USING CONCEPT MAPS TO IMPROVE SCIENTIFIC COMMUNICATIONS

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Abstract

Scientific talks, like scientific papers, are an important part of the scientific communication process. Good oral presentation skills, are vital to educational sciences, as well as to many other fields. In the engineering community, such presentations offer, a quick outline of project proposals and progress reports. In the academic community, the ability to clearly transmit scientific information, in an oral presentation, is critical to both teaching and research. Over the last years, it has become apparent, to many educational researchers, that representing knowledge, in a visual format, allows one to better recognize and understand, incoming information. Since Novak, placed concept mapping on the educational agenda, it has become an increasingly popular advanced teaching and learning tool. Due mainly to the innovation of visual design software like CmapTool, the production and modification of Concept Maps is straightforward. While there are no strict rules about how to give a motivating and compelling presentation, there are some guiding principles which are easy to grasp and apply. The modern scientist must be able to create well organized, well delivered scientific talks. In this context, Concept Maps harness the power of our vision to understand complex information "at-a-glance". We propose some ideas and resources based, on the use of concept maps to make the process of preparing and organizing good talks easier. In essence, good scientific talks must satisfy the following three goals: to connect with the audience, to direct and hold attention, and to promote understanding and memory. To accomplish these goals talk material must be elaborated carefully and logically. The plan to achieve them should have four parts: preparation, structure, design, and exposition. We focus our work on the first two parts of the plan, and supply some helpful

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guidelines on effective ways to prepare the scientific information, using conceptual maps with the software CmapTool.

Keywords - scientific talks, concept maps, Cmaptool software

1 Introduction

Scientific conferences, like scientific papers, constitute an essential element of the communication process of research results. As a matter of fact, scientific talks are the most effective way to communicate the key aspects of scientific research. Through public dissemination of results, the true nature of research is accomplished, thus making a real and updated contribution to the scientific community. Moreover, people who deliver good talks are often offered better jobs and obtain more recognition among the scientific community, Anholt [1]. Actually, an inadequately prepared talk communicates that the speaker does not care about the audience and possibly lacks a sincere interest in the topic.

According to Kosslyn [2], virtually any effective presentation accomplishes the following three goals: 1) to connect with the audience; 2) to direct and hold attention; and 3) to promote understanding and memory. Although worthy of achievement, these goals are in practice difficult to fulfill because the presenter faces many constraints. The most important are the limited time allotted and the background knowledge of the audience.

Firstly, regarding the time, it is impolite and egocentric to exceed allotted time. Running over time also reveals a lack of preparation and experience. The first steps in preparing a talk with time constraints are defining the scope and organizing the material to fit within the specified time frame. Concept maps, as will be seen later, will help in adjusting to the time.

Secondly, the audience must be taken into account in order to fulfill Kosslyn's goals. Concepts, jargon, symbols, amount of information, depth and scope, must be adapted to the interests and goals of the audience and to its background and intellectual capacity. Only relevant information conveying the fundamental message of the talk should be delivered, leading the audience to pay attention to what's important, in a manner which is easy to follow, digest, and remember.

Therefore, to prepare oral presentations fulfilling Kosslyn's goals, the presenter must previously select the fundamental concepts of the talk, and organize them in a clear and concise manner, adapted to the particular audience for a given time amount. To simplify, we assume that the lifecycle of an oral presentation can be divided into four stages:

1. Preparing for the talk: time, audience, fundamental concepts.

2. Structuring the overall talk: title, introduction, body, conclusions.

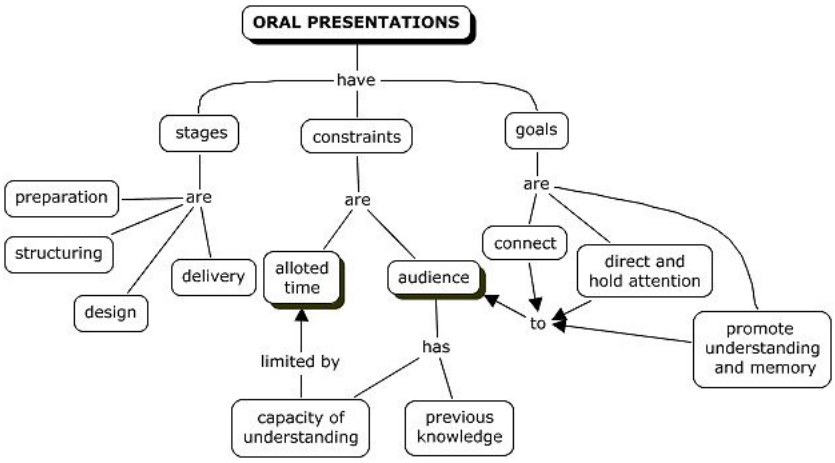

Figure 1: Concept map of an oral scientific presentation.

3. Designing slides and supporting material.

4. Delivery.

In this paper we will only be concerned with the first two stages. Concept maps offer a new method for organizing information. Because of their graphical nature, they help desired information to be more accessible. We present concept maps as a useful tool in the preparing and structuring of a scientific conference. Design and Delivery stages are not covered, since they are not addressed by concept maps. However, the reader is referred to [3] and [4] for good advice on the topic. Figure 1, shows an example of a concept map of a presentation.

The rest of this work is organized as follows. First, we explain the basic principles of building concept maps and then we present the methodology for using them in preparing the presentation. The last section summarizes the conclusions.

2 Concept Maps

A concept map is a graphic display tool that allows any person to do a schematic and easy to understand representation about their knowledge in a particular field or domain. The concept mapping method was developed by Prof. Joseph D. Novak and his colleagues at Cornell University in the early 1970's. Their work was based on a constructivist model of human

cognitive processes, in particular, the assimilation theory of David Ausubel, who emphasized the importance of prior knowledge in being able to learn about new concepts that would lead to meaningful learning.

Although Milam et al [5], establish that there are many different definitions of concept maps, we agree with the definition given by its creators. In Novak and Gowin [6], Novak's definition establishes that concept maps are "tools for organizing and representing knowledge". The primary elements of knowledge are concepts, generally surrounded by circles or boxes of some fashion. Relationships between concepts are indicated with lines showing *linking words*, so that concepts linked by these words form *propositions* (meaningful statements), as explained in Novak and Cañas [7]. By convention, links run top-down unless annotated with an arrowhead. Novak defines concepts as "perceived regularities or patterns in events or objects, or records of events or objects, designated by a label".

Concepts are represented hierarchically in a two-dimensional configuration. The vertical axis expresses a hierarchical framework for the concepts; with the most general and inclusive concept positioned at the top of the hierarchy and the most specific and least general concept toward the bottom.

Propositions are simplified sentences about some event or object that show a relationship between two or more concepts forming a meaningful statement, sometimes called units of meaning. The horizontal axes comprises *cross-links* showing relationships between concepts in two different areas of the concept map. Identifying new cross-links may sometimes lead to a creative insight, [6]. Concept maps tend to be read progressing from the top downward.

Although concept maps have mainly been used to assess an individual's specific knowledge or cognitive structure, they have also been employed to present information to a scientific advanced organizer,[8].

2.1 Applications of concept maps

Concept maps are an effective mean of representing and communicating knowledge. When concepts and linking words are carefully chosen, these maps can be useful tools for observing nuances of meaning, helping users to organize their thinking, and summarizing subjects of study. The technique of concept maps has been broadly applied in many disciplines and various educational levels, eventually expanding beyond its original intent. There are numerous applications for concept maps including their use as an educational tool [9; 10], an interactive learning tool, a pedagogical curriculum design, knowledge acquisition tool during the construction of expert

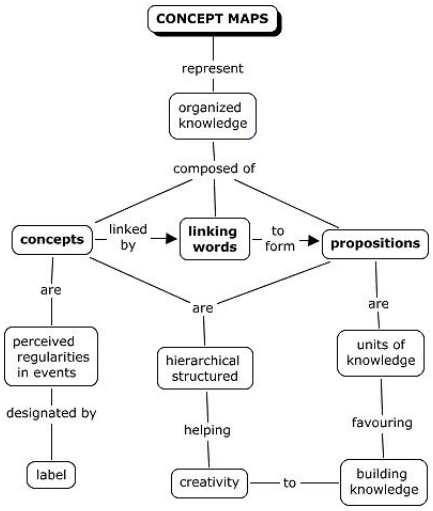

Figure 2: Example of a concept map that describes the structure of concept maps and illustrates some of the features mentioned in the text. This concept map was constructed using the concept mapping tools software package CmapTools.

systems, performance support systems, and as a means of capturing and sharing experts' knowledge [11], etc.

2.2 The Cmaptool software to construct conceptual maps

The CmapTools software (download at: http://cmap.ihmc.us) was developed at the Institute for Human and Machine Cognition. It brings together the strengths of concept mapping with the power of technology, particularly the Internet and the World Wide Web (WWW). According to Novak and Cañas [9], the CmapTool software facilitates the construction of concept maps in the same way that a word processor supports the task of writing text. It a-llows users to collaborate at a distance in the construction of their maps, publish their concept maps so anybody on the Internet can access them, link resources to their maps to further explain their contents, and search the WWW for information related to the map. CmapTools provides a rich collection of additional features that aid users in the collaborative manipu-lation of knowledge models. The user can create a hierarchy of folders in the user's computer or at a server to organize concept maps, images, videos, or URLs, all resources associated with a project.

3 Application of Concept Maps to Presentations

The main scenario in which we propose the use of concept maps is at the first two stages of the presentation lifecycle: preparing and structuring the talk. In this context, concept maps are used as tools for outlining presentation topics in a non linear manner. This method allows for a quick interpretation of related material and its relationship with the subject of the presentation, helping to refine the principal message to be transmitted to the audience.

3.1 Preparation stage

Most usually, scientific presentations are the culmination of a research work or project, where a paper or document with the results is presented in abbreviated form to an audience. The procedure of concept mapping starts after reading repeatedly the original article or the gathered material for the conference.

During this stage the core concepts of the presentation have to be identified and summarized in a fundamental, take-home message. It is important to avoid offering irrelevant information or secondary details, which overwhelm the audience, preventing grasping the fundamental idea. Everything not contributing to communicate the fundamental message should be eliminated from the presentation. This can be easily achieved through the usage of concept maps.

There are three basic features used in creating concept maps, as shown in Novak and Gowin [6]:

1. A list of concepts.
2. Lines that represent the relational links between these concepts.
3. Labels for these linking relationships, forming propositions.

The creation of a concept map for a presentation can be described as a process of seven steps, described next. The usual case is starting from a written document: a scientific paper or report.

3.1.1 Constructing a good focus question

Concept map structures are dependent on the context in which they will be used. As suggested by Anholt [1], basing the conference on a single, well-formulated question results in a presentation focused on the main idea

or concepts. Stating the major question of the presentation at the beginning and, if necessary, then breaking down this question into sub-questions arranged hierarchically, creates a *context* that will help to determine the hierarchical structure of the concept map. It is also helpful to select a limited domain of knowledge for the first concept maps.

3.1.2 Suggesting relevant concepts

Once the major domain is selected and the focus question or problem in this domain is formulated, the next step is to identify the key concepts that apply to this domain and that are needed to provide the knowledge required to answer the focus question. If starting from an already written document, the main concepts or ideas can be highlighted or underlined from it.

3.1.3 List of concepts

Next, facts, terms, and ideas which are in any way associated with the main idea and which might also be needed to answer the focus question are identified. A list of these concepts is made using a single word or short phrase for each of them. This is the brainstorming process, so everything regarded as important should be written down. There is no need to worry about redundancy or relative importance at this moment. Before this step is completed, a list of about 15 to 25 relevant concepts might have been compiled.

3.1.4 Rank order

Next, a rank-ordered list is established starting at the top with the most general concept to the most specific, least general concept at the bottom. Concepts can be rearranged freely and new items introduced that were omitted initially. Generally, this list is called a parking lot in the literature, Fig. 3, since these concepts will move into the concept map as seen fit. Some concepts may remain in the parking lot until the map is completed, if the presenter does not find a good connection of these with other concepts in the map.

3.1.5 Preliminary concept map

The next step is to construct a preliminary concept map. The concept map is initially built with 1 to 4 most general concepts from the parking lot, and then explicit linking words to relate concepts are chosen, i.e., to form good

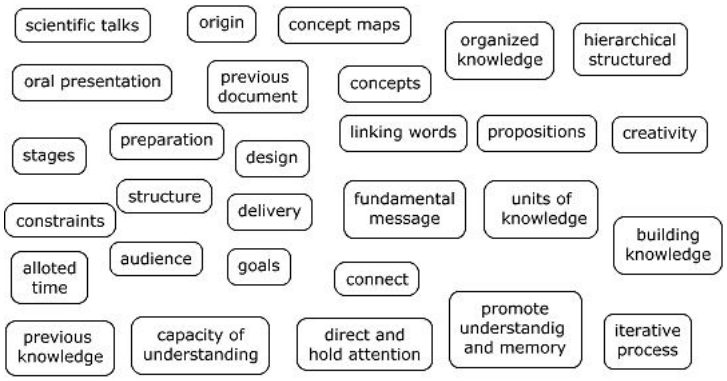

Figure 3: An example of parking lot with the concepts handled in this article.

propositions. This can be done by writing all of the concepts on post-its, or preferably by using the CmapTools program described previously. Post-its allow a group to work on a whiteboard and to move concepts around easily. This is necessary as one begins to struggle with the process of building a good hierarchical organization. The Cmaptool program allows restructuring the map as well by the moving of concepts together with linking statements and the moving of groups of concepts and links. This process prevents the inclusion in the map of irrelevant information or secondary details. As already stated, concepts not contributing to communicate the message should not be included in the final presentation.

3.1.6 Iterative process

After a preliminary map is constructed, it is always necessary to revise it. The concept hierarchy can be rebuilt by iteratively considering the relevance and concept organization and the addition of arrows. Once the preliminary map is built, cross-links should be sought, that show relationships between concepts in two different map sections. These help to illustrate how domains are related to one another. Good maps usually result from three to many revisions. This is one reason why using computer software is helpful.

In reviewing your concept map, the following questions proposed by [12], can be considered:

- Accuracy and thoroughness. Are the concepts and relationships correct? Are important concepts missing?
- Organization. Was the concept map laid out in a way that higher

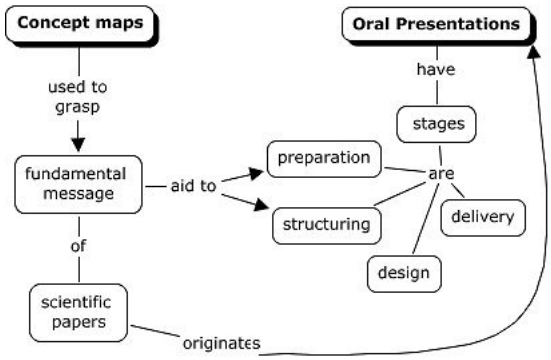

Figure 4: Using concept maps to improve scientific communications.

order relationships are apparent and easy to follow? Does it have a title?

- Appearance. Was the assignment done with care, showing attention to audience expectations? Is it precise and orderly, or is it chaotic and messy?

- Creativity. Are there unusual elements that help communication or stimulate interest without being distracting?

3.1.7 Reposition and map structure refinement

Finally, the map should be revised, concepts re-positioned in ways that lend to clarity and better overall structure, and a final map is thus prepared. In this way, what the fundamental message of the presentation is should be clearly understandable, so that it can be clearly communicated to the audience, avoiding irrelevant information or secondary details which distract and often obscure the main message.

When computer software is used, one can go back, change the size and font style, and add colors to the concept map. Summing up, concept maps are a powerful tool for capturing, representing, archiving, and summarizing the knowledge accumulated from research (article, book, or project) in a synoptic way appropriate for oral communications. Figure 4, shows the map relating oral presentations (see Fig. 1) and concept maps (see Fig. 2).

4 The Structure of Presentation

As pointed out by many authors, such as Anholt [1] or Alley [4], a well-structured presentation consists of three parts: the introduction, the main body, and the conclusions. It is not obvious at first what to say in each part, with what depth, within what time, and how to transition from one part to the other (and within parts of the body). One of the most simple and helpful pieces of advice is, "Tell them what you are going to tell them, then tell them, and then tell them what you've told them".

Before structuring the presentation, the important role played by the title must be remembered, as it can attract or deter an audience. Therefore, it should be descriptive, concise, and give the scope and focus of the conference. The concept map already prepared can help to identify the key words and concepts to appear in the title.

The introduction is the place to explain what the talk is about and why it is important to the audience. This is the time to introduce the focus question or main message. The concept map will have helped to clearly identify this main idea or core concept.

In the body of the presentation, there should appear the evidence and details supporting the thesis, but without overwhelming the audience. Depending on the audience's background knowledge and on the allotted time, different strategies can be followed to achieve a satisfactory balance between scope and depth (see [4] for a meaningful discussion). The concept map helps to identify the main and subordinate or secondary concepts, thus giving a clue about which concepts should be included in the final presentation and which should be left out. The different branches of the map can articulate different parts of the main body.

Finally, in the conclusion, the fundamental message should be impressed upon the audience with a short and memorable phrase. As Anholt [1] points out, "it provides the take-home message, often the only thing that will be remembered".

5 Conclusions

Exchange of scientific information through verbal communication is becoming increasingly more important in conferences, universities, committees, and even academic job interviews. Oral presentations are not written articles read loudly to the audience. In a presentation, the relevant information must be separated from irrelevant details and secondary information,

from overwhelming amounts of supporting data and detailed experiment descriptions. All this information is of course important and must be given, but in the form of an article, a report, or any other type of printed document, and not in oral form during the presentation. With the aid of concept maps, it is easy to better visualize fundamental concepts and how they fit in every part of the structure of an oral presentation. They help to include only the relevant information in the place where it is needed, thus contributing to the overall improvement of presentations and science communication.

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