APPLICATIONS OF VISUAL KNOWLEDGE REPRESENTATION IN INSTRUCTION MODELS

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ABSTRACT
One of the objectives of instruction process is to transfer knowledge from teachers to learners, and this knowledge has to be interpreted, to be clear and to be retained from learners. Taking in consideration one of the roles of the knowledge representation, that one of expression's mode of the humans, the languages in which the teachers can present things, theories, facts and so forth, visual methods of knowledge representation have a lot of applications in the process of education.This paper presents the utilization of the informal and formal concept map, and theirs associate visual languages. Visual knowledge representation and the active participation of the learners in instruction process are certain keys of the success of teaching and learning process. All of these can be realized using concept map as tools of instruction and making the learners to take part in designing and realizing informal concept map, conceptual graphs and even conceptual dependency for the objects of the course's content.

KEYWORDS
Conceptual map, conceptual graph, instructional technology

Knowledge is a subject that supports more definitions. In the framework of artificial intelligence, knowledge is not only a simple static codification of facts. It also includes the skill of using all these facts in processes of interaction with the real world. The knowledge of a subject is the skill of constructing a mental model, which represents exactly that subject (concept, theory, thing, and so on) together with the actions realized by it and about oneself.

The knowledge representation is one of the main concepts of artificial intelligence, playing a dominant role in the design and construction of a high intelligent system. The knowledge representation supports more definitions. Randall Davis, Howard Shrobe and Peter Szolovits argue that knowledge representation can be understood in the terms of five distinct roles it plays:

- the knowledge representation is a substitute of objects and things, used to enable to determine consequences by thinking rather than acting;
- a set of terms which can represent the real world;
- the role of the theory of intelligent reasoning;
- opportunities of realizing software programs;
- the medium of human expression.

One of the objectives of the instructional process is to transfer knowledge from teachers to learners, and this knowledge has to be interpreted, to be clear and to be retained by learners. These objectives can be reached using a favorable environment for instruction, which uses a multitude of methods for representing concepts, theories, and knowledge.

Thinking to the fifth role of knowledge representation, the medium of human expression, expression is language for teachers in order to make the content of the courses about objects, facts, theories (different knowledge), we use knowledge representation like a relation of the type $PK \leftrightarrow PKR$, which establishes

a link between the identification symbol PK (piece of knowledge) and the symbol PKR (piece of knowledge representation).

An essential argument for understanding and retaining knowledge that will be transferred to the students is the use of visual and audio-visual knowledge representation. The instruction has to follow the cognitive structure made in the human mind about the real world, concepts, facts, and theories.
This paper presents the utilization of the informal and formal concept map in the instruction process and their associate - visual languages.

Visual languages are knowledge representation languages in two-dimensional and three-dimensional graphical forms. Unlike pure textual languages, which are used by experts in the knowledge domain, graphical forms present intuitively information and they are successful for common users.
Concept maps are a general term, which describes a kind of visual language.

Concept maps can be informal, like charts, schemes or graphs used in education, enabling to students to explain their understanding about conceptual knowledge. The informal conceptual maps are easy to draw. They have not any constraints. These are useful in the educational process, in brainstorming, in primary stage of knowledge acquisitions.

Concept map may also be very formal with constraints. To build this kind of conceptual map, the user needs to have some advanced knowledge, but their formalism allow their interpretation by computer systems. These are useful in design and building of expert systems.
The pioneers of applications of conceptual maps in the instructional process are Novak and Gowin (1984). They have defined the term of conceptual map like a schematic tool for representing concepts in a contextual framework.

Concept maps are graphs, which consist of a set of nodes with arcs that interconnect the nodes. The nodes and the arcs are labeled; the arcs represent relations between conceptual nodes. The nodes are labeled with text, which is a concept and the labels of the arcs are the relations between concepts. Also, the nodes and the arcs can be drawn using visual attributes: colors, shadows or borders. The concept maps can be extend to contain contexts, places for sub-conceptual maps (conceptual maps for nodes).
During the process of instruction, conceptual maps are helpful tools for both teachers and students, for each person who wants to learn.

For students, concept maps are learning tools used:
- to organize the material;
- to develop ideas, concepts;
- to build idea map;
- to organize their thinking;
- to integrate new material in their prior knowledge;
- to build a mental map with knowledge about a subject;
- to fix learned material in the long – term memory;
- to revise effectively for examinations;
- to solve exercises.

For teachers, concept maps are teaching tools used:
- to design courses, to organize teaching strategies;
- to assess students prior knowledge;
- to plan activities, contents of courses;
- to assess student's learning;
- to review topics;
- to design lessons;
- to present materials contents of the courses; to introduce new concepts.

Also, starting from this model of knowledge representation, we could determine a technique of design for instruction.

The success of the instruction depends on the preliminary level, when the instructional expert makes a plan of the instruction. Sometimes, it's difficult to make a good project, as there are a lot of different items of knowledge and a lot of kinds of students' learning styles.

Here is an example of instruction plan:

- set goals and objectives of the instruction;
- describe in detail students 'activities;
- specify the kind of knowledge (declarative, structural, procedural) for every activity;
- select the learning results which fit the instructional development;
- set topical activities;
- build a teaching strategy for every activity;
- select teaching-learning media: print courses, multimedia courses;
- evaluate performances.

We will describe an instruction project technique, starting from a conceptual map. The technique consists of:

- One objective of the instruction is represented by a piece of knowledge that is desirable to be taught, for every piece it is made a conceptual map.
- "To teach" a conceptual map means to associate it to an instruction plan (goals, strategies, topics, and so forth) or "to teach" every node of the map.
- "To teach" a node of the map means to associate it to an instruction plan or to expand it to another conceptual map or the node is known. Every node must have associated a plan of evaluation of knowledge.
- The nodes will be expanded until the teacher considers all the nodes are known.

In the scheme form the figure bellow (figure 1), we have drawn a conceptual map, which represents Internet protocols. Using this scheme to explain the subject Internet, the students will be forced to understand the principles of the Internet and its protocols.

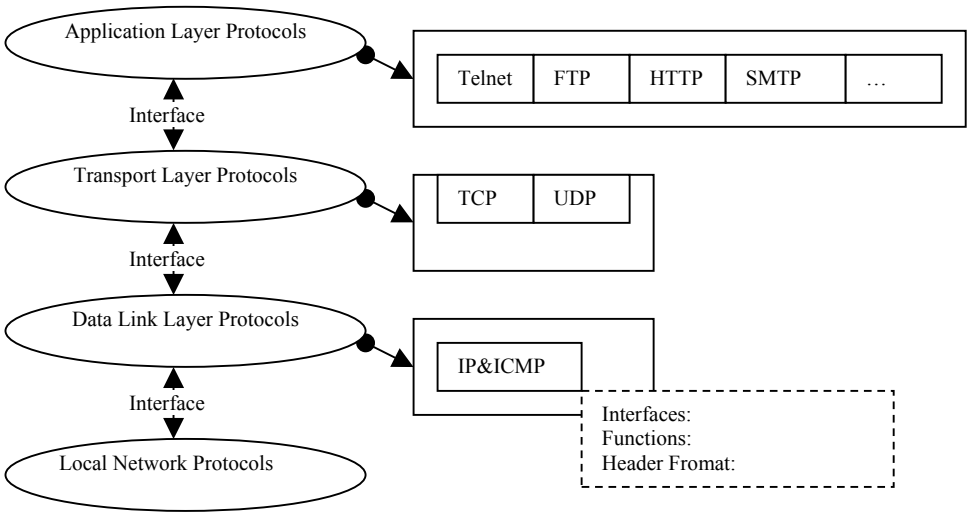

Figure 1. Conceptual map of Internet Protocols

-IP&ICMP Internet Protocol&Internet Control Message Protocol; TCP Transmission Control Protocol; UDP User Datagram Protocol; FTP File Transfer Protocol; HTTP Hyper Text Transfer Protocol; SMTP Simple Network-Management Protocol.

The concepts are drawn using oval forms and the instances are drawn using rectangle forms. Each node can have a link to another conceptual map, which interprets the concept of the node, generating a "Hyper" conceptual map. In this way, the term hyperlink node can be defined. Also, every node can have hypermedia components: sounds, movies, pictures, photos, and so forth. In the figure 2, we have used the main concept: "relational model of database" (drawn bold rectangle form) and other concepts (drawn simple rectangle form). The concept "relation in the mathematical theory" has associated another conceptual map, in "relation in the mathematical theory" like the main concept. To design a model for "relational model of database" means to design three instruction units for all three conceptual areas.

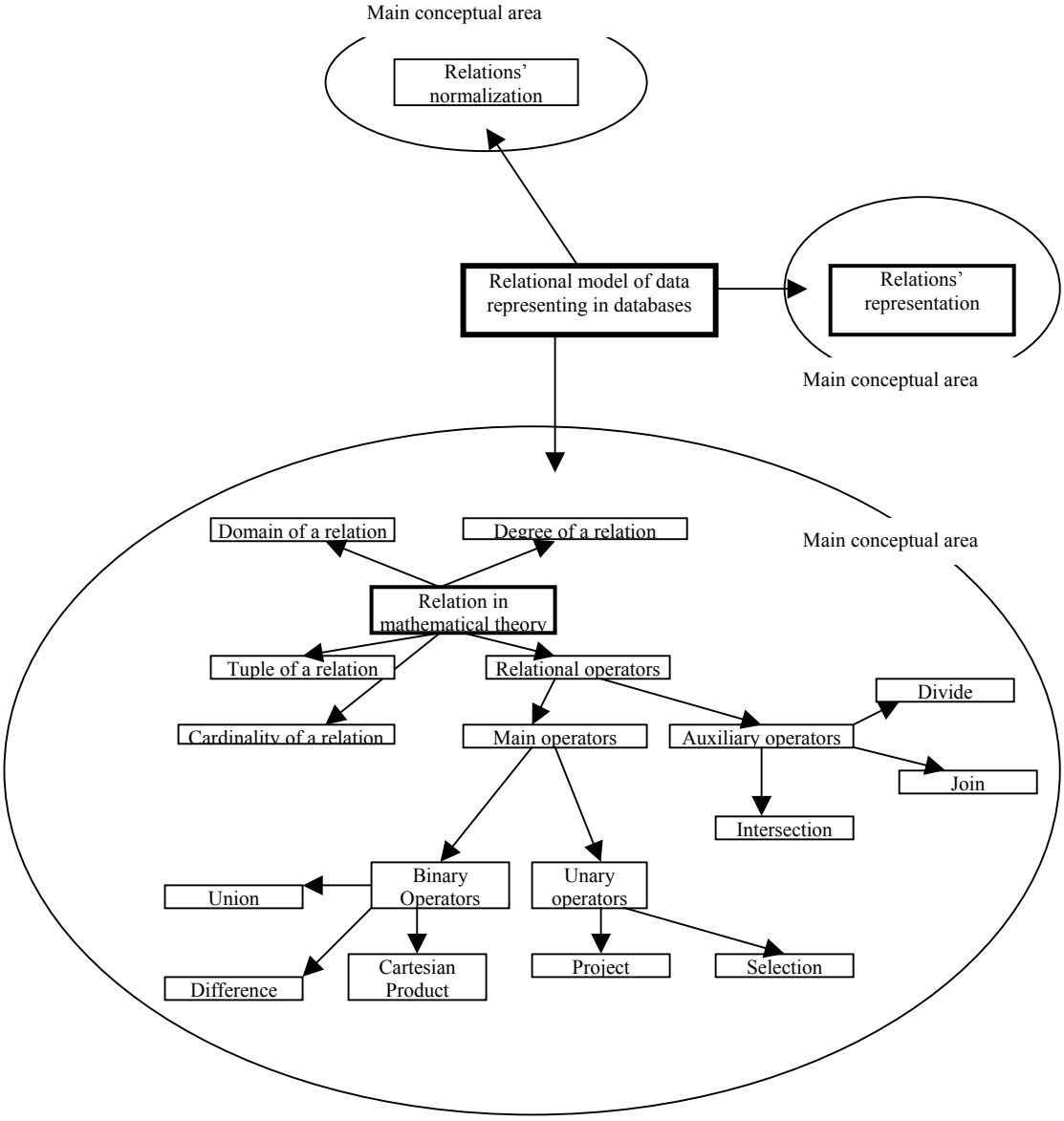

Figure 2. Conceptual map of Relational Model of Database

The students see the following screen:

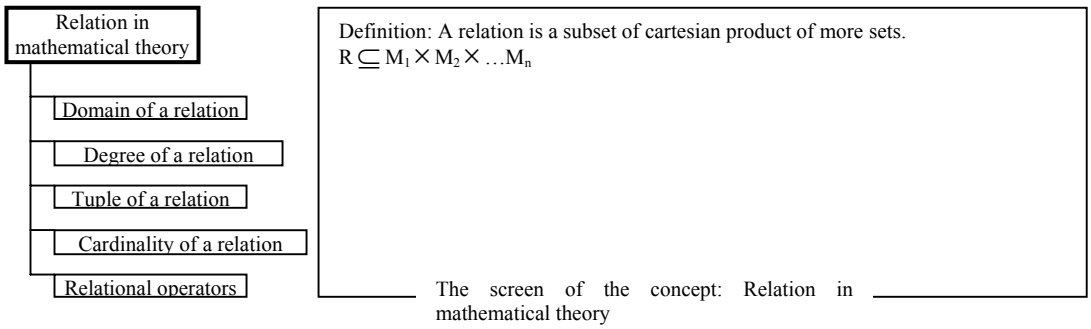

Figure 3. The students' screen for the concept "relation in mathematical theory"

A visual language is any form of communication that relies on two- or three-dimensional graphics rather than on simply (relatively) linear text. Visual languages involve simple pictures: nodes and connecting arcs, or complex pictures like as nested graphs.

In order to illustrate visual knowledge representation used in education, we consider the software program called Inspiration 7, which we found on address www.inspiration.com.

We proposed to teach "the general model for data communication: ISO model". We need to make a project for a lesson and to show to the students an intuitive scheme for ISO model. The first step, which we have considered, was to build a conceptual map for ISO model. In the figure below we present the conceptual map:

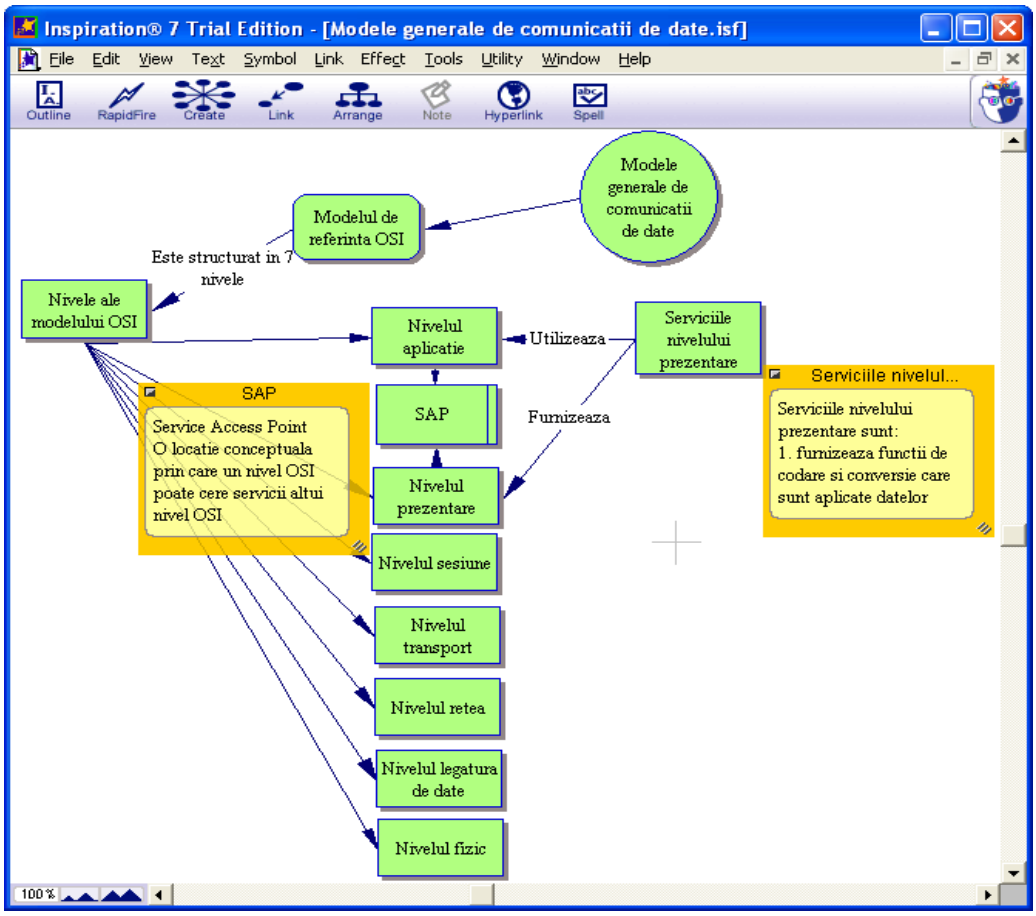

Figure 4. A conceptual map realized with Inspiration 7

The software program enables to select a main concept. We choose “the general model for data communication: ISO model”, which will become the main chapter in the content of the lesson. The second node”ISO model” is linked to the main concept, and it will become sub-chapter (chapter I) in the content of the lesson. The node “OSI layers” is linked to the “ISO model” concept and we wrote the label “it is structured in 7 layers”. This node will become a sub-chapter (chapter A) in the content of the course.

Starting from this concept map, the software program realizes a plan of the lesson (the below picture). The file can be saved with HTML extension. So, we can realize an educational WEB site.

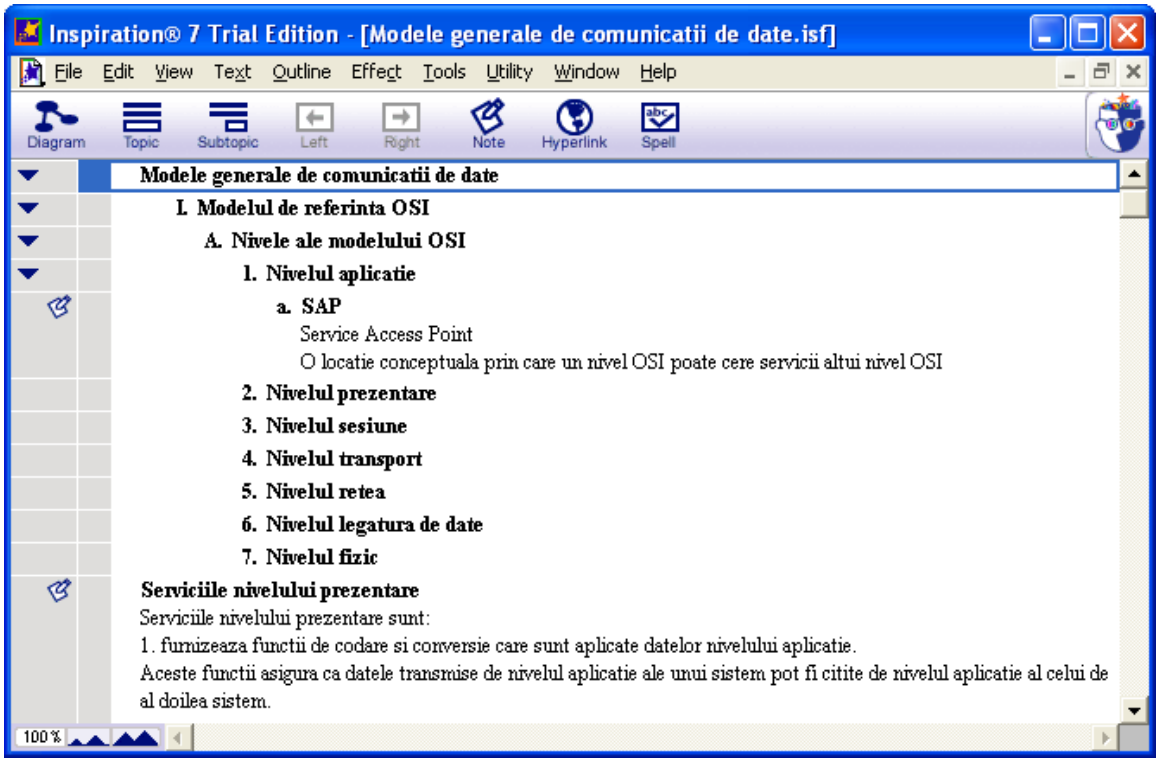

Figure 5. The table of a content dedicated to “the general model for data communication: ISO model”

Also, these educational concept maps can be used in collaborative learning or in brainstorming. In a multi-user environment, all students can bring contributions to the subject.

Another application consists in evaluating students. Novak (1977) developed a system of concept maps that has been widely applied in the evaluation of the student’s learning in the school system. The figure 6 shows a map from these studies.

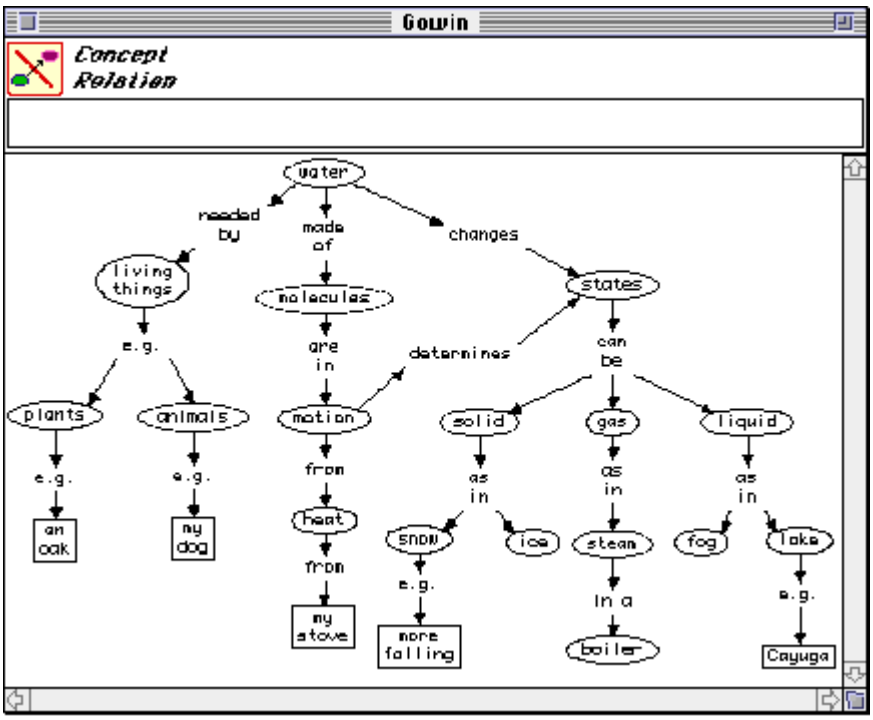

Figure 6. A map after Novak

Another concept map tool is KMap. Brian R Gaines and Mildred L G Shaw developed it. Here is a short description of this software:

> "We have developed a general concept mapping tool called KMap (Gaines and Shaw, 1993; Gaines and Shaw, 1994) which provides a grapher for nodes and arcs that can be programmed by the user to support different forms of concept map. User interaction with KMap takes place through the creation of statements in the visual language, and through interaction with such statements through popup menus whose content is specific to node type. The action initiated is context-sensitive: to the node selected for the popup, to nodes linked to it, and to other nodes preselected by clicking on them. This allows complex activities to be initiated by natural user actions."

More information, there are at the address: http://ksi.cpsc.ucalgary.ca/articles/ConceptMaps.
If the participants in the instructional process use formal concept maps like: conceptual graphs and conceptual dependency, a deep understanding of knowledge will be realized. Formal conceptual maps are not easy to create, they need advanced information about knowledge representation, but their formalism can be compiled by the computer systems.

Conceptual graphs represent a logic system based on existential graphs, defined by Charles Sanders Peirce and semantic networks of artificial intelligence. They express knowledge in a logical form, easy to understand and capable to be programmed with a computer.

Conceptual graphs support two notations: "display form" (CGDF) and "linear form" (CGLF). The descriptions of these graphs are developed by John F. Sowa in „NCITS.T2 Committee on Information Interchange and Interpretation".

The following graph (figure 7) shows a conceptual graph associated to the subject "Internet protocols".

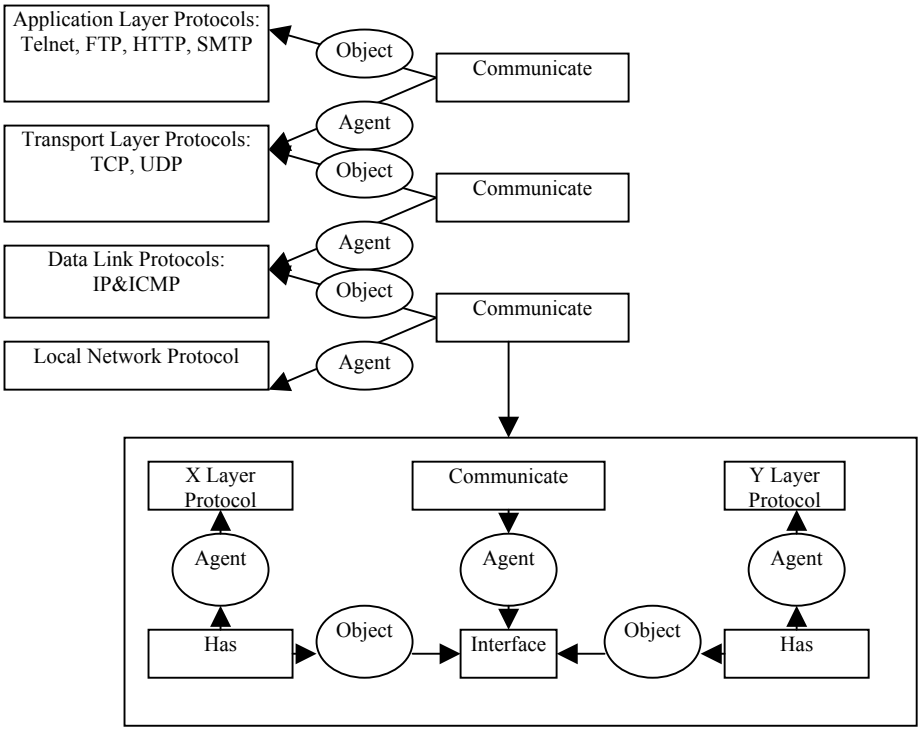

Figure 7. A conceptual graph of Internet Protocols

A tool for these kind of graphs is CharGer. "CharGer is a conceptual graph editor intended to support research projects and education. Its current version is primarily an editor to create visual display of graphs. It is deliberately and explicitly a research tool meant for conceptual graph researchers to explore implementation issues in conceptual graph interfaces." There is more information at the address: http://www.cs.uah.edu, "A Conceptual Graph Editor" by Harry Delugach.

The presentation of a lesson using visual forms, establishes the attention's gain of the participants at the educational process and the most important outcome is the issue of creative thinking.
It could be interesting to see the results of an educational experiment, in different fields, in which it will be used two techniques of instruction, one of them based on textual methods and the other based on the visual representations. The metrics can include the time needed to learn, the retaining of the knowledge and the interpretation of the knowledge.

Until now, we can say that using visual representation of knowledge in the field of computer science, programming language, we can obtain higher outcomes in the process of instruction.

Another important application of the conceptual maps is the using of these like navigational tools in educational hypermedia contexts. The conceptual map describes the plan of teaching in any domain. We can identify the main concepts, which are interconnected by intermediate concepts. Every concept is associated with a hypermedia screen and instances. The students cannot see the conceptual scheme, which determine the track in content of the course, but they use the specific features of this type of navigation.

These are:

- it records the navigation path, the student can return any time to the explored nodes;
- to facilitate straight line navigation to any screen associated to a concept or instance;
- the navigation path is not linear;
- the students can insert their own notes;
- the students can control the navigation mode depending on their knowledge and understanding.

- passing from a screen to another screen is realized from relations of conceptual map, called virtual navigation path.

The conceptual maps are not proposed only to display information. Students can bring their owner contributions to realize the conceptual map. They can restructure their knowledge and include new information into their cognitive structure.

Also, we can use conceptual maps to evaluate knowledge understanding. Method consists of demanding to the students to complete a conceptual map.
In the picture below the students have to complete with correct nodes (instances).

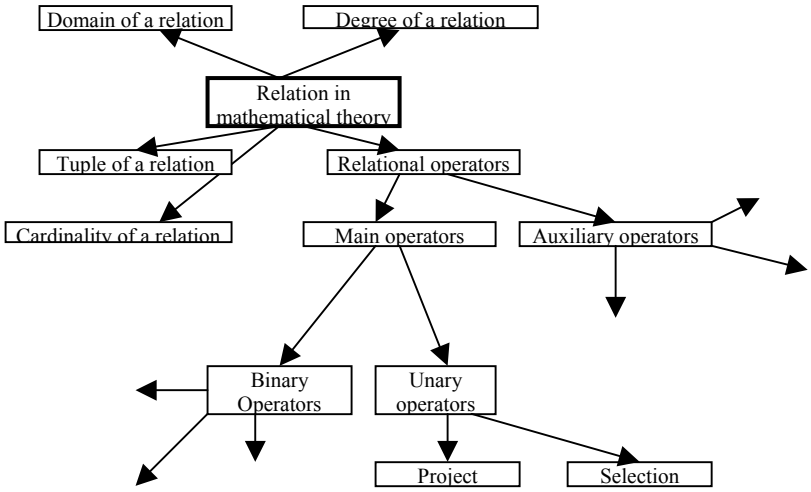

Figure 8. A conceptual map used to evaluate students

The actors involved in educational process can negotiate to optimize understanding of knowledge using the following scheme.

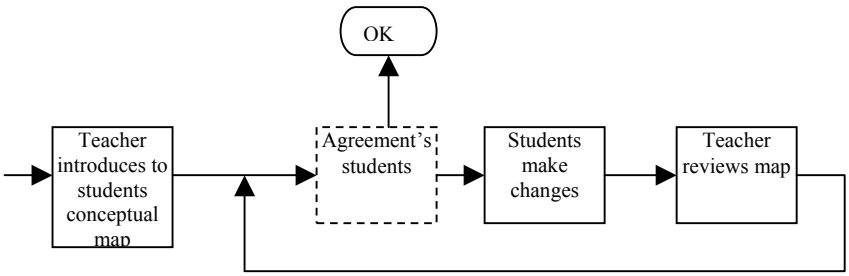

Figure 9. The negotiation process about conceptual map

Visual knowledge representation offers a lot of applications in instruction models. An important application is realization of intelligent pedagogical resources.

Intelligent pedagogical resources are the educational flexible materials adaptable to the learning style of the instructed person. The first studies on learning styles have been initiated by Kolb and they were called Kolb's Learning Style Inventory.

Howard Gardner generated the idea of multiple intelligences: linguistic intelligence, logical/mathematical intelligence, visual/spatial intelligence, musical/rhythmical intelligence, kinesthetic /gestual intelligence, interpersonal intelligence, intrapersonal intelligence. The high number

of students presupposed the consideration of all learning styles in the educational process. IT technology offers the possibility of developing the same educational content in different formats: text, image, sound, simulation, graphics, video, animation etc. and delivering to the students according to their individual learning characteristics.

Semantic networks, ways of representing knowledge, offer the possibility of developing new techniques for producing pedagogical resources.

This technique consists in:
- to each instructional objective, a semantic network (a hybrid network) will be associated;
- to arcs and nodes we associate educational contents in different formats;
- delivering an instructional objective represents delivering of arches and nodes of the network;
- a node is labeled with the attribute „associated educational content" if all the nodes it is interconnected to and all corresponding arches are labeled with „associated educational content" attribute.

Using this technique, an instructional objective is divided into educational aims, the educational resource being the result of the reunion of all educational materials (selected in the format dedicated to a certain learning style) associated to the nodes and arches of the semantic network.

Advantages:
- the possibility of generating an instructional system orientated on reusable learning objects. Traditional courses for computer assisted instruction are monolithically structures of big dimensions, that do not allow the usage of certain information in other lessons, the regrouping of information according to the students, the quick search for information, the adoption of delivering courses in accordance with learning style students. These all result in defining instructional objects oriented models;
- the pedagogical resource projected with this technique will contain all the information needed to deliver an instructional objective;
- the pedagogical resource is flexible, the same educational content will be presented to the students according to their learning styles.

In our university, we issued a project to make a software program, a tool for conceptual map used in education. This software will be used both by students and teachers and the results will be published on the Internet.

The knowledge representation based on conceptual maps defines a new technology to design and plan the instruction generating cognitive actions of the students. The students have to understand the representation, they have to understand the relation between representation and knowledge domain, and they have to accurately design their own representations. The software programs, tools for conceptual maps are useful both to students and to teachers, or for any other person who is involved in the educational process.

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