Cognitive support: a Machine-Mediated Communication perspective.

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Abstract
This paper provides an MMC perspective for the provision of cognitive support. First, an overview of cognitive operations and categorization of cognitive tools is given. It then briefly describes a cognitive support application based on the provision of semantic structures of content. The suggested tool is shown to provide an ‘operational’ dimension that extends its intrinsic nature as an ‘observable’ asset.

1. Introduction

One of the greatest challenges for Machine-Mediated Communication (MMC) is the provision of cognitive support. This is where the machine mediates the communication of cognitively-demanding content, providing support to the high order cognitive processes involved in the conception of such content. There are various situations in which such support would be required e.g. amongst other things, there is learning, problem-solving, design. We are mostly concerned with learning in the work we do at the APT Research lab at the University of Bolton.

In order to find out about the role of technology in general, and MMC in particular, in the provision of cognitive support we need to identify the cognitive processes to be supported. In the literature, tools of technology used to provide cognitive support are referred to as cognitive tools. In general, such tools are said to enhance, amplify and extend the cognitive capabilities of users. To do this, such tools are said to help users in their elaboration, reflection, visualization, representation… and so on. In other words, it aims to support higher order thinking processes, to engage users in critical thinking and/or to free learners from the tedious, labourious and memory intensive processes (lower level thinking processes) that tend to overburden the cognitive system [1,2].

Another perspective, very rudimentary but quite effective, is an old Chinese proverb: “I hear and I forget, I see and I remember, I do and I understand” This is a reflection of how effective it is to use multimodality in MMC; by attaining full engagement.

In spite of the appeal of such an elementary view, we have to take a more informed psychological perspective, and we start by defining our scope of cognitive operations in section 2. Following that, an outline for the categorization of cognitive tools is given in section 3 before the semantic structures for cognitive support is considered in section 4.

2. Cognitive operations

The interest in understanding cognitive processes is now far greater than ever before because of the potential of computers in supporting and enhancing such human capability. Various schemes have been developed along the years to analyse and categorise cognitive processes, ranging from Jug’s eight cognitive processes [3] to Bloom’s taxonomy [4].

In our analysis we distinguish between three aspects of cognitive operations: cognitive levels, cognitive processes and cognitive activities. A cognitive level is an indication of the level of processing in which the subject may be involved. Along the lines of Bloom and Gagne, four cognitive levels could be identified: interpretation, comprehension, integration and application. Interpretation is mainly a perceptual level in which the cognitive system behaves autonomously with no conscious intervention from the subject. The latter three are levels of rational thinking in which conscience cognitive processes are involved. The first of these is the level of comprehension, mainly responsible for the conceptualization of perceived data, in which the subject deals with resolving basic concepts. This is a basic level of rational cognitive thinking, above which the other two levels of higher order thinking operate.

At all cognitive levels, various cognitive processes are involved. For example, at the interpretation level, processes of recognition, schema activation and recall are called upon. The comprehension level, on the other hand, involves the three levels of knowledge acquisition identified by Rumelhart and piaget: accretion, tuning and reconstruction [5]. Then, higher order thinking is encountered in integration and
application, in which the subject is involved in processes of organization and categorization, comparison and contrast, analysis and evaluation... and so on, in order to integrate new knowledge with previous experience and to be able to apply the newly acquired knowledge to real-life situations.

The third aspect of cognitive operations is that of cognitive activities. This refers to the external activities in which the subjects get involved in order to enhance and support their intrinsic conscious cognitive processes. Simple things like diagramming and sketching on a piece of paper have always been very effective cognitive activities, in which the pencil and paper used are the cognitive tools; the corresponding cognitive activities are externalization and representation. With the advent of computers, however, we are faced with the challenge of harnessing such a powerful machine for extending and enhancing these cognitive activities.

3. Cognitive tools

Cognitive tools are computational applications designed to support, extend and enhance the cognitive processes referred to in section 2. More specifically, the various aspects of externalization and representation that could be supported by computers can be grouped in three categories: visualization, content-based processes and model-based processes. Visualization is a straightforward extension of the basic graphing and diagramming activity that used to be supported by pen-and-paper, but now aims to use the sophisticated capabilities of computer graphics. Activities in the other two groups are based on content handling e.g. for marking and note taking, and user-modelling e.g. to provide guidance and feedback; this territory used to be known as intelligent tutoring systems (ITS). Other aspects of support e.g. authentic activities, such as simulation and remote access, and collaborative environments are not considered in this brief overview. Our own contribution to cognitive support is a content-based application, which is considered in the following section.

4. Semantic structures for cognitive support

The development of a semantic structure for a presentation aims to provide a sophisticated conceptual representation of such content, with which the user can ‘interact’. This adds an ‘operation’ dimension to what is basically an ‘observable’ asset, as suggested by Elsayed [6]. The semantic structure we are working on aims to combine a hierarchical classificatory organisation with a semantic network organisation in a single framework. The user can then take a ‘hierarchical content’ approach or a ‘networked index’ approach when interacting with a supported document. Furthermore, the user can produce his/her own conceptual understanding of the document in the form of topic/mind maps, which the system can check and support, having access to an explicit semantic (machine) representation of the document. Finally, the user can produce ‘e-notes’ while working through the document, hence allowing the accumulation of collected notes in a ‘personalised’ form.

5. Conclusions

This paper addresses the challenge of using MMC as a framework to guide the development of cognitive tools. After providing an overview of cognitive operations, the paper offered a perspective for the categorization of cognitive tools.

A methodology for cognitive support was then briefly described to show that the provision of semantic structures of content is capable of providing an ‘operational’ dimension that extends its intrinsic nature as an ‘observable’ asset. Such ‘operation’ provides an opportunity for full engagement with content, something that was not possible before. We are now planning a number of experiments to test the effectiveness of this new cognitive tool. The results of this work will be reported in future publications.

6. References