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COMBINED USE OF CONCEPT MAPS AND DATABASE AS MIND TOOLS TO HELP INTERDISCIPLINARY TEAMS TO SOLVE REAL CASES BASED ON THE THEORY OF COGNITIVE FLEXIBILITY. EXPERIMENTAL STUDY

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Technologies modify the way to face the challenges of learning by widening our biological capacities. This use of technologies as mindtools, cognitive reinforcers, activators of psychological functions, can determine the turning point to consider its unavoidable incorporation into interdisciplinary working processes, problem resolutions and shared building of knowledge. Training of experts to face real cases compels to reach competences such as learning to learn; learning environments must not only make transformative learning processes easier, but also facilitate learning in cooperation and cognitive flexibility to analyze the cases from different points of view. The use of information and communication technologies and specifically mind tools such as concept maps and database, can help to the achievement of expert learning. The investigation made with a sample of 63 students and speech therapists, psychology and pedagogy professionals is presented. They have to solve 11 real cases of children and non vocal adults that use communication augmentative in the cooperative work with computer resources. One of the groups handles the traditional protocols and the other concept maps and database. The novel groups of students learn the same way by using either protocols or database. Nevertheless expert students and professional improve their performance when their learning is managed by concept maps and database.

1 Introduction

Knowledge construction is an individual act, but, at the same time, it is a complex process that can be fostered by external tools. Technology can nowadays provide the teacher, the student and the learning context with certain resources and tools hat somehow disburden both the teacher and the students´ minds allowing them to undertake complex problem resolution that are frequently incorrectly structured, at last from an optimized point of view. As pointed out by Adell (2004): “The use of technology by itself does not improve teaching and learning. A good teacher is so with or without technology. However, when using the right technology, a teacher is much better indeed”. Hence, it is tempting to extend this rationale to the student and the teaching context as well: that is, a good student (a good context) becomes much better in the presence of the appropriate technology. Most of the real problems faced by teaching professionals require a certain control over the apprenticeship itself, in order to take decisions, reflex, plan, evaluate resources and elaborate a new product. In this regard, many authors point towards the use of semantic networks in complex teaching processes as a simple tool in order to face the real problems from various points of view and then develop collaborative activities.

2 Cognitive Flexibility Theory

Cognitive flexibility theory (Feltovich, Spiro y Coulson, 1989; Lima, Spiro y Koehler, 2004) presents learning as the skill to represent human knowledge, insufficiently structured, from various perspectives. This multidimensional way of learning is considered the most adequate to move around the diffuse knowledge domains, in which the solutions to problem are not clearly delimitated, hence demanding the apprentice to face the problem considering various options and possibilities.

“By cognitive flexibility, we mean the ability to spontaneously restructure one’s knowledge in adaptive response to radically changing situational demands. This is a function of both the way knowledge is represented and the processes that operate on those mental representations” (Spiro y Jehng, 1990: 165).

Most of the knowledge domains encountered by both teaching professionals and higher students possess significant degrees of complexity. This learning model affirms that the cases and problems of the world are unique and multidimensional, enclosing several aspects, hence requiring from the apprentice the adoption of a large variety of perspectives (Shapiro y Niederhauser, 2004). These fields of knowledge, which are ill-structured can be better undertaken from the simultaneous use of TIC, since because of its non-lineal access system and treatment of information, because of its hypertextual composition, facilitate the achievement of metacapacities of flexible thinking.

3 Mindtools

These tools are based upon the theoretical fundaments of cognitivism and constructivism. Part of the attraction exerted by conceptual networks lays on the similarities found by many authors with the performance of human mind or various forms of artificial intelligence, or even similarities with the hypertextual structure of the network of networks (Nó, 2004; Tiffin y Rajasinghan, 1975). There are numerous tools in the Internet (semantic networking tools) that allow the generation of semantic networks in a simple way, and they even facilitate ways of navigation due to the inclusion of links to additional webpages or networks, and tools that permit the generation of network frameworks, communicate and share the generated products, etc. In the same way, a database allows the apprentice to organize the information according to various criteria, establish comparisons, analyse phenomena and make decisions. It must be built by the apprentice himself, preferentially in a cooperative working environment, since they guarantee the assumption of various perspectives in order to create the criteria. Several authors involved in the use of semantic networks and databases in learning processes (Jonassen, 2004; Jonassen, Howland, Moore y Marra, 2003) indicate that they are indeed some of the simplest mind tools and with a wider and popular use.

4 Experimental design

The aim of the present study is the examination of the development of critical thinking aptitudes, to learn how to learn and to learn how to teach, always applying these emerging capacities to contents positioned in the ill-defined borders of knowledge, generating pa learning environment capable of undertaking ill-structured problems, following working methodologies of cooperative work within a format of case solving format. This group of personal competences, grouped under the name “expert knowledge”, would allow the student to supply innovative solutions during the resolution of problem cases. With that in mind, two comparison groups were established: “G1-mindtools” and “G2-matrices” in which young alumni worked with expert alumni and teachers in a collaborative way. The first group G1 used mindtools with a backup of databases and concept maps (figure 1) whereas group G2 used traditional instruments based on protocols.

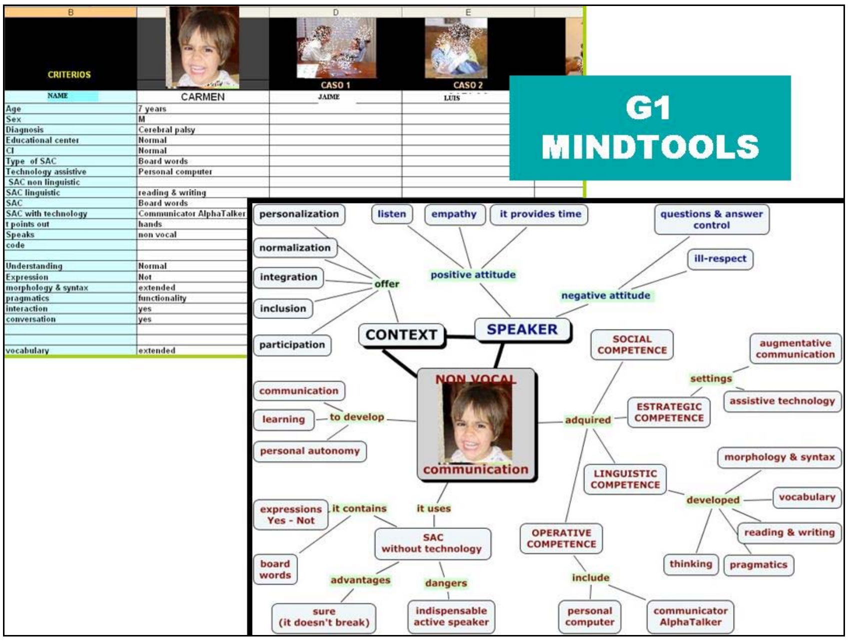

Figure 1: Mindtools: concept maps and database.

All of them were analysed and they solved 11 cases of kids, youngsters and adults with Brain Paralysis and non-vocals that tried to introduce improvements in their Augmentative Communication systems. These cases had been selected by a group of 15 experts, professionals that had been over 8 years working on the evaluation and intervention with Augmentative Communication users. These experts established the learning level to be reached by means of a questionnaire applied to study cases A and B in which 20 questions of low complexity and 20 questions of high complexity were proposed. The degree of approach to expert knowledge defined by these experts would be the criteria to be used in order to evaluate the learning degree of the students.

With the aim of assuring the control and internal validity of the experiment both groups and subgroups were positioned in a same spatial and temporal context, hence guaranteeing the equivalence of both groups during the experiment. A special car was taken on the fact that both groups would receive the treatments at the same time. In order to assure that the treatment times were identical in both cases the various phases were marked by means of the projection in a big screen of the videos corresponding to the 11 practical cases, with independence of the fact that each group might or might not want to go over them during their cooperative working. Two computers connected to the Internet were provided to each group, one intended for the visioning of the cases and for the analysis of the clinical histories and the other to develop the different proposals by means of the two types of instruments previously described. During the phase of design, special care was taken so that the working visual environment would mimic the system followed by the professionals that have to appraise and decide over the various cases presented. With that in mind, 11 cases of kids, youngsters and non vocal adults who were using Assisted Communication Systems were presented, complementing the environment with clinical history data, real videos, comments from teachers, parents, evaluators or people from the surroundings, with the main intention of focalizing information, improve reflection, motivation and active style. The first (A) and last (B) of these cases were taken as reference in order to obtain data regarding the learning level in three different moments (figure 2)

- Situation previous to the applying the learning programme, after analysing the first practical case A: Observation PreA.
- Situation posterior to applying the learning programme, after analysis of case B. Observation PostB.
- Situation posterior to applying the learning programme in which practical case A is again calculated. Observation PostA.

G1-mindtools	**Noveles** **Medios** **Avanzados**	**O1** **Observation PreA**	**X11** **Programa flexible**	**O2** **Observation PostB**	**O3** **Observation PostA**
G2-matrices	**Noveles** **Medios** **Avanzados**	**O4** **Observation PreA**	**X12** **Programa rígido**	**O5** **Observation PostB**	**O6** **Observation PostA**

Figura 2: Rationale of the proposed research.

5 Analysis of the results

As shown in figure 3 there are differences in the progression towards expert knowledge which favour the alumni that used mindtools, specially when the results obtained from the most advanced subgroup are compared.

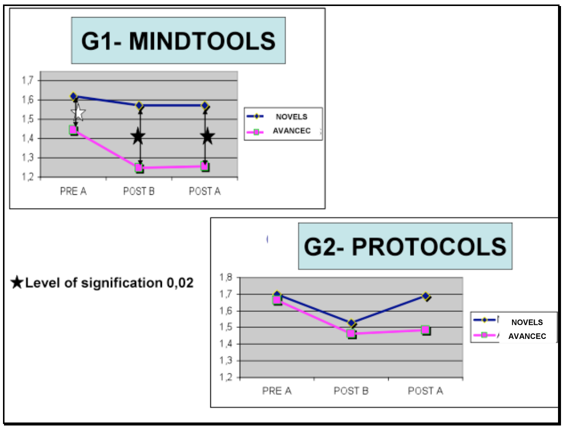

Figure 3: Progression towards expert knowledge (0 score) of both inexperienced and advanced students.

No significant differences were found in the resolution of low-complexity between G1 groups (using flexible tools) and group G2 (using rigid tools). Low complexity tasks were solved with efficiency both by group G1 participants, with flexible tools, and by group G2. Nevertheless, the protocols are not adequate in order to work with high complexity knowledge (figure 4). The use of rigid tools matches immediate responses and time. Knowledge simplification diminishes the personal attitude to solve insufficiently structured problems, hence diminishing the search for alternative solutions as well.

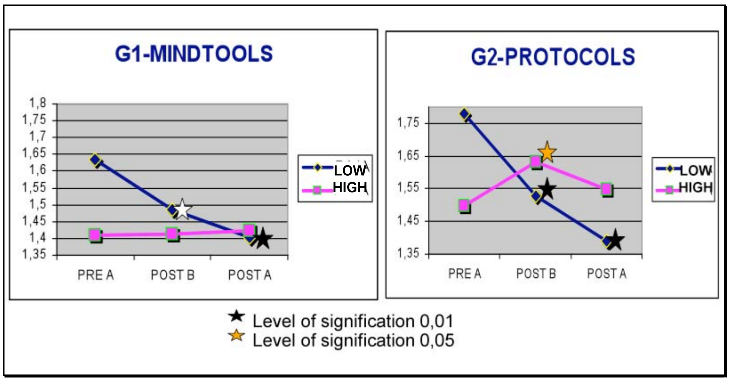

Figure 4: Comparison of G1 and G2 groups low and high complexity contents.

6 Conclusions

The aim of this study is the construction of knowledge through ill-structured problems, by means of Information and Communication Technologies (TIC) use.

The research hypothesis exposes the comparison of two learning/teaching environments based on TIC and applied in a university context in order to provide solutions to real clinical cases. The so-called "decision-making protocols or matrices" environment uses a more rigid, convergent and traditional approach. On the other hand, the so-called "mindtools" environment follows the contributions of the knowledge flexibility theory, allowing the use of databases and conceptual networks hence providing an improved flexibility and facilitating the multi disciplinary approach. The experiment was performed with 63 psycopedagogy, mastery and logopedy students with a varied previous formation (inexperienced, middle and advance) who agreed to participate in an intensive course of evaluation and counselling of kids, youngsters and non-vocal adults using Augmentative Communication Systems.

The conclusions of this study demonstrate that the traditional rigid environments only allow the inexperienced students to progress whereas the more flexible environments improve the learning skills of inexperienced, middle and advanced students. In the same regard, it is shown herein that the more complex and diffuse knowledge require flexible tools. Advanced students, with an initial knowledge that more closely resembles that of professionals, require flexible environments in order to face insufficiently structured, high complexity problems.

7 References

Feltovich, P. J., Spiro, R. J. & Coulson, R. L. (1989). The nature of conceptual understanding in biomedicine: The deep structure of complex ideas and the development of misconceptions. *Cognitive science in medicine: Biomedical modeling*, 113-172.

Jonassen, D. H. (2004). Learning to solve problems: an instructional design guide. San Francisco: Pfeiffer, cop.

Jonassen, D. H., Howland, J., Moore, J. & Marra, R. M. (2003). *Learning to solve problems with technology: A constructivist perspective*. Upper Saddle River, NJ: Merrill Prentice Hall.

Jonassen, D.H., Dyer, D., Peters, K., Robinson, T., Harvey, D., King, M. & Loughner, P. (1997). Cognitive Flexibility Hypertexts on the Web: Engaging Learners in Meaning Making, In: Khan, B. E. (coord.). *Web-based instruction.* Englewood Cliffs, NJ: Educational Technology Publications**,** 119-134.

Lima, M., Spiro, R. J. & Koehler, M. J. (2004). Collaborative interactivity and integrated thinking in Brazilian Business Schools using cognitive flexibility hypertexts: the Panteon Project. *Journal of Educational Computing Research 31(4)*, 371-406.

Nó, J. (2004). De la enseñanza programada a los espacios de interacción, modelo de construcción del conocimiento en entornos tecnológicos. *Sociedad y Utopía. Revista de Ciencias Sociales 24*, 195-205.

Oh, S (2005). The effects of constraint based argumentation scaffolding and epistemological beliefs on ill structured diagnosis-solution problem solving. *Dissertation Abstracts International Section A: Humanities and Social Sciences 66(2-A), p. 564.*

Shapiro, A. & Niederhauser, D. (2004). Learning from hypertext: research, issues and findings, In: Jonassen, D. H. (coord.). *Handbook of research on educational communications and technology*. *Second Edition.* Mahwah, N.J.: Lawrence Erlbaum**,** 605-622.

Spiro, R. J. & Jehng, J.C. (1990). Cognitive flexibility and hypertext: Theory and technology for the nonlinear and multidimensional traversal of complex subject matter, In: Nix, D. & Spiro, R. J. (coord.). *Cognition, education, and multimedia: Exploring ideas in high technology.* Hillsdale, NJ: Lawrence Erlbaum**,** 163-205.

Tiffin, J. & Rajasinghan, L. (1975). In search of the virtual class: education in an information society. London: Routledge.