

## THE POWER AND BENEFITS OF CONCEPT MAPPING: MEASURING USE, USEFULNESS, EASE OF USE, AND SATISFACTION<sup>1</sup>

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**Abstract.** The power and benefits of concept mapping rest in four arenas: enabling shared understanding, the inclusion of affect, the balance of power, and client involvement. Concept mapping theory and research indicate concept maps (1) are appropriate tools to assist with communication, (2) are easy to use, and (3) are seen as beneficial by their users. An experiment was conducted to test these assertions and analyze the power and benefits of concept mapping using a typical business consulting scenario involving sixteen groups of two individuals. The results were analyzed via empirical hypothesis testing and protocol analyses and indicate an overall support of the theory and prior research and additional support of new measures of usefulness, ease of use, and satisfaction by both parties. A more thorough understanding of concept mapping is gained and available to future practitioners and researchers.

### 1 Introduction

Originally developed in 1974 as a technique to make sense of data gathered in clinical interviews (Novak & Musonda, 1991), concept mapping has been used in numerous ways in education, psychology, and organizational settings (Fraser, 1993; Novak, 1995). The power and benefits of concept mapping rest in four arenas: enabling shared understanding, including affect, balancing power, and involving the client. By enabling an individual to express one's domain understanding to others, a shared understanding is created between the individuals. It must be noted, however, that shared understanding does not mean agreement, but rather an understanding of each other's position. Concept mapping facilitates the creation of this shared understanding and reduces the miscommunication between individuals (Fraser, 1993). Concept maps are not limited to the inclusion of facts or factual understanding. Affect – emotions, feelings, and other affective concepts (e.g. frustration, challenge, fear, anger, joy, fulfillment) – has a natural place in concept mapping, as affect is an integral part of thinking and acting (Novak & Gowin, 1984).

In a traditional consulting situation, the trained consultant/analyst (the expert) is seen as much more powerful than the client who is in need of assistance with some situation. Clients will often resist the consultant (Marakas & Hornik, 1996) and/or feel dependent towards the consultant (Fraser, 1993) as a result of this power imbalance. Concept maps are able to correct this imbalance and at the same time create a sense of responsibility on the part of the client (Mazur, 1989). Finally, concept mapping can increase the overall participation of the client, user, employee, etc. when the concept map is used supplementally. This is related to the concept of the power relationship because if the client feels as though s/he has no power and no responsibility, the client's participation will likely be very minimal. However, if a sense of responsibility can be created or enhanced, the client will likely participate to a greater extent.

This leads to the following general research questions: What are the effects of the use of a concept map on enabling a shared understanding, including affect, balancing power, and involving the client? By what means does the concept map achieve these benefits? In addition, in what ways do users perceive the concept map, and how does the concept map affect communication?

### 2 Concept Mapping

Concept mapping is a technique to let one person convey meaning to another in a visual format, and concept maps have been shown to foster a joint understanding between two individuals viewing the same map (Novak, 1977; Malone & Dekkers, 1984; Hoover & Rabideau, 1995; Novak, 1998). The concept map is believed to enhance recall and memory, aid in negotiation and balancing of conflicting needs, and create mutual understanding.

Concept maps are generally used to either express a conceptualization of an issue to others (Fraser, 1993; Glynn, 1997) or to attempt to understand the conceptualization of an issue by others (Suen et al., 1997; Thatcher & Greyling, 1998). They allow collaboration in problem solving by people in different disciplines or situations

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<sup>1</sup> This paper presents a condensed version of a study previously published in the *International Journal of Science Education*, <http://www.tandf.co.uk/journals>.

(Howard, 1989). They are effective at increasing team performance (Cannon-Bowers et al., 1993; Hinsz, 1995; Blickensderfer et al., 1997) and at increasing shared expectations and shared understanding (Rewey et al., 1989; Kraiger & Wenzel, 1997). Trochim (1989, p. 1) argues “concept mapping encourages the group to stay on task, results in an interpretable conceptual framework, expresses this framework in the language of the participants, yields a graphic or pictorial product, and improves group or organizational cohesiveness and morale.”

Describing an individual’s cognitive structure through other techniques such as “a spoken narrative, an outline, a written summary, formal and informal conversation, a flowchart, etc.” is limited in that these techniques are linear and unable to depict the complexity of the relationships between concepts and ideas (Fraser, 1993, pp. 40-41). The process of creating and using the map is as important as the content of the map. For example, “through the actual process of constructing a concept map the individual can also make new connections and recognize concepts which should be added” (Fraser, 1993, p. 33). Concept mapping will allow for a very inclusive diagram of the scenario with few structural limitations.

Creating and drawing these maps is one exercise, but being able to assess them is important for understanding them and comparing multiple maps to one another (Novak & Gowin, 1984; Shavelson et al., 1994; Dorrough & Rye, 1997). In general, concept maps can be measured either quantitatively or qualitatively (Rink et al., 1994; Rowe & Cooke, 1995), and both techniques play a role in this study.

### **3 The Experiment**

#### *3.1 Hypotheses*

The satisfaction of the users of a new technique or process is an important criterion in the overall evaluation of that technique or process (Vennix & Gubbels, 1991). Based on the literature that found motivation and concentration to have increased after using concept maps (Hall & O’Donnell, 1996), we believe that the use of the concept map will be perceived as beneficial to the parties involved. This prediction is also based on the literature that suggests that concept maps are helpful in gaining a shared understanding (Fraser, 1993; Taber, 1994). This prediction is not concerned with the entire communication session, rather, just with the use of the concept map as a technique within the session. Though not necessarily a direct benefit of concept mapping, Taber (1994) reports that students had positive comments towards concept mapping in terms of both a) the task, because concept mapping is different, interesting, and brings back “memories” of other concepts, and b) in terms of their own learning, because the maps show what you know and the links actually evoke new concepts, a point also made by Fraser (1993). This reaction should be helpful when concept mapping is added to a task. We, thus, express Hypotheses 1a and 1b below.

H1a: Analysts using concept maps will perceive them to be a beneficial part of the communication process.

H1b: Users using concept maps will perceive them to be a beneficial part of the communication process.

As previous studies have shown cognitive maps to be successful communication tools (Burgess et al., 1992; McKay, 1998), there should be a greater sense of satisfaction with the entire communication process for analysts and users who employed the concept map. In other words, analysts and users from dyads that used a concept map to assist their communication will feel that they were better able to communicate with each other and that the whole session was more successful. This is expressed in Hypotheses 2a and 2b.

H2a: Analysts from dyads using concept maps will have a higher satisfaction rating of the requirements elicitation session than those analysts from dyads not using concept maps.

H2b: Users from dyads using concept maps will have a higher satisfaction rating of the requirements elicitation session than those users from dyads not using concept maps.

While the inclusion of affect is an important aspect of concept mapping, it is beyond the scope of this study. However, the other three arenas will be tested and analyzed via quantitative and qualitative methods. Concept maps will generate the benefits as indicated, and these are expressed as Hypotheses 3a, 3b, and 3c.

H3a: The concept map will enable shared understanding during the communication process.

H3b: The concept map will create a balance of power during the communication process.

H3c: The concept map will result in increased client involvement during the communication process.

#### *3.2 Methodology*

An experiment was conducted with dyads of simulated business professionals – end-users and analysts. The experiment involved two treatment groups: one group that utilized concept maps during the communication session and a second group that did not utilize concept maps. Data was collected from eight dyads in each treatment group. The subjects were recruited as volunteers from senior-level courses in the undergraduate program of a US business school. Analysts were Information Systems (IS) majors and had already completed at least one (and possibly two) systems analysis and design courses where they learned and practiced the techniques of being a systems analyst/consultant. Users were non-IS majors. As such, these groups are representative of the “typical” entry-level analyst and end-user, respectively, that would be involved in a systems consulting project.

The analysts assigned to the concept mapping group received training on creating concept maps based on Novak & Gowin’s (1984) and Novak’s (1998) introduction and training technique, though adjusted based on Shavelson et al.’s (1994) and Taber’s (1994) modifications regarding hierarchy to allow for more flexibility in creating the maps. This training was performed carefully so that the analysts were not biased into creating their concept maps in a certain way or in a certain format based on the training. The analysts were told that they would be required to utilize this technique during their upcoming session with the user. They were told that they may construct the concept map at any point during the session. Each analyst in this group was given a short test of their understanding of the components and rules regarding concept mapping.

Following the training session, the analysts were given an abridged version of a business scenario to use as a basis for discussion in the upcoming session with the user. While the analysts were receiving the appropriate training, the users received a full description of the scenario. The users were told that they were to take on the role of one of the users of this system, and were to use the given information and nothing else. They were told that they would soon be meeting with a systems analyst whose job was to fully understand the workings of the system. They were also told that they were to answer all of the analyst’s questions accurately and fully, but were not to provide information on their own (i.e. unprompted), nor were they to provide extra information not contained in the scenario.

The entire session was videotaped. When the dyads felt they were finished, the subjects were asked to fill out an exit questionnaire (in separate rooms) consisting of questions regarding their perception of including the additional technique (only for subjects from the concept mapping group) and their satisfaction with the session.

#### **4 Analysis and Discussion**

Throughout the remainder of this document, the two treatment groups will be referred to as Map – the group that received an introduction and training in concept mapping – and Control.

The videotapes of the sessions allowed for protocol analyses to be conducted of the interaction between the analyst and user within the session and the drawing of the concept map. These videotapes of each session were each analyzed and detailed quantitative and qualitative codings were made. These data, alone and in combination with the actual maps and the questionnaires, provide answers to the questions of “what did the participants feel about the map,” “what effect did the map have,” and “how was the map used.”

##### *4.1 Hypotheses 1a and 1b*

H1a stated that the analysts (from the Map group) would find the concept map to be a beneficial part of the requirements elicitation process. Similarly, H1b stated that the users (from the Map group) would find the concept map to be a beneficial part of the requirements elicitation process. To measure the satisfaction ratings of the concept map itself, analysts were given the Perceived Ease of Use (six items) and Perceived Usefulness (six items) scales from Davis (1989). Both measures were given on a seven-point Likert scale with a midpoint response of 4.0. The results show strong, positive feelings towards both the Usefulness and Ease of Use of the concept map, and both measures were significantly positive with p-values of 0.004 and 1.828E-05, respectively.

The highest ratings for individual items from the Usefulness scale were from the questions regarding the concept map enhancing effectiveness on the job (6.125) and being useful on the job (5.625). The highest Ease of Use ratings regarded the concept map being easy to learn (6.375) and being flexible to interact with (6.125). Though both measures are predominantly above the midpoint, the correlation between the two measures of 0.329 was not significant at the 0.05 level.

In addition to the Usefulness and Ease of Use scales, the post-experiment questionnaires contained questions to ascertain overall feelings regarding the concept map and its use within the session. The questions concerned perceptions of the concept map's helpfulness in communicating with the other party, representing the requirements of the system, representing the structure and logic of the system, and the role of the concept map in the session in terms of time. In addition, the users were asked whether they were pleased that the concept map was available and whether they would be likely to use a concept map in the future when communicating with an analyst. The four analyst questions and the six user questions were analyzed individually.

All four satisfaction measures for the analysts were significantly positive, further indicating that the analysts felt the concept map was beneficial, helpful, and useful. All six satisfaction measures for the users were significantly positive, indicating that the users in the Map group felt the concept map was beneficial, helpful, and useful, and they were glad the concept map was available in the session with the analyst. In summary, Hypotheses 1a and 1b were both supported as the analysts and users had significantly positive satisfaction ratings for the concept maps.

#### 4.2 *Hypotheses 2a and 2b*

H2a stated that analysts in the Map group would rate their session satisfaction higher than analysts from the Control group. Similarly, H2b stated that users in the Map group would rate their session satisfaction higher than users from the Control group.

The ten-item scale used to measure the session satisfaction, adopted from Essex (1998), contained questions concerning whether the other party was a good listener, the clarity of the communication, the purposefulness of the communication, and the communication compatibility between the two parties. For the analysts, there was no significant difference (p-value of 0.310) between the Map and Control groups' ratings, though the Map group ratings (5.078) were higher, as hypothesized, than the Control group (4.891). Regarding the users and their session satisfaction ratings, the p-value of 0.403 indicates no overall difference between the two groups. Like the analysts' ratings, the mean for the Map group (4.975) was also slightly higher than the mean for the Control group (4.838). These results seem to say that according to the users, the session with the analyst was no different in terms of communication. Overall, there was a 0.588 correlation (p-value of 0.017) between analyst and user session satisfaction ratings, signifying that both the analyst and the user were generally in agreement with each other regarding their satisfaction with the session.

In summary, Hypotheses 2a and 2b were both rejected as Session Satisfaction for the analysts and users from the Map group were not significantly different from the Control group.

#### 4.3 *Hypotheses 3a, 3b, and 3c*

H3a stated that the concept map will enable shared understanding during the communication process. The satisfaction ratings from the analysts and the users regarding both the concept map itself and the elicitation session indicate that the concept map was helpful in achieving a shared understanding. The session satisfaction ratings for the analysts and users were significantly positive, and since much of the scale focused on self-reported levels of communication and understanding the other party, these ratings indicate that both groups felt there was positive communication during the elicitation sessions. Furthermore, the analysts and users both had significantly positive ratings of satisfaction with the concept map itself as being helpful for communication and for representing the requirements, structure, and logic of the scenario. These all indicate that the concept map was perceived to be beneficial and perceived to be a technique that would help create a shared understanding.

H3b stated that the concept map will create a balance of power during the communication process. The concept maps seemed to have mixed results. While there was not a large difference in power to begin with (since both the analysts and the users were students from the same business school), there was definitely a sense of a power difference because the users all waited for the analyst to begin the session as if they knew that the analyst was the one in charge. During their introduction to the experiment and the scenario, the users were told that they would be meeting with an analyst, and it is possible that the users assumed that the analyst would be in charge. This difference may not have been as large as a user would experience in the real world when working with a senior analyst from a consulting firm with 15 years of experience, but there was still a gap. In some instances, the analyst was the leader in the creation of the concept map and the user interacted with the analyst in a way that would signify a clear power distinction. However, in other instances, as would be expected, the user and the analyst jointly created the concept map – both in terms of ideas and in actual writing on paper. In these instances the user appeared to feel very much a part of the process and able to contribute equally.

Additionally, the concept map seemed to create a sense of responsibility on the part of the user with regards to the entire process and the eventual end results of the session. In one case, the user actually initiated the final concept map as a display of responsibility and ownership.

H3c stated that the concept map will result in increased client involvement during the communication process. While related to the arena of balancing the power relationship, one is not necessarily required for the other. For example, a great deal of user participation with poor analyst attitudes and communication can still lead to a perception of a great power imbalance. With regard to the user-analyst interactions and to the overall participation of the users, the concept map had a very strong influence. As soon as the analyst brought up the idea of creating a concept map and gave the user a brief explanation or demonstration, the user's posture at the table became more upright and open and the user's engagement with the analyst increased in terms of offering ideas and opinions. As previously stated, several users actually participated in the physical creation of the concept map. Additionally, the very nature of a joint concept map (a map created together by two or more people, as was the case with this experiment) requires that the two individuals agree on the content of the map. Therefore, no matter who was creating the physical map on paper, the other party was asked if they agreed with both the placement of a new concept and the choice of the linking word to link the new concept to an already existing concept. This participation in the creation of the concept map is directly related to the overall participation of the user in the elicitation session.

In terms of the three arenas just discussed, it seems that the concept map worked as expected. It created a sense of shared understanding, it created a balance in the power of the relationship, and it created greater participation by the user. More details can be gained via the protocol analyses.

#### *4.4 Concept Map Creation*

The first part of the protocol analyses concerned when the concept map was created. The analysts were told that they must create the concept map with the user at some point during the session but that it was their decision as to exactly when it would be created. Two of the analysts began creating the concept map with the user right away. The other six analysts went through an interview process with the user (asking questions about the scenario) that lasted between two and thirteen minutes before they began creating the concept map with the user.

The next part of the protocol analyses concerned who actually drew the concept map. In all cases, the concept map was a "joint" concept map, meaning that both the analyst and the user participated in the creation of the map in one way or another, as will be discussed shortly. However, in only two of the sessions did the user physically participate in the drawing of the concept map by adding concepts and appropriate relationships. In the other six sessions, the analyst was the only person who physically created the concept map on the piece of paper. This additional participation by the two users reinforces the earlier discussion of the power of the concept map to increase participation, though this was not the only way that participation was increased as a result of the concept map.

During the communication session, the concept map played a very large role in terms of time. The analysts and users spent, on average, just under 19 minutes creating the concept map. The range was from just over 9 minutes to just over 34 minutes. This time was split between drawing the concept map, reviewing the concept map, talking about potential concepts and/or relationships, and reviewing the scenario and other written notes.

It should also be noted that none of the dyads redrew their concept map or started over at any point. (All of the drawing took place on paper with either pen or pencil based on the analysts' and users' preferences.) All corrections or changes made to the concept maps were made on an individual-item basis without starting over or redrawing the whole concept map. In fact, during many of the sessions, there was a lot of erasing and re-drawing of concepts and links as the analyst and user discussed the scenario and the concept map. During the training session with the analysts, they were told that they could use as many sheets of paper as necessary to complete the concept map.

#### *4.5 Concept Map Interactions*

Now that we know when the concept map was created, who did the physical writing, and how much time it took to create the concept map, we can look at the interactions between the analyst and user during the creation of the concept map. While the analyst may have done all of the physical writing in most cases, this did not mean that the user was not a part of the process. In four of the sessions, the analyst began the mapping process by explaining to the user what a concept map is, what they do, and what they look like (often using one of the

concept maps drawn during the introduction session as an example). In a fifth session, the analyst explained the concept map when they were finished creating it, probably too late to help the user gain any additional understanding. In the other three sessions, the analyst offered no explanation of the concept map, nor did the user ask any questions regarding its purpose, meaning, or use.

In all of the sessions, the analyst began creating the map by writing the main concept near the middle of the paper. (This was a direct result of the introduction and training.) In half of the sessions, the analyst asked the user to help determine the main concept, and when they agreed, the analyst wrote down this concept. From that point, the analysts continued to add concepts and the appropriate linking words to create relationships among the concepts. In six of the sessions, the analyst spoke aloud while creating the concept map (increasing the overall level of involvement as the user knew what the analyst was doing) and asked the user “yes/no” questions to confirm the existence and placement of concepts and the appropriate linking words for the relationships. Based on the user’s response, the analyst would either continue to the next concept or relationship on the concept map, or the analyst would ask follow-up questions in order to reach an agreement on what was just drawn. In the other two sessions, as well as in two of the previous sessions, the analyst involved the user to a greater extent in the creation of the concept map by asking open-ended questions so that the user was participating in the actual construction of the concept map. Based on the responses to these questions, the analyst would add concepts and relationships to the concept map. These analysts and users evenly shared the responsibility for adding items to the concept map, whereas in the other dyads, the responsibility was still shared, but the user took on the role of someone with veto power.

During the session, the analyst and user sat on opposite sides of a small table facing each other. Therefore, since the analysts were doing the physical writing on the concept map, it was natural for the analysts to have the map facing them and, as a result, upside-down to the users. However, in several of the sessions, the analysts physically turned the map sideways so that it was partially between themselves and the users. This helped increase a sense of balance of power and helped increase actual participation on the part of the user. In several other sessions, once the analyst and user began creating their concept map, the user sat upright in his/her chair and showed a greater degree of interest in what was happening. Also, in several sessions the interaction between the analyst and the user was very casual, at least much more so than in other sessions. These dyads were laughing at different points and were conversing with very casual tones and gestures.

Regarding the two sessions where the user physically created part of the concept map, in one session, while the analyst was involved in creating a list of potential concepts on a separate sheet of paper, the user began adding concepts and relationships to the concept map. When the analyst finished the list, the analyst noticed (with some surprise) that the user had added items to the map. The two of them then reviewed the additions, discussed them, made some changes, and continued with the process. In the other session, the analyst had the user create a similar list of words. After a few minutes, the analyst began adding ideas to this list. When the list was completed, the analyst had the user begin to add items to the concept map. The analyst noticed that the user was getting “stuck” and was unsure of how to continue, so after a few minutes, the analyst took over and became the main drawer of the concept map. Even so, the user in this dyad was very involved in the creation of the concept map. In a third session, even though the user did not physically create any part of the concept map, the user initialed the paper as an indication of agreement with the content and look of the concept map.

The final interaction between the analyst and the user deals with a final review of the completed map. In five of the sessions, the analyst specifically reviewed the concept map with the user. In these cases, the analyst began with the main concept and continued to describe the contents of the concept map. In at least one instance within each of these reviews, the analyst and/or user decided that a change was necessary to one of the relationships, indicating that there were benefits to the review process in terms of making sure the concept maps were correct and that both parties were in agreement.

#### *4.6 Other Observations*

The protocol analyses also enabled several other observations. While drawing the concept map, a few of the analysts included items from the scenario that the user knew very little about. In one case, the user specifically stated that the analyst’s question could not be answered, but the analyst still included the items of concern in the concept map and created relationships between them and other concepts. Finally, several of the concept maps were drawn at a very high level, meaning that they contained only the major concepts (such as the main entities within the scenario) and their primary relationships to each other. With one of these high level concept maps, the analyst and user actually discussed several detailed relationships while creating the concept map, but they were left out.

Additionally, by creating the concept map and thereby reviewing much of the material already elicited and discussed, the user was forced to be sure that the information was correct. This review by the analyst in the form of the concept map provided exposure to the information a second (or third) time, and thereby gave the analyst a much clearer understanding of the scenario. This was seen in the way that the analyst communicated with the user while creating the concept map – the analyst stated much more of the relationships by memory without the need to look at notes; the analyst spoke much more coherently and smoothly about the processes and the scenario; and the analyst and user confirmed each other's responses much faster.

There was not one "best" method for creating the concept map that ultimately led to either a larger or more complex map. The protocol analyses of the concept map creation phase indicate that there were very diverse techniques utilized by the analysts in creating the concept maps with the users. It seems that different combinations of interactions, question styles, and activities all produced concept maps with many nodes, many links, and high complexity. This is likely due to the fact that the concept map is a relatively ill-structured technique and there was no uniform technique across the teams. While the concept map is relatively ill-structured, this does not mean that it is not useful nor that it cannot be understood and utilized. By ill-structured, it is meant that there is no single technique for creating a concept map with another person and the process is very individualistic. As the concept map is a very personal (to either one person or multiple people working together) representation of an internal mental model, so are the interactions and choices made while producing the concept map.

## 5 Conclusion

There are several known limitations to this study. First, as a laboratory experiment, there are aspects of the real world that are not a part of the overall design. For instance, the scenario that is used is not a real business situation, though it is realistic. On the other hand, a laboratory experiment provides a greater degree of control over the subjects, the task, and the measurements. In addition, there are limitations of using students for all of the subjects. However, this choice was made in order to keep the subject populations (analyst and user) as homogeneous as possible to control for covariates, and it follows prior research in systems development (Marakas & Elam, 1998).

This study showed the concept map to be a good communication tool and both parties found the concept map to be beneficial, easy to use, and useful. The power and benefits of concept mapping were realized and measured through both quantitative and qualitative techniques. These are all solid, practical findings for those interested in utilizing this technique to assist communication between two parties.

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