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THE CONCEPT MAP AS A COGNITIVE TOOL FOR SPECIALIZED INFORMATION RECALL

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Abstract. The present article discusses some aspects related to the process of text analysis with a concept map aiming at structuring textual knowledge and achieving a better recall of information in the context of teaching technical translation. The concept map is considered not as a system for representing knowledge structures of domains, but as a cognitive means used as a method for text analysis in specialized fields. The paper reports data from a research project in which the author carried out an experiment on two groups: the 1st group analyzed the text by extracting its data in the form of a concept map, whereas the 2nd group proceeded using the traditional tool of text analysis. The two groups were later subjected to recall tests; free recall and recall by questionnaire. One very consistent finding shows that the use of the concept map as a tool of text analysis helped not only in retaining the main information units of the text, but also in recalling textual units in defined semantic categories.

1 Introduction

The referential basis of this paper is a study by the author on knowledge representation in both reading and translation tasks and its effects on knowledge acquisition and development in specialized fields. In bringing the translation learner to the expert level, we argue that performance can be improved when the methods and strategies are specifically targeted and taught. This paper sets out to briefly develop the use of concept maps as a means to cognitively maximize and structure domain-specific knowledge and hence guarantee better integration and retrieval of information in specialized texts. The study is part of an ongoing thesis research project at the School of Translation and Interpretation, *Ecole de Traduction et d'interprétation* (ETI), and joins a series of studies being presently launched by this institution with the purpose of developing the empirical research base in translation and interpreting studies. It aims at improving professional training in specialized fields to keep pace with the increasing demand for highly-qualified specialized translators. The massive quantity of information available in real or cyberspace obliges trainers to conceive innovative training methods that provide students with consistent strategies or techniques to approach the considerable mass of fragmented textual materials. Introducing concept mapping as a synthesis instrument is believed to facilitate the management of information written in expert language. In this sense, the use of concept maps may help students in specialized translation courses to distinguish the essential from the accessory when processing domain-specific texts and to acquire instrumental skills for "meaningful learning". In fact, the concept of "meaningful learning" implies that we learn new knowledge by relating new concepts to a network of concepts we already know. Therefore, learning meaningfully means being aware of the nature of relationships we define between objects or facts when integrating them into the existing knowledge base. Consequently, information is being stored in specific organized blocks. Contrary to rote learning, where new information is integrated without defining links between old and new information, the construction of knowledge through concept representation may lead to more efficient storage in memory and superior retention over time compared to retention of unrelated descriptions of a topic.

Over the last three decades work in the psychology of language has focused on the description of cognitive structures and processes of language comprehension and production (Bereiter and Scardamalia, 1987; Gernsbacher, 1990). In textual linguistics, it is assumed that understanding a text implies constructing a mental representation of its meaning. A reader builds a mental representation of the text content when reading (Britton and Graesser, 1996; van Dijk, 1997; Kintsch, 1998): *"A reader's resultant mental representation of a text is not a mere copy of the text with its linguistic structures, but converts the text form from a linguistic object to a conceptual object"* (Van Dijk, 1997, 18). One effective method to reach a coherent mental representation for encoding and retrieving information is to rely on the structure of the text (Meyer, 1975; Meyer and Poon, 2001). A skilled reader tends firstly to extract from a text a conglomerate of highly important units of information in order to construct the abstract mental representation of the text (Langacker, 2001). In this way, discourse features and other linguistic signals are considered as *"a kind of temporary scaffolding, put up in stages in order to construct a more permanent consolidated structure"* (Langacker, 2001, 181). Due to working memory constraints (Baddeley, 1992), it is not possible for a reader to retain everything in a text, therefore *"some information more than others must be selected for deeper encoding and more cycles of processing or elaboration"* (Meyer and Poon, 2001, 141).

The study of professional communication has brought new insights into the nature of linguistic skills and shown how expertise is acquired through knowledge organization and reorganization and not only by way of a steady accumulation of information (Swales, 1990; Ericsson and Kintsch, 1995; Moser-Mercer, 2000). We know that experts are able to perform domain-specific tasks at a level consistently superior to the performance of non-experts. We also know that experts develop, through extensive practice, domain-specific skills that allow them to extend their working memory ensuring fast and reliable performances (Ericsson and Kintsch, 1995; Baddeley, 2000). Empirical findings in the cognitive field have confirmed the positive effects of knowledge organization and cognitive representations on information memorization (Schenk et *al.*, 1998). These positive consequences are determined by a higher availability of information when processed in a structured representation. Cognitive representations can, therefore, guarantee information conservation and knowledge systematization. Extending these findings to the translation field, empirical studies have shown that qualitative differences in translation performance between experts and novices were the result of the former's superior knowledge organization structures associated with the translation task (Wilss, 1996; Moser-Mercer, 2000; Jarvella et *al.*, 2002; Shreve, 2002). Thus, much depends on how things are cognitively arranged, represented, and stored in or retrieved from memory (Shreve, 1997, 161). In other words, professional translators are aware of developing strategies and working methods when translating and do not simply rely on the quantity of information they know.

Considering that translation involves, firstly, a particular type of text comprehension, the notion of mental representation serves as a major translation goal knowing that mastering translation is equivalent to extracting and retaining from a text the essence of its meaning in order to transfer it to the target language. However, the distinction between important and less important information is dependent on the type of textual content and its relation to the specialized field. In a specialized context, mental representations are basically conceptual and constructive, because the objects of interest are conceptual systems. Therefore, the reader is bound by a presupposed discourse type, in form and content, that is to say by linguistic and conceptual features, because the text type is governed by established norms and realities leaving little space for the reader's interpretation. Consequently, the construction of a translational mental representation of a text in a technical domain, for example, calls for a map that contains information on technical concepts. The resultant map regards features of the text in its relation to the technical context within which the text is formulated. Accordingly, one assumption would be that the permanent structure in a specialized field refers to a unit of a conceptual representation belonging to a global conceptual system. For this reason we refer to mental representations as conceptual representations. Applying the notion of conceptual representation by means of concept mapping, for instance, could help improve the quality of information extraction and text comprehension. We chose to limit the current study to a specialized field for two specific reasons: not only does specialized discourse seem to be situated at the borderline of expert knowledge and "fuzzy" knowledge, the latter including various discourse aspects such as style, rhetoric (typical metaphors), discursive structures (text patterns; methods of proof and demonstration); but it also, and essentially, deals with conceptual information in an organized manner that is articulated within the representation of conceptual systems. In this way, specialized texts refer to concepts which have been classified and defined by experts in their field of performance (Van Dijk, 2001, 8). Whether the reader manages to construct a congruent model of the text depends on how coherent she/he can make use of the information contained in the text. The reader who does not possess the knowledge of the expert needs to have access to the relevant knowledge in order to understand the text and be able to translate it. She/he should have an adequate mental model of the technical field dealt with to be able to understand and maintain the appropriate connections between the text and its domain of reference. Since comprehension involves the abstraction of information from the linguistic form to integrate it in a abstract form, this process entails many cognitive sub-processes ranging from problem resolution (trial, hypothesis, error) to decision making (confirmation, conclusion), implying the involvement of some domain-relevant tasks or language-processing strategies.

2 Strategies for Translation in Reading Phase

Considering the fact that translation is a complex activity that comprises many sub-skills; reading-comprehension-writing, reasoning, problem solving, decision making, attention and recall, etc. (de Groot, 2000), it seems logical to start analyzing the translation process at the very beginning, i.e. at the level of the reading process. Any strategy to be envisaged for taking translation decisions would have to be based, to a large extent, on the quality of the input process, i.e. the reading comprehension process. Research on reading indicates that any outcome of text processing is determined by the level of understanding needed for an optimal performance and the extent to which one is able to derive information from the text and coordinate it with the reader's existing cognitive representations. This

assumption holds true as long as verbal material can successfully access an integrated conceptual representation in the memory system. The fact is that cognitive studies admit that one of the principal factors responsible for comprehension in reading is the knowledge stored in long-term memory and the way this knowledge is transferred to working memory as new information interacts with existing information. In language processing, there is an assumption that activation input, through reading for example, relates to networks assembled in long-term storage. These connections are thought to include lexical representations, word order patterns, conceptual/functional representations that represent communicative intentions or meanings (MacWhinney, 1997). Other memory structures related to procedures (strategies, tactics), representations of textual schemata, concept structures, etc., are supposed to be implicated in input activation. There are many strategies to represent a problem in a specific situation. One of the most frequently used in enhancing memory capacity and visualizing the problem from different vantage points is the strategy of classification by categories. This classifying strategy uses tools ranging from visual maps, semantic networks, hierarchical schemata, etc., and intensifies specific cognitive skills such as analysis, comparison, inductive and deductive reasoning, and thus improves comprehension. We propose that the conceptual mapping technique is a means to allow for mental knowledge organization by delimiting the conceptual framework of a domain through the identification of links between different concepts. We believe that this type of concept arrangement may facilitate not only the acquisition of structured knowledge, but also the retrieval of mentally linked concepts and benefit the recall of information. For technical texts, the introduction of concept mapping as a cognitive strategy during the reading process might lead to a better representation of their conceptual contents and, more specifically, enhance the process of knowledge construction for the development of expertise in specialized fields.

2.1 The Concept Map; a Mental representation Tool

Many studies investigated concept maps as information research tool (Kommers et *al*., 1992; Kremer and Gaines, 1996; Debourges et *al.*, 2001). From a communication perspective, the emphasis is put on the efficiency of cartography to synthesize complex realities in a new composite world represented as a complex network of information. Such representations bring out the complexity of relations that characterize information superhighways, as we are developing schemata in trying to "come to grips" with the knowledge industry. Concept maps can also detect common ideas that are implicit and help reorganize information that needs to be communicated (Lemire et *al*., 1998). In that sense, the representation of sets of concepts or ideas highlighted in a map is not normative and the linkage between concepts is not predetermined. Accordingly, a concept map is not comprehensive. It describes the knowledge structure of an individual, expert or novice, on one specific theme: *"concept maps are represented as one way to synthesize the conceptual structures of individual experts in a domain and describe this expertise in a visual and coherent manner"* (Lambiotte et *al*., 1989). For that reason, it is sometimes employed to underline the differences between novice and expert performances. Therefore, it is important to keep in mind its highly individual nature.

From a cognitive perspective, the concept map has been used as a psychological artifact or instrument to structure, guide and, if needed, transform knowledge on the basis of socio-cultural and psychological traditions. Hence, as a learning aid, several experiments directed at improving learning were carried out in various situations and for specific purposes; evaluating program courses (Thomson, 1997); eliciting experienced mentor teachers' practical knowledge (Zanting et *al*., 2003); analyzing the presentation of concept descriptions in textbooks (Wu et *al*., 2004); developing and sharing training materials destined to the interpreter trainers' community (Moser-Mercer et *al*., 2005). In this context, the benefit of concept mapping rests on its mediating feature as cognitive scaffolding that sets a specific aim for the activity to be achieved (by selecting concepts and defining the linkages between them); determines the schema that needs to be developed in order to achieve this aim (by representing the conceptual set), and offers an opportunity to choose the means for achieving this aim (by making a deliberate choice of nodes and their relationships according to how they are perceived). In view of all these considerations, concept mapping represents a method of work that emphasizes awareness and familiarity with the nature and structure of the problems encountered. This aptitude refers to the notion of *deliberate practice* which explains, in the literature on expertise, the experts' superior performance, because it mediates the development of skills for knowledge acquisition rather than represent aggregate experience. In a way, concept mapping provides for ongoing pattern learning whose aim is the identification of meta-knowledge, its representation and storage. This orientation brings us back to one of the most important ideas in Ausubel's theory stating that the storage of information in the brain is highly organized with linkages formed between various older and newer elements. This cognitive structure

represents a framework for organized concepts which are the individual's representations of sensory experience (Ausubel, 1968, 506).

In the field of specialized and technical translation, every one agrees that prior domain-specific knowledge is crucial for ensuring a high level of translation quality. In addition to the fact that translators must take into account the translated text in accordance with the norms governing a specific translation situation and the pertinent value of its information, they are involved in the coherent construction of discourse itself. This is made possible through the construction of knowledge of the specific field and through existing knowledge. This is further support for the cognitive view of learning defended by Ausubel who stated that: *"The most important single factor influencing learning is what the learner already knows"* (Ausubel, 1968, vi). For that reason, we borrow the notion of concept mapping that has proved effective in the educational field (Ausubel, 1968, Novak and Gowin, 1984) and apply it as a specific-domain knowledge structuring tool and as an aid for information recall. Consequently, we see concept mapping as an efficient tool and strategy to be used in specialized translation training. The following have been taken as working guidelines: *"The recall of previously learned and known ideas – the individual thinking "What do I know about {x}?...The recording of new ideas as a result of some learning situation…An individual "thinking about" some already known idea or ideas in response to some event or situation"* (McAleese, 1994, 9). On the basis of these arguments we have chosen to include the cognitive process of recall as an integral part of learning. Our experiment focuses on the influence of concept map construction on the reader's ability to retain specific-domain information contained in a technical text.

3 The experiment

This concept mapping study explores concept representations in text processing through the use of concept maps as a cognitive tool. The study analyzes students' retention performance after having been trained to construct concept maps. We hypothesize improved recall of specialized concept representations at the end of training on text analysis with concepts and, after practice, more efficient knowledge construction. More specifically, we will discuss the performance of students in recalling the main information extracted from technical texts. "Main information" is considered to be information units that meet the criteria for main information set by the instructor. We considered the following criteria as measures to evaluate recall performance for both groups:

- Number of information units recalled in general,
- Number of main idea units recalled,
- Degree of cohesion between information units

Answers were examined according to their fit with the information units defined in the conceptual grid.

3.1 Method

We believe that the process through which a cognitive tool is appropriated and mastered by a student is not a simple task. It is a rather demanding process which requires extensive training and controlled practice (O'Malley and Chamot, 1990; Wertsch, 1998); *"Because strategies are complex skills, a person attempting to apply an unfamiliar strategy to a demanding task will have difficulties in controlled processing that can be anticipated from performing two complex tasks simultaneously. It is for this reason that teaching students to use new strategies with cognitive tasks is extremely difficult"* (O'Malley and Chamot, 1990, 52). Despite the fact that we initially had planned for a study period lasting several months, we could not mobilize the same participants for a period exceeding one month.

3.1.1 Participants and Material

A representative sample of 14 francophone students (7 females and 7 males) studying at the School of Translation, University of Geneva, participated in the experiment. All of them have a very good level of English as a second language. In spite of that, we introduced a Likert type test composed of nine questions to assess their perceptions of training and to test their perceptions of text difficulty, background knowledge, motivation, importance, clarity of arguments, organization, etc. For example, for difficulty assessment, the question asked is: How difficult did you find the text to read and understand? For quality assessment, the question was: How would you assess the level of your background knowledge in this text? The answers were rated on a scale from one to five. For example, to

measure quality, answers were rated on the following scale: Very good, Good, Barely Acceptable, Poor, Very poor. As far as the linguistic part of the Likert test is concerned, the results of the test showed that despite the complexity of specialized knowledge, answers reflect general comprehension of all texts. Subjects could choose to answer in French or English; this was done in order to exclude any linguistic reason that might hamper the recall of information. The participants were selected from two different curricular phases of the translator training program; 1st and 2nd cycle. They were divided into two groups (Gr.A and Gr.B).

Two technical-scientific texts, one on the *Watch*, the other on the *Brain*, were submitted during the last session of training to Gr.A and Gr.B for analysis using either the concept map technique or the traditional text analysis technique. These texts were then the object of free recall and questionnaire recall tests. Both texts represent a granular description of the aforesaid notions (Watch and Brain) and were prepared to have identical content structure with approximately the same number of idea units; 36 for the *Watch* text and 37 for the *Brain* text. But they had different content, that is to say lexical units specific to text and not exactly the same types of relations between idea units. For that, they were prepared according to an analysis grid divided into conceptual categories ranging from the most important segment of the text analyzed to the less important. Each segment was referred to by the type of its conceptual class defined by its links with surrounding lexical units. A conceptual framework was then developed regrouping concepts of each text according to their conceptual category. For the *Watch* text, the concept of *"mechanical watch"* comprises, for example, the following:

- Mechanical watch(Part) = mainspring, gear train, escapement
- Mechanical watch(Spec) = self-winding watch, complicated watch

"Part", holds for the category designating the parts of the watch. *"Spec"*, holds for the conceptual category referring to different types of this watch, etc. As for *Brain* topic, the concept of *"cerebellum"* comprises the following:

- Cerebellum(Func) = coordinating movement
- Cerebellum(Prop) = 10% of the brain weight

"Func", is the category referring to its function. *"Prop"*, refers to its characteristics, etc.

3.1.2 Procedure: training and recall tests

Participants were introduced to the technique of conceptual representation (either concept mapping or traditional text analysis techniques) for a period of four weeks. Recall tests were administrated two days after the end of the first part of training without any prior notice. The entire experiment involved two experimental design-components. During the first phase, group one (Gr.A) was introduced to the technique of concept mapping for analyzing technical texts after reading. Gr.A was given theoretical material on concept mapping followed by text analysis exercises. They constructed several maps individually by analyzing expository technical texts of about 400 words each. They were asked, for instance, to find the key concept in the text and determine its links with other associated concepts; or, to select different linking words (*marqueurs linguistiques*) and define the conceptual category to which they belong; etc. Under the same conditions, the second group (Gr.B) performed text analysis in a traditional fashion, that is to say, by breaking down a text into ideas. Gr.B proceeded by dividing the texts into paragraphs and extracting major, secondary and tertiary ideas.

Experimental Group	Presentation of method I	*TEST 1* : 2 weeks after training on method I	Presentation of method II	*TEST 2* : 2 weeks after training on method II

Table 1: Experimental Design

For reasons of counterbalancing, the groups were inversed and the same measures were repeated for Gr.B. during the second phase of the training.

After a month of training, the two groups (Gr.A and Gr.B) were subjected to recall tests: free recall and recall by questionnaire. The free recall test was administered first. Subjects were asked to recall, in the form of continuous writing and not as separate ideas, the content of the text they had analyzed two days prior to the recall test. They were asked to write down all the information they could remember from the text, using their own words if they could not recall the exact term. In case they remembered an idea but not how it was related to other idea units, they were invited to explain the idea and not simply write down the word. The test lasted 20 minutes. Recall data was scored according to the presence or absence of idea units as compared to the original text. As for the questionnaire, seven conceptually-oriented questions were asked. Following are examples of some of the questions:

- What are the different types of a mechanical watch as mentioned in the text? (*Spec*) Give one main characteristic of each type (*Prop*)
- Name at least two parts of the analog quartz watch? (*Part*)
- How would you define a watch with analog display? (*Prop, Part, …*)

Recalled information was scored for accuracy in accordance with idea units of the text. For the purpose of this article, we focus our discussion on the results of the 1st phase of the experiment; Gr.A/concept mapping technique *vs*. Gr.B/traditional analysis technique.

3.2 Results and Discussion

The mean of remembered ideas by each subject was computed. The mean of the total recall for both groups was also computed. We present here the average of the recall scores of our results: the recall average for Gr.A, the first one to be initiated to the concept mapping technique, as established through questionnaire is 50.5% of the text value (as established by the instructor). The value of recall did not exceed 35% of information remembered within the same group (Gr.A) after having analyzed a text with traditional text analysis tools (text division into paragraphs and ideas). One interpretation of the results is that when the specialized content was not familiar, Gr.A subjects mentally represented the network of concepts drawn from the text in an organized way and recalled more ideas. The definition of the nature of links between concepts helped with the retrieval of idea units. On the other hand, Gr.B who used the traditional text analysis first, recorded an average of recall of only 36.42%, with a slight improvement of recall (42.85%) when applying the concept mapping technique. This improvement in recall may be explained by the fact that with a specialized unfamiliar content, Gr.B subjects used the concept map as an organizational and explicit strategy for text analysis. They selected from memory the representation they used as an overall structure processing defining main concepts and the nature of their relations. Their attention became more focused on specific concepts than on linguistic units and recalled more information. This interpretation was backed by the comments collected from the subjects after the recall tasks. We have noticed the same recall tendency in the free recall results - a better performance for Gr.A than Gr.B - with a slight improvement in information retention capacity when both groups perform a free recall.

From a qualitative analysis perspective, at least two different situations emerge:

- Terminological problems show that even though terms were not exactly reproduced, the notions were perfectly retained even if they were described in other words; e.g. “a self-winding watch” *vs*. “winding by wearer’s arm movement” or “automatic”. This conclusion is apparent with subjects of Gr.A while they were using the concept mapping technique. Notional abstraction necessary for information accumulation operations does not seem to pose as many problems as for the recall of terms.
- Organizational problems refer to difficulties encountered in linking conceptual units. An interesting confusion during data recall was noticed for Gr.B. The analysis of *Brain* text revealed that Gr.B subjects had more problems differentiating properties of parts of the brain than subjects in Gr.A: e.g. the misattribution of one of the properties of the “brainstem” (reflex control) to the “forebrain”, or the confusion between one of “brainstem’s” parts (medulla) with another part of the “forebrain” (cerebrum). In brief, it seemed that the borderline between different notions evoked in the texts was not as distinctly clear-cut for Gr.B as it was for Gr.A subjects.

Generally speaking, recall results show that the average of recall performance was low for both groups. We attribute this performance to the time that had elapsed between text analysis exercises and to the effect of surprise; recall tests were administered 2 days later without prior notice. The low number of remembered idea units could

perhaps be attributed to the complexity of ideas described in texts used during the training sessions and during the recall tasks; text difficulty as established through the Likert scale questionnaire was significant for most subjects. This low recall value could also be explained by the fact that the twenty-hour training period, even though spread over one month, was too short to enable the subjects who were not familiar with concept mapping to develop the strategy adequately. But the traditional technique of text analysis did not produce better results either. There was, as noticed, a significant difference between the two groups' results, with a better score for Gr.A using the concept mapping technique for text analysis. The results of the Likert scales, backed by comments collected from the subjects after the recall tasks, showed that subjects were more motivated analyzing texts by using the concept representation strategy than in a discursive classical fashion.

4 Summary

From a cognitive perspective and to sum up previous observations, we would presume that high level conceptual knowledge facilitates low level text processing when it is organized in an isomorphic way through mapping between domain conceptual systems, as reflected in specialized texts, and the external representation as drawn in a map by the individual. As a result the integration and accumulation of new information in cognitive preexisting structures is facilitated. Confusion noticed in examples of Gr.B results suggests that Gr.A subjects' attention was redirected from the beginning (reading process) towards the recognition and definition of conceptual links between notions which consequently facilitated access to the mental representation.

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