman started his work on concept maps and classification when entering his LIU Ph.D. program in 2002. In 2004, he presented his first paper on concept maps based on Frege's and Austin's philosophical perspective to the Long Island Philosophy Society (LIPS). In 2006, he presented a paper at the 9th ISKO Conference in Vienna Austria on authors' use of concept maps in their conference papers. The framework of his work was based on Peirce's theory of "sign." In 2008 his paper was published at the third Concept Map Conference (CMC). He is currently teaching in the New York City area.

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ABSTRACT: Concept mapping is a technique for representing knowledge in graphic form. It is often used in academic conference papers by professionals in the field of knowledge organization. By examining the entire run of conference proceedings from ISKO and ASIS SIG/CR, looking specifically at the nationality and professional occupation of the authors who used concept maps in their papers, this study analyzes how concept maps have been implemented. A total of 652 papers and 327 concept maps were examined, from nine volumes of ISKO conference proceedings and thirteen volumes of ASIS SIG/CR conference proceedings. In addition, I applied Dahlberg's classification in order to better understand the nature my findings. I found that Dahlberg's "object" category covers the majority of titles and concept maps found in the proceedings. Future studies need to address how concept maps used by researchers can be organized to support retrieval.

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1.0 Introduction

Concept mapping provides visual representation of knowledge structures and argument forms. It has provided visual representation of knowledge structures in academic and business settings since the late 1930s. Concept mapping has mostly been employed to facilitate collaborative learning in the educational paradigm. Friedman (2006) found that concept mapping is used frequently in academic conference proceedings by scholars of knowledge organization. He examined the Sixth and Eighth ISKO conference proceedings and discovered that the technique has become a standardized procedure in the field.

Scholars define the field of knowledge organization as one that specializes in the arrangement and retrieval of concepts and knowledge. According to Dahlberg (2006, 1995 and 1983), knowledge units are the core of the theoretical examination of knowledge organization. Concept mapping is a technique for visualizing the relationships among concepts. In this study, concept maps were used as a focal point for examining how academic scholars in the field of knowledge organization represent knowledge units (i.e.,

concepts). Given the growing popularity of concept mapping, I applied Dahlberg's classification system to examine the titles of the papers and the titles of the concept maps that authors used to illustrate their findings. I proposed the following three questions:

1. How do scholars represent concepts using concept maps?
2. How can knowledge units (i.e. concepts) contained in the maps be classified?
3. Do national or professional differences influence the way concepts are mapped?

I believe that by addressing these questions, we will better understand the value of concept maps in representing academic knowledge.

2.0 Background

The term "concept map" was developed by Novak and Gowin (1984) who aimed to provide a better tool for lecturers, teachers, and their students. Their definition employs three key terms: concept, proposition, and learning. According to them, the label stands for a single word, although sometimes we can use symbols such as "+" or "%." Propositions are statements about some object(s) or event(s) in the universe. They can be either naturally occurring or constructed. They contain two or more concepts that are connected with other words to form a meaningful statement. Sometimes these are called semantic units or units of meaning. The term "learning," according to Novak and Gowin, stresses the important role of prior knowledge in students' acquisition of new concepts. However, Novak and Gowin do not refer to the use of concept maps by academic researchers, nor do they address how to classify the titles of maps. Concept mapping has mostly been employed to facilitate collaborative learning in the field of education (Roth 1994; Roth and Roychoudhury 1994). However, other fields also examine the use and nature of concept maps. In the history of science, concept maps have been used to represent the processes of conceptual change in scientific revolutions (Nersessian 1989; Thadgard, 1992). In the philosophy of science, Toulmin (1958) developed a theory of scientific argument based on typed concept maps, which are regarded as one of the major themes of the rhetoric of western thought (Golden, Berquist and Coleman 1976). In the field of computer science, Sowa (2000) examined the nature of concept maps in Artificial Intelligence. And in the field of knowledge organization, Priss (2004) has studied the nature of concept maps and developed a methodology of concept mapping with regard to programming languages.

The field of knowledge organization facilitates the arrangement of knowledge to assist its retrieval. A more precise definition is provided by Smiraglia (2005); according to him, knowledge organization involves the "ordering of what is known," particularly for information retrieval. Nowadays, with the increasing variety of non-printed material, including electronic documents, sound, images and maps that carry intellectual and physical properties, defining the field of knowledge organization has become more complex. In addition, according to Andersen and Skouving (2006), the field of knowledge organization cannot be known only for its principles and rules; it needs to be recognized as a human and social activity. According to Hjørland (2003), the term knowledge organization means the organization of information in bibliographic recordings, including citation indexes, full-text records, and electronic documents over the Internet. Dahlberg (2006) provides a different understanding, stating that the field of knowledge organization needs to be concerned with the structuring and systematic arrangement of concepts or knowledge units. This structure is completed by assigning value to inherent knowledge elements according to the contents of referents of all kinds. As a technique, studying concept maps provides a lens for examining how knowledge units are represented by academic scholars in the field knowledge organization.

3.0 Methodology

I examined the entire contents of the volumes of conference proceedings of two conferences that took place between 1990 and 2006: a total of 22 meetings, during which 642 papers were presented, containing 327 concept maps. In order for a concept map to count in the study, it must present text, image, and links that illustrate the relationship between the nodes and arcs in the map. The arcs represent the type of relationship between the nodes they represent, which is consistent with the definition of the term concept map given by Lambiotte et al. (1984).

The study progressed through four steps. First, I recorded the nationality and occupation of the authors of the papers. In the second stage, I calculated the most-used mapping formats. In the third stage, I used Dahlberg's classification to classify the papers and concept maps. In the final stage, I conducted cross tabulation to check for national or occupational influences.

4.0 Results

I examined the entire contents of the volumes of published proceedings of the two series of conferences that took place between 1990 and 2006. This included a total of 22 meetings, during which 652 papers were presented. ASIS SIG/CR contained 158 papers and ISKO proceedings contained 494 papers. Note that the last printed ASIS SIG/CR occurred in 2002. Although the meetings continue, the proceedings were not available during the period in which this study took place. Out of 652 papers, I found a total of 327 concept maps: 202 maps from ISKO and 125 maps in ASIS SIG/CR. However, a closer look at the number of papers and the number of concept maps per conference in both series of proceedings reveals that the ASIS SIG/CR conferences showed a higher percentage and a closer relationship between the number of concept maps and the number of papers per conference than the ISKO conferences did. Although the ISKO proceedings included more concept maps, the ratio of the number of concept maps to the number of papers per conference indicates that the ASIS SIG/CR presenters employ more concept maps per paper than the ISKO presenters. The reason for the difference is the relatively larger number of papers presented during each ISKO conference event: recall that the ISKO proceedings included 494 papers, compared to only 158 papers at ASIS SIG/CR conferences.

First I examined the occupation of each author who contributed a paper to the conference proceedings. The results were classified into three categories: professor/academic teachers, practitioner, and student. Regarding the relative proportions, I found no major differences between the two sets of conference proceedings. In both conference series, the majority of the authors were professors: out of 602 authors, 431 were professors. In addition, I examined the country of employment of each researcher. During the period under examination, most of the presenters at ASIS SIG/CR were American-based, whereas most of the presenters at ISKO were based in Europe. Unlike ASIS SIG/CR, I found that the majority of presenters at ISKO conferences were professors who worked in one of four major European countries: Spain, France, Germany, and Demark. The USA and Canada supplied the next largest number of participants. It is interesting to note that in the early ISKO conference proceedings (ISKO #1 - #4) the majority of presenters came from the host country. This trend changed over time. In the last ISKO conference (#9: Vienna, Austria), the majority of the presenters came from the United States.

With regard to the characteristics of the authors who included concept maps as part of their papers, I found no major difference between the two conferences. Table 1 shows the top-ranked country of employment and occupation of those who presented concept maps at ASIS SIG/CR meetings.

In contrast, the ISKO presenters were a more international group. However, at the majority of ISKO conferences, the United States-based presenters who used concept maps did not outnumber researchers from other countries. Out of 101 ISKO concept-map presenters, only 21 worked in the United States. Researchers from Germany ranked second, with 10 concept maps. Table 2 presents the top-ranked country of employment and occupation of the concept map creators for each ISKO conference.

	Number of presenters using Concept maps	Top Country of Employment	Top Occupation	Total number of maps
ASIS SIG/CR #1	4	USA= 75%	Professor = 63%	10
ASIS SIG/CR #2	3	USA= 100%	Professor = 78.5%	6
ASIS SIG/CR #3	5	USA= 80%	Professor = 75%	12
ASIS SIG/CR #4	5	Canada = 40%	Professor = 88%	18
ASIS SIG/CR #5	6	USA = 50%	Professor = 81%	18
ASIS SIG/CR #6	4	USA = 50%	Professor = 80%	9
ASIS SIG/CR #7	3	Germany = 66%	Professor = 79%	9
ASIS SIG/CR #8	1	Canada = 100%	Professor = 54%	1
ASIS SIG/CR #9	3	USA = 66%	Professor = 62%	10
ASIS SIG/CR #10	4	Denmark = 50%	Professors = 62%	9
ASIS SIG/CR #11	6	USA = 83%	Professors = 63%	8
ASIS SIG/CR #12	3	USA =66%	Professor = 67%	9
ASIS SIG/CR #13	3	USA = 100%	Professor = 82%	6

Table 1. ASIS SIG/CR presenters according to profession and country of occupation

	Number of presenters include Concept maps as part of their paper	Top Country of Employment	Top Occupation	Total number of maps
ISKO#1	6	Germany = 75%	Professor = 60%	11
ISKO#2	10	Sweden = 66.6%	Professor = 60%	24
ISKO#3	4	France = 60%	Professor = 78%	11
ISKO#4	12	Germany = 40%	Professor = 64%	20
ISKO#5	17	France = 36%	Professor = 80%	41
ISKO#6	13	USA = 33%	Professor = 79%	25
ISKO#7	12	USA = 50%	Professor = 85%	20
ISKO#8	12	Spain = 50%	Professor = 75%	24
ISKO#9	16	USA = 21%	Professor = 80%	26

Table 2. Shows ISKO concept-map creators according to profession and country of occupation

Overall, the majority of the contributors to both sets of conference proceedings are United States-based professors who used concept maps to illustrate their findings. Future studies should address the issue of country of employment and area of research of the participants who contribute to knowledge organization conferences, as well as the factors that influence the use of concept maps. Next, I counted the most frequently used form of maps found throughout the two sets of conference proceedings.

5.0 The most used forms of concept maps

Out of the 327 maps I reviewed, I found three main classifications: concept maps, mind maps, and conceptual graphs. Concept Maps consist of text, images, and links, all of which describe the relationship between specific nodes and arcs that yield the semiotic essence of any given presentation. Mind Maps are diagrams that are used to represent words, ideas, tasks, or other items that are linked to, and arranged around, a central word or concept. Conceptual Graphs are systems of logic that are based on both the existential graphs of Charles Sanders Peirce and propositional logic. Table 3 presents the findings.

	Concept Maps	Mind Maps	Conceptual Maps
ISKO	128	23	51
ASIS SIG/CR	78	13	34
Total 327	206	36	85

Table 3. The form of concept maps most used

Accounting for 62% of the total, the concept map was the most-used format. As the preferred method of displaying scientific information in the series of ISKO and ASIS SIG/CR conferences, concept maps integrate graphics and text most efficiently. It is interesting to note that most researchers added further graphic representations to their maps, without providing detailed explanations of their meaning. This apparent oversight should be examined in future studies. Next, I employed Dahlberg's classification in order to better understand the nature of the concept maps found in the two series of conference proceedings.

6.0 Analysis using Dahlberg's classification

In order to understand the topical parameters of the papers and their concept maps I used Dahlberg's (2006) Classification System for Knowledge Organization Literature to categorize the titles of both papers and concept maps. Dahlberg outlines ten categories: (1) general-form concepts, (2) theories and principles, (3) object classification systems and thesauri, (4) activity processes, (5) property attributes, (6) persons, (7) institution (8) technology and production, (9) application and determination, and (10) distribution and synthesis. The first group classifies certain kinds of documents, including bibliographic works and conference proceedings. The second category refers to theories and principles that deal with indexing and classification. The next group, "object," addresses classification systems and thesauri that deal with the classification of the object. "Activity process," which is the fourth category, involves methods of classifying and indexing. The fifth category deals with the property attributes of indexing and classification. The sixth category, "person," deals with subject-related systems, mainly taxonomy. The seventh group ("institution") deals with related systems. The next class involves concepts from fields (mainly technological) that are related to knowledge organization; the title of this class is "technology and production." The ninth classification, "application and determination," covers the

methods of the field that are applied to document forms and subject contents. It also covers intellectual products in the field. "Distribution and synthesis," the last group, addresses the environment of the field and its social organization, as well as issues of education, law, economics, and service. Dahlberg concludes that the first category and the last three categories are successful for arranging the research framework of knowledge organization (2006, 14).

With respect to the use of paper titles, major differences emerged between the two series of conferences. Most of the titles of ISKO papers fell into two major groups: "object," which ranked at the top, and "technology," which ranked second. Under Dahlberg's classification, papers classified under the "object" group discuss concepts and classification in knowledge organization. Under this heading, 115 out of 652 titles were classified, which represents 15% of the total number of papers. In every ISKO conference proceeding examined for this study, "object" appeared at least five times or more. Based on Dahlberg's classification, the second-highest ranking group ("technology") discusses concepts from other fields that are directly related to the field of knowledge organization. "Technology" accounted for 90 out of 652 titles, representing 13% of the overall number of papers. This category maintained a strong presence throughout the two series of conference proceedings. The one exception is the third ISKO (1994) conference, where none of the papers were classified under this group. Only 40 titles, accounting for 6% of the total, came from the third group, "application." According to Dahlberg's classification, the "application" group discusses methods that are applied to classify documents and data classes.

In comparison, the most dominant group-theme classification in the ASIS SIG/CR proceedings was "activity component," which appeared in 12 out of 13 conferences. The "activity" group applied to 36 titles out of 158, representing 22% of the overall number of papers. "Technology," which was also one of the top groups in ISKO, ranked second at these conferences. It accounted for 31 paper titles, or 19% of the overall number. With only 24 paper titles, equaling 15% of the overall number, the "application" group came third.

Thus the proceedings from the two series of ISKO and ASIS SIG/CR conferences share the same second and third place classification groups: "technology" and "application." When examining the proceedings with regard to the "activity" group, the following difference emerged: in ASIS SIG/CR, "activity" was the highest-ranking term, but in ISKO it was a relatively distant sixth place. In ASIS SIG/CR, I found that American presenters led both in terms of nationality and in the use of the following categories: "activity," "technology," and "application." The second leading group of contributors was from the UK. This group secured second place in both of Dahlberg's top categories. Overall, the majority of contributors were American professors, who presented a total of 89 papers out of 158 papers.

It is interesting to note that in the proceedings of both series of conferences, the researchers from the USA had a stronger presence than those from any other countries. In the ISKO conference proceedings, cross-tabulation demonstrates that many American papers were classified under Dahlberg's "object." In ASIS SIG/CR, the American-based contributors lead the way, with "activity" the leading group. In both series of proceedings, professors were the leading professional category. Future research needs to analyze the relationship between the country of employment of authors and their respective subject of research.

Applying Dahlberg's classification to the concept maps used in ISKO conference papers, the "object" group appeared most often. Out of 202 maps, 51 come under this category, representing 25%. At every ISKO conference, this classification appeared at least twice. "Activity," which discusses the methods and activities of classes and their explanation, featured second at ISKO. This category holds 39 maps, representing 19% of the overall total. In third place, the group "technology" consists of a total of 30 maps, or 14% of the total. The most dominant classification in the ASIS SIG/CR events was "technology and production," which appeared in 11 out of 13 conferences. It was present in 20 out of 125 maps, totaling 17%. In second place, I found the group "activity," with 20 maps, representing 16% overall. In third place, the "object" group accounted for 17 maps, or 14%. Table 4 summarizes the concept maps found in the entire set of ISKO conference proceedings.

The most dominant group-theme classification in the ASIS SIG/CR events was "technology and production," which appeared in 11 out of 13 conferences. Maps classified under this group display concepts from fields related to knowledge organization. The second highest category was "activity," which stands for methods and activities of classifying and indexing. The third ranked group was "object," which stands for a particular activity relate to the object in the concept systems. Table 5 summarizes the concept maps in the entire series of ASIS SIG/CR proceedings according to Dahlberg's classification.

ISKO	General form	Theories	Object	Activity	Property	Persons	Institution	Technology	Application	Distribution
#1			3	3	1					
#2	1	2	8	7	4		1	1		
#3	1	1	3	3		3	1		1	
#4		1	4	3	5		2	4	2	
#5		2	12	8	1	1	1	12	4	2
#6	3	1	5	5	1	5		5	3	
#7		2	8	2	3	2	2	2		2
#8		3	5	5	6	1	3	4		
#9		3	9	6	2	2	2	3	1	
Total	5	13	51	39	19	17	12	30	12	4

Table 4. A summary of concept maps found in ISKO proceedings according to Dahlberg's classification

ASIS SIG/CR	General form	Theories	Object	Activity	Property	Persons	Institution	Technology	Application	Distribution
#1					6	2		2		
#2			1	1	1	1		2		
#3		1		4	3	1		1	1	
#4		4	2	3	1	4	1	2	1	
#5		2	2	3		4	2	4	1	
#6	1		1	2	2			3	1	1
#7		1	1	1	2	2	1	1		
#8				1						
#9		2	1			2		2	2	
#10		1	1	2		2		2		2
#11				1			4	2	1	
#12			2	2	1			2	2	
#13			6							
Total	1	13	17	20	15	18	8	21	9	3

Table 5. A summary of the entire ASIS SIG/CR events according to Dahlberg's classification

In summary, although the series of ISKO and the ASIS SIG/CR conference events do not reveal the same top-ranked themes, I found similar patterns regarding Dahlberg's "object" group. This particular group was ranked third in ASIS SIG/CR and first in ISKO. In addition, the "activity" group was among the top three most-used categories in both series of conference proceedings. At ISKO, "activity" was ranked in second place, the same as it was ranked in ASIS SIG/CR. More studies need to examine how authors employ concept maps to define the major concepts in their discussions.

7.0 Cross Tabulation

I conducted cross tabulation to analyze the sources of the papers and concept maps by country of origin and institutional affiliation. At ISKO, Americans contributed 23% of papers to the conference out of a total of 494 papers, while American presenters at ASIS SIG/CR accounted for 159 papers, or 61% of the concept map contribution. I also found that the majority of the contributors were professors. At ISKO, 54% of all papers examined were authored by professors, and at ASIS SIG/CR, 65% of all contributors were professors. With regard to concept maps, the majority (38%) of the contributors in both series of conferences were also U.S.-based professors.

Between the two series of conference proceedings, I found no difference with regard to the creators of concept maps vs. authors of papers. United States-based professors were the most highly represented group in both conference series and for both types of contribution. At ISKO conferences, 38% of creators of concept maps were American. At ASIS SIG/CR, 72% of all concept map makers were based in the United States. The majority of those who included concept maps in their papers were professors. At ASIS SIG/CR, 74% of the concept-map presenters were professors, while at ISKO 81% of concept maps were created by professors.

I also found a similar pattern between the papers and the maps using Dahlberg's classification. Most of the titles of the papers at ISKO fell into two major groups: "object," which ranked at the top, and "technology," which ranked second. I found that the concept maps and the papers had the same leading group-theme, "object," which accounted for 11% of all paper titles and 25% of all concept maps found in ISKO. "Activity" ranked second and "technology" third. Things were different at the ASIS SIG/CR conference meetings, where the most dominant group-theme classification was "technology," followed by "activity" and "object."

With regard to concept maps, the most dominant Dahlberg classification at ISKO was "object," which applied to 25% of all the maps. Once again, "activity" ranked second and "technology" third. In contrast, the most dominant classification among the ASIS SIG/CR concept maps was "technology," which appeared in 23% of all the maps. The second ranked category was "activity," while "object" was third.

It is noteworthy that while Dahlberg suggests that her first category and last three categories ("general form," "technology," "application," and "distribution") are the most popular, I found, regarding the titles of the papers, that "object" and "activity" ranked at the top of both series of conference proceedings. These two categories do not even appear on her list of most-popular groups. When looking at ISKO concept maps, "object" once again ranked highest. In terms of Dahlberg's ranking, the only match I found in the ASIS SIG/CR proceedings was the group "technology and production." Dahlberg's classification has never been examined with regard to its application to the nature of paper titles or concept maps in knowledge organization conference proceedings. Future studies need to apply Dahlberg's categories to the classification of conference papers and concept maps in order to evaluate the strength of Dahlberg's scheme. In addition, more studies are needed to understand how concept maps are used by academic researchers, especially to define the core concepts in their discussions.

8.0 Summary and Discussion

Knowledge organization is often defined in terms of facilitating information retrieval. Dahlberg maintains that the core examination of knowledge organization can be found in the knowledge units, or concepts. Concept mapping (which shows the relationship among concepts) is a technique for visualization. In this study, concept maps were used as a lens for examining how knowledge units are represented by academic scholars in the field of knowledge organization. Using Dahlberg's classification, I examined the titles of the papers and the titles of the concept maps found in two major series of conference proceedings in the field of knowledge organization: ISKO and ASIS SIG/CR.

A total of 642 papers and 427 maps were found in the proceedings of these two series of conferences between 1990 and 2006. In both series, the majority of the researchers who utilized concept maps as part of their papers were professors: they created 227 out of the 329 total maps contained in the proceedings. In addition, the majority of the participants who employed concept maps as part of their presentation were based in the United States. This trend had a stronger impact at the ASIS SIG/CR events, where the majority of the presenters worked in the U.S. By contrast, the ISKO presenters were a more international group.

I found that concept maps were the preferred method for representing knowledge. Concept maps were defined as maps that represent text, images, and links that explicate a relationship between the nodes and arcs in the map. It is interesting to note that researchers most often did not provide detailed explanation about either their maps or the connections between the nodes and arcs. Using Dahlberg's classification, I found that the "object" category predominated in both series of conference proceedings when evaluating the title of the papers and the titles of concept maps. Similarly, "activity" ranked near the top in both series. I conducted cross-tabulation to conclude that the United States provided the greatest number of contributors and concept map creators in both of these series of conferences. I also found that the majority of the contributors were professors. With regard to concept maps, the majority of the contributors in both conferences were also U.S.-based professors. The predominant form of concept maps used by authors was concept maps—rather than mind maps or conceptual graphs. Future studies need to address how the work and concept maps used by researchers in conference proceedings can be classified in the field of knowledge organization.

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