A MODEL FOR VISUAL LEARNING IN AUTISM

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Abstract: The paper describes a nearly new learning and teaching model referred to as visual learning. The definitions of "visual learning" and "concept map" are given. The use of concept mapping is described together with a number of semple applications. The advanges of concept maping are explained. A comparsion is made between visual learning model based on cocept maps and a concrete practical model used by the autor in education of 10 years old autistic boy. The possibilities of appying of such kind of visual learning models in education of autistic children are described Ideas for the extension of this model and its application are given.

Keywords: mental models, cognitive psychology, visual learning, concept map, autism.

ACM Classification Keywords: J.1 ADMINISTRATIVE DATA PROCESSING – Education; J.4 SOCIAL AND BEHAVIORAL SCIENCES - Psychology; K.3 COMPUTERS AND EDUCATION - K.3.2 Computer and Information Science Education

Introduction

Visual learning is a powerful method for representing information in a graphical way as a tree diagram or organizational chart. Each "node" of the chart contains an idea, concept or question linked together by branches to show their relationship to each other. Visual learning techniques teach students to clarify their thinking, and to process, organize and prioritize new information. Visual diagrams reveal patterns, interrelationships and interdependencies. They also stimulate creative thinking.

Visual Representation of Information

The basic elements of human thinking are the **cncepts** (ideas) and i**mages** (visual, hearing, smelling, sensory). This dualism of the theory of mind is initially presented by Paivio [Paivio, 1986]. According to Ehlberg [Ehlberg, 2002] it stands the critical assestmant and corresponds all the rest theories and facts about human thinking.

Human beings all the time build "schemes" about the world with or without intention to do this. They construct both perceptual (sensory) schemes based on world images, and coceptual (ideal) schemes based on concepts (ideas) [Ehlberg, 2002]. Perceptual and conceptual schemes are internal representation of the world [Bunge, 1983; Bunge, 1983-a]; Ehlberg, 2002]. In the past Tolman [Tolman, 1948] called these schemes **cognitive shemes.** Elsewere they are known as **mental schemes** [Ehlberg, 2002]. These internal cognitive strustures can be represented in the form of graphs wich are external representation of these structures Ehlberg, 2002], [Novak, 1984].

In the 1960s, Joseph D. Novak [Novak, 1993] at Cornell University began to study the concept mapping technique. His work was based on the theories of David Ausubel [Ausubel, 1968],, who stressed the importance

of prior knowledge in being able to learn about new concepts. Novak concluded that "Meaningful learning involves the assimilation of new concepts and propositions into existing cognitive structures."

According to Jonassen et al. [Jonassen, 1990], concept maps are "**representations of concepts and their interrelationship that are intended to represent the knowledge structures that humans store in their minds.**" Usually, concept maps are defined as **semantic representations of declarative memory presented graphically** [Jacobi, 1991].

A **concept map** is a visual representation of information in **graphical mode** where **nodes** (points or vertices) represent concepts, and **links** (arcs or lines) represent the relationships between concepts. The concepts, and sometimes the links, are labeled on the concept map. The links between the concepts can be one-way, two-way, or non-directional. The concepts and the links may be categorized, and the concept map may show temporal or causal relationships between concepts [Plotnick, 1997].

A simpler view of cognitive cartography has also been proposed under the term of **mind maps** [Buzan, 1995], where only concepts and their proximity are represented, without any particular meaning imposed on the relationships.

Purpose of Concept Mapping.

Concept mapping is a type of knowledge representation. Jonassen & Grabowski [Jonassen, 1993-a] state that structural knowledge may be seen as a separate type of knowledge. "Structural knowledge provides the conceptual basis for why. It describes how prior knowledge is interconnected. … Structural knowledge is most often depicted in terms of some sort of concept map that visually describes the relationships between ideas in a knowledge domain." Representing knowledge in the visual format of a concept map allows one to gain an overview of a domain of knowledge.

Visual representation has several advantages [Plotnick, 1997]:

- Visual symbols are quickly and easily recognized;
- Minimum use of text makes it easy to scan for a word, phrase, or the general idea; and
- Visual representation allows for development of a holistic understanding that words alone cannot convey.

Concept mapping can be used for several purposes [Plotnick, 1997]:

- **Creativity Tool** - Drawing a concept map can be compared to participating in a brainstorming session. As one puts ideas down on paper without criticism, the ideas become clearer and the mind becomes free to receive new ideas. These new ideas may be linked to ideas already on the paper, and they may also trigger new associations leading to new ideas.

- **Hypertext Design Tool** - As the World Wide Web becomes an increasingly powerful and ubiquitous medium for disseminating information, writers must move from writing text in linear fashion to creating hypertext documents with links to other documents. The structural correspondence between hypertext design and concept maps makes concept mapping a suitable tool for designing the conceptual structure of hypertext. The structure of both a hypertext document and a concept map can be seen as a directed graph or a knowledge graph [Conklin, 1987]. A concept map placed on the Web in hypertext may also serve as a Web navigational tool if there are clickable areas on the concept map that take the user immediately to indicated parts of the hypertext document.

Designing hypertext is an activity with inherent problems. Botafogo, Rivlin & Schneiderman [Botafogo, 1992] describe a dilemma faced by designers of hypertext authoring systems. In order to stimulate authors to write clearly structured hypertext (usually hierarchical), they have to decide when to force authors to reflect upon the structure of their work. Imposing a hierarchical structure from the beginning may result in too many restrictions for the author, while any effort to stimulate hierarchy afterwards is too late, and it may even be impossible for authors to restructure the jungle of nodes and relationships. Concept mapping may be a good intermediate step for authors to use to reflect upon their work when developing hypermedia.

- **Communication Tool** - A concept map produced by one person represents one possible way to structure information or ideas. This is something that can be shared with others. A concept map produced by a group of people represents the ideas of the group. In either case, concept mapping can be used as a communication tool for people to use to discuss concepts and the relationships between the concepts. They may try to agree on a common structure to use as a basis for further action.

- **Learning Tool** - Novak's original work with concept mapping dealt with learning. Constructivist learning theory argues that new knowledge should be integrated into existing structures in order to be remembered and receive meaning. Concept mapping stimulates this process by making it explicit and requiring the learner to pay attention to the relationship between concepts. Jonassen ([Jonassen, 1993] argues that students show some of their best thinking when they try to represent something graphically, and thinking is a necessary condition for learning. Experiments have shown that subjects using concept mapping outperform non-concept mappers in longer term retention tests [Novak , 1983].

  Concept mapping is also gaining inroads as a tool for problem-solving in education. Concept mapping may be used to enhance the problem-solving phases of generating alternative solutions and options. Since problem-solving in education is usually done in small groups, learning should also benefit from the communication enhancing properties of concept mapping.

- **Assessment Tool**-Concept maps can also be used as assessment tools. The research team around Joseph Novak at Cornell found that an important by-product of concept mapping is its ability to detect or illustrate the imisconceptionsl learners may have as explanations of content matter. The conceptions students may have are often incomplete and deficient leading to misunderstanding of instruction. Concept maps drawn by students express their conceptions (or their misconceptions) and can help the instructor diagnose the misconceptions that make the instruction ineffective [Ross, 1991].

Some Applications of Concept Mapping.

According to Kay Hawes [Hawes, 1998] concept maps can be devided to three basic groups:
- process maps
- problem soution maps
- characteristic maps
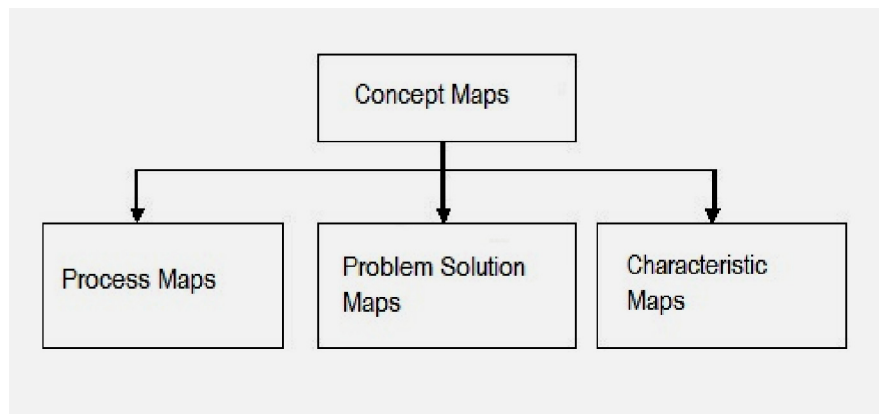
Next figure shows a concept map about the cocept maps:

Figure 1: A concept map about the cocept maps

The samples below show some of the kinds of maps

- *Process Maps*

Process maps show a process for accomplishing a task. There is a beginning and an end, with multiple steps and alternatives at each step.
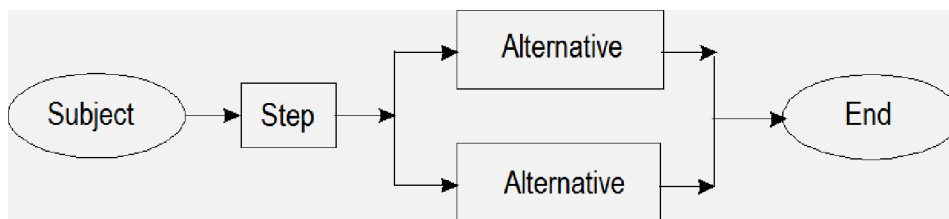

Figure 2. A process map

- *Problem Solving Maps*

A fairly straightforward map is a problem-solution map. In this, there is problem statement, definition, causes, and effects, leading to a possible solution.
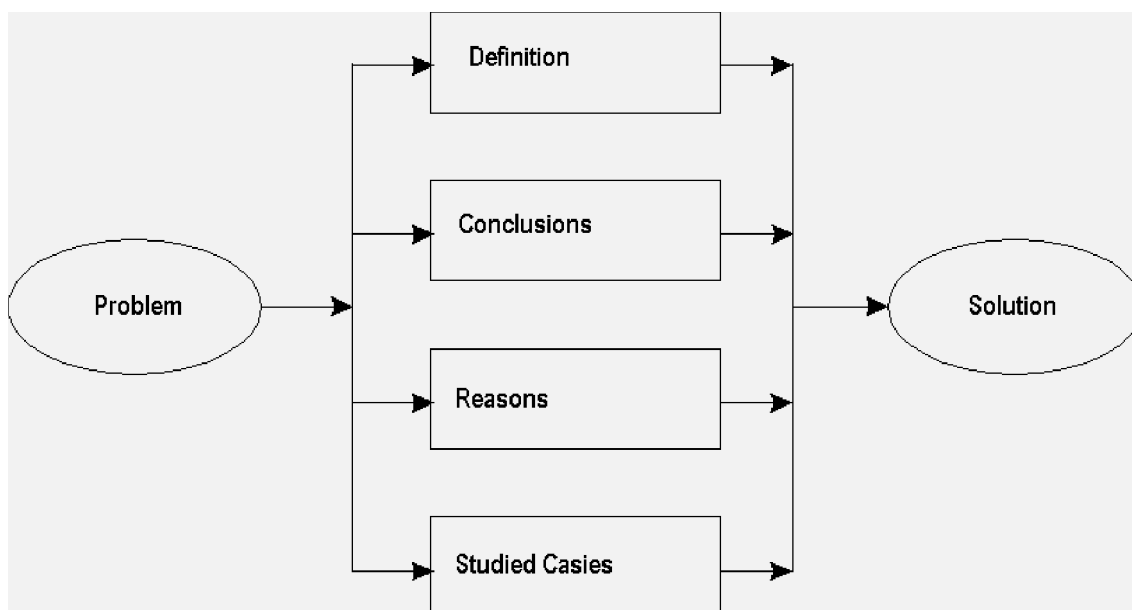

Figure 3. A problem solving map.

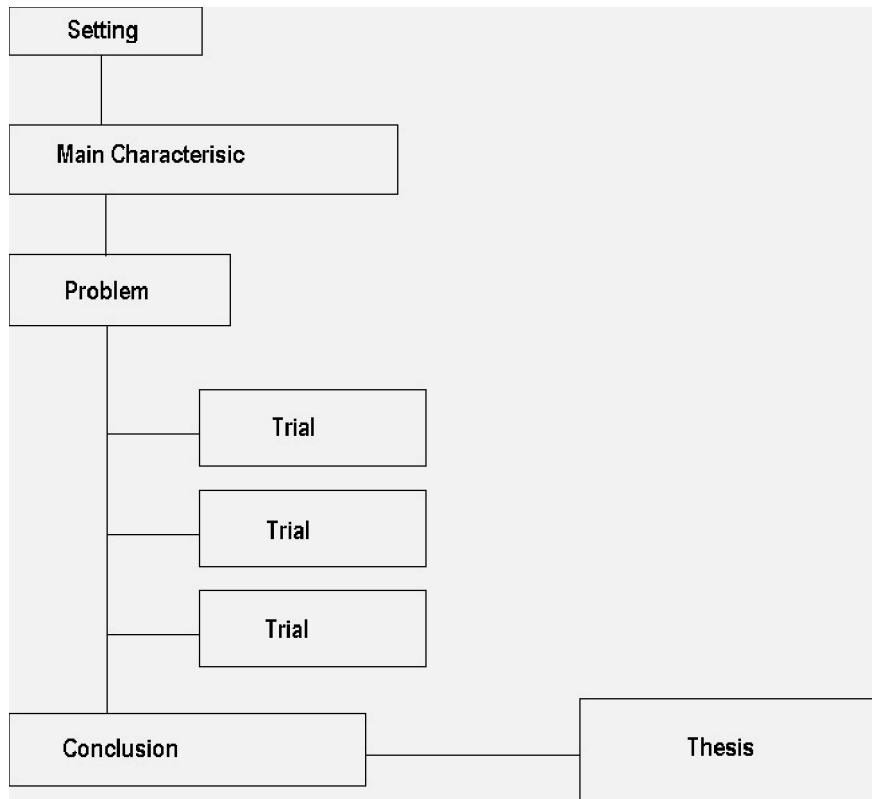This scheme leads to narrative story line maps and persuasive argument maps:
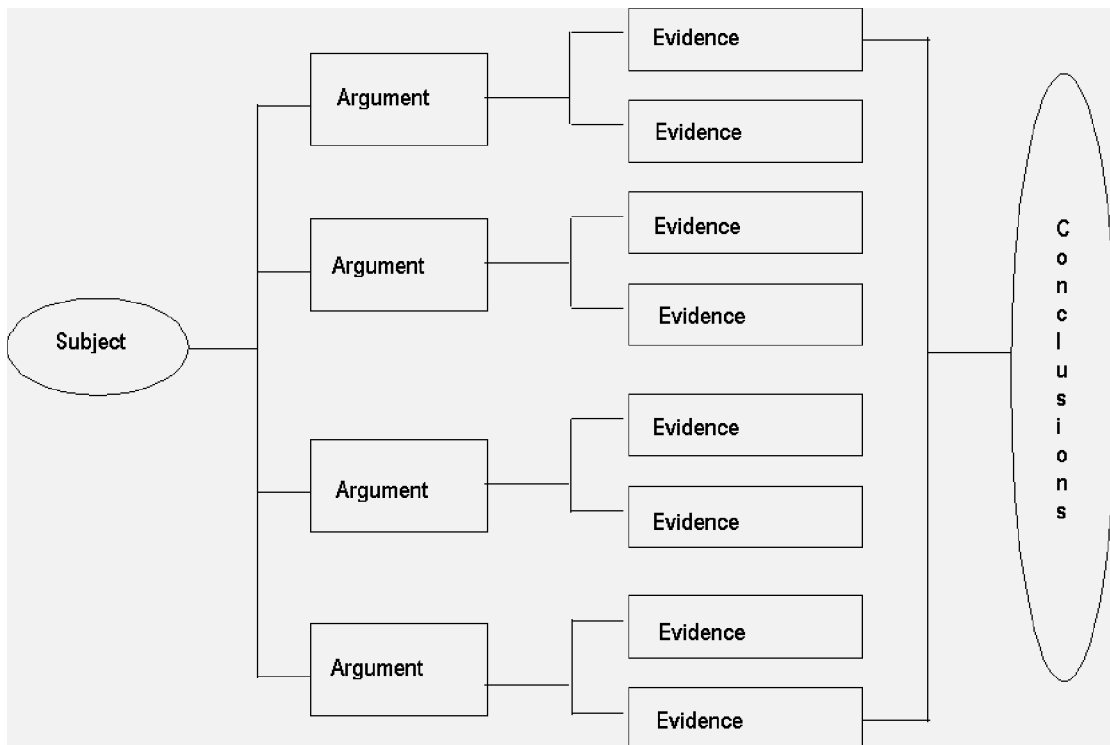
Figure 4. A story line map.

Figure 5. A persuasive argument map.

- *Characteristic Maps*

These maps show characteristics or atributes which describe the given object or person. They may include object specification, list of some of its chracteristics and functions, studied events and its importance.
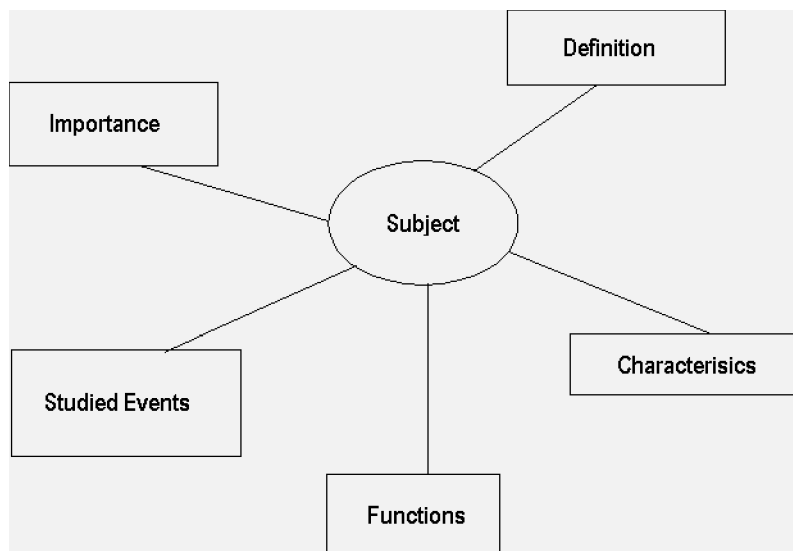

Figure 6. A characteristic map

What is Autism?

Clinically autism is barely fifty years old. Although with the benefit of hindsight it is possible to identify likely cases of autism throughout the century and, in specific isolated incidents, throughout history, the initial identification of the condition was presented to the world towards the end of the second world war. In a fantastic coincidence, possible only as a result of the global conflict, two completely independent studies and publications identified and discussed a 'new' severe condition effecting social interaction, communication, behaviour and development. What is more remarkable is that the authors of both studies, Leo Kanner and Hans Asperger, chose to describe the condition as 'autism'. The word autism itself is derived from the Greek 'autos', meaning self. The world was used earlier in the century to describe an element of schizophrenia where the sufferer becomes detached, unresponsive and unaware of the outside world. In many ways it is a very apt and profound use of medical nomenclature.

Autism as defined in Hans Asperger's paper (published in German in 1944) has developed into what is now described as Asperger's Syndrome. In many ways this is seen as a form of High Functioning Autism and is discussed in depth elsewhere. Of greater relevance to current diagnostic criteria for autism is Leo Kanner's paper (published in 1943) and the 'classical autism' which he described is still very much the typical standard by which autism is understood today [Kanner, 1943].

Following five years of observation and study in Baltimore Leo Kanner published his paper 'Autistic disturbances of affective contact' in 19436. He illustrated the condition with 11 case studies. He provided a vivid and enduringly perceptive insight to autism and many of his observations survive as the foundation for current identification and diagnosis. A number of these observations related to behaviour and ability as presented by the children in his case study. These included a profound lack of affective contact with other individuals, an inability to form reciprocal social relationships and interactions; a reliance and desire for sameness which included stereotypical

behaviour, elaborate routines with a high degree of repetitiveness and seeming compulsion, and an obsession with manipulating and relating to objects (as opposed to other individuals); severe deficits or difficulties in the use of speech and communication (including literalness, echolalia and failure to use the first-person pronoun) as well as muteness in three cases; generally severe learning disabilities in most areas; the existence and presentation of the disorder from birth or by the age of 30 months. In addition to these elements of Kanner's autism he also observed that his subjects demonstrated high level skills in some areas (such as rote memory learning and visuo-spatial skills) in comparison to their general learning disabilities. Kanner also described his children as presenting an attractive appearance with the suggestion of an inner alertness or intelligence. This theme is often repeated throughout the history of autism and although it demonstrates a desire to look at the autistic child as an individual with an identity of their own it also raises the risk of false assumptions and unrealistic goals and aims in intervention and interpersonal relationships (the effect of these perspectives are considered elsewhere in this section).

Contemporary to Kanner and as enduring and relevant to understanding of autism today was the work of Hans Asperger. Working in Vienna during the second world war Asperger's insight into the condition which he was studying was equalled by the compassion, understanding and devotion he extended towards the children he was involved with. Both are important in terms of current day theory and practice. The condition that Asperger described received little attention outside of the German speaking world at the time in which he published his paper 'autistic psychopathy in children' [Asperger, 1944]. More recently however appreciation and use of the observations and inferences that he made are widely recognised and accepted. Today Asperger's syndrome is commonly used to describe an 'autistic' condition associated with higher levels of functioning. A raised IQ often within the bounds of normality is not rare, social interaction impairments are present but masked or compensated for in a number of cases and there is often regarded as being a greater acquisition of language although deficits in the use of language may be starkly evident.

Autism (sometimes called "classical autism") is the most common condition in a group of developmental disorders known as the autism spectrum disorders (ASDs). Autism is characterized by impaired social interaction, problems with verbal and nonverbal communication, and unusual, repetitive, or severely limited activities and interests. Other ASDs include Asperger syndrome, Rett syndrome, childhood disintegrative disorder, and pervasive developmental disorder not otherwise specified (usually referred to as PDD-NOS).

There are three distinctive behaviors that characterize autism. Autistic children have difficulties with social interaction, problems with verbal and nonverbal communication, and repetitive behaviors or narrow, obsessive interests. These behaviors can range in impact from mild to disabling.

The hallmark feature of autism is impaired social interaction. Parents are usually the first to notice symptoms of autism in their child. As early as infancy, a baby with autism may be unresponsive to people or focus intently on one item to the exclusion of others for long periods of time. A child with autism may appear to develop normally and then withdraw and become indifferent to social engagement.

Children with autism may fail to respond to their name and often avoid eye contact with other people. They have difficulty interpreting what others are thinking or feeling because they can't understand social cues, such as tone of voice or facial expressions, and don't watch other people's faces for clues about appropriate behavior. They lack empathy.

Many children with autism engage in repetitive movements such as rocking and twirling, or in self-abusive behavior such as biting or head-banging. They also tend to start speaking later than other children and may refer to themselves by name instead of "I" or "me." Children with autism don't know how to play interactively with other children. Some speak in a sing-song voice about a narrow range of favorite topics, with little regard for the interests of the person to whom they are speaking.

Many children with autism have a reduced sensitivity to pain, but are abnormally sensitive to sound, touch, or other sensory stimulation. These unusual reactions may contribute to behavioral symptoms such as a resistance to being cuddled or hugged.

There is no cure for autism. Therapies and behavioral interventions are designed to remedy specific symptoms and can bring about substantial improvement. The ideal treatment plan coordinates therapies and interventions that target the core symptoms of autism: impaired social interaction, problems with verbal and nonverbal communication, and obsessive or repetitive routines and interests. Most professionals agree that the earlier the intervention, the better.

- Educational/behavioral interventions;
- Medications;
- Other therapies;

One of the most damaging side in autism is the lack of generalizing skills. This leads to the lack of ability to think in abstract ideas and to deduce new knowledge from the existing one, namely to learn from his or her own experience. On the other side autistic children have many other talants like a good memory and a visual thinking (thinking in pictures).

As is mentioned in previous part, in visual learning with concept maps the structure of the knowledge can be graphivally presented which makes them easy to understand and mastered, and sutable for education of autistic children.

Let see some examples from the autor`s practice in education of 10 years old autistic boy.

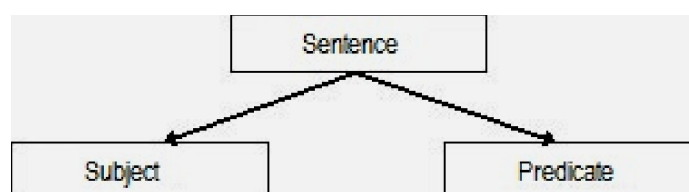Next scheme has been usd for the representation of the Bilgarian sentence structure:

Figure 8. A scheme of the sentence structure.

It shows that the Bulgarian sentence consists of a subject and a predicate. Here is an example of a sentence:
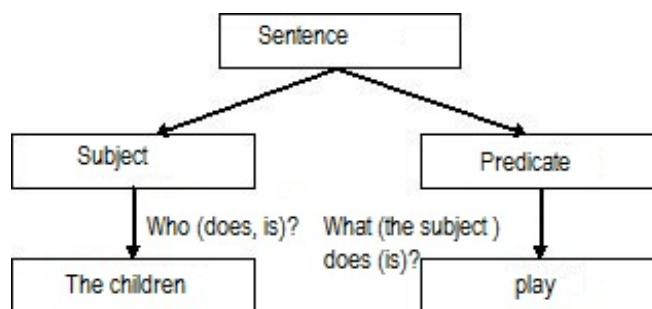
Figure 9. A scheme with an example of a sentence.

The questions about the subject and the predicate are presented.

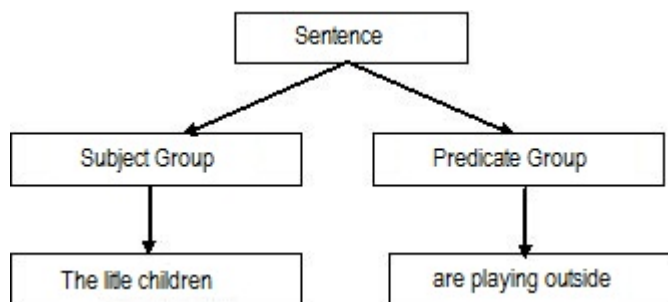This scheme can be extended to subject and predicate group respectively:

Figure 10. Extended sheme of the sentence structure.

These schemes are similar to the map representing concept maps in previous part (Fig. 1).

Using these schemes the boy learned to make sintactical analysis of different kind of sentences. Furthermore he overcame step by step the difficulty to distinguish the sentences in written text wich helped him later to understand simple texts and to perform different tasks upon the written instructions as recipes and software users guides.

One of the main difficulties of autistic children is the lack of narrative skills and verbal communication of the information. They much easly can learn the hole text by heart then to explain it by his or her on words. Again in this case cane be used some kind of concept maps.

A simmilar approach is applied in the tutoring of the same boy to make him able to tell a reading story. The instructions started with fairy-tales. Initially the story is devided into logically independent parts. Then each part of the story is expressed in one or two simpleand easy to understand phrases. The boy writes the phrases down and drows s picture about the matter they are expressing. In this way a numbered list of such kind of phrases is made and in the and the moral is written. Here is the example of the Bulgarian story "The fishman and the golden fish" (in Bulgarian):

Приказка за рибаря и рибката

1. Живял дядо със своята баба край брега на морето в схлупена къщурка. Старецът ловял с мрежа риба. Веднъж хванал в мрежата златна рибка. Златната рибка се помолила на дядото да я пусне срещу откуп.

2. Дядото се върнал вкъщи и разказал на бабата за златната рибка и за откупа. Бабата се скарала на дядото, че не е поискал едно ново корито. Дядото се върнал на брега и поискал от златната рибка ново корито. Тя му го дала.
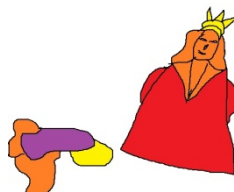

3. Бабата отново била недоволна и поискала нова къща. Рибката изпълнила и това желание.

4. Бабата се разлютила, че дядото не е поискал още повече. Поискала да стане дворянка. Дядото се примолил на рибката и тя изпълнила за последен път желанието на бабата.

5. Вбесена, бабата поискала да стане царица, а дядото и рибката да й бъдат слуги.

6. Златната рибка се ядосала на ненаситността на бабата и си взела всичко обратно. Бабата се оказала пред старата къща и пробитото корито.
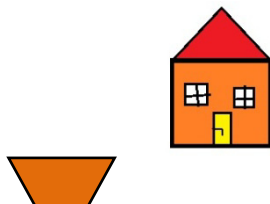
7. Извод: Човек не трябва да е ненаситен. Той трябва да е скромен, да работи и да не чака да получава богатства и титли наготово.

After this the boy learns the text from the points by heart. The instructor yhen asks him questions about each point. Step by step the boy beins to answer the questions and later he becomes able to tell the hole story as it is written before.

This scheme with points illustrated with corresponding pictures is the simple version of the story line map from the previous part (Fig. 4) and is applied in learnig process during the whole school time. Each point fro the list is simmilar to the nodes in the concept maps and the pictures illustrate the matter of the point. The numbers of the points represent the sequence of the story parts like the arrows in the context maps.

In the course of study this scheme has become more complicated and extended. Gradually the pictures dropped out and this scheme turned to learning outlines of the other subjects like history, geography and science. To the main points the subtopics and charts and illustrations are added to them.

It is important to mention that these schemes and outlines are made in cooperation between the boy and his instructor and the meaning of the text is cleared.

The need of visual representation of information arrised in the course of work with psychologist when it was found that he easily copes with the description of subjects and events and with the comparsion between them when he uses som visuale cures. In this case a extention of the described above educational model can be implemented with the use of the two versions of the characteristic maps (fig. 6 and Fig. 7) both in description and camparsion between studied subjects and events. This is a possible way for extension and improvment of the visual learning model described here.

Results

In the first sight the model explained here looks like text memorizing and repeating over and over again without any sence of its content. Actually, in addition to the acquisition of the elementdy knowledge from the text the following results are obtained:

- The text of each topic can be presented in the form of question;
- A lot of language patterns are coleected;
- Gradually begins to answer questions
- Acquisition of conversation skills;
- Acquisition of skills for sharing experiences;
- Illustrating of thegeneralizting can be done.

The model has some disadvanages,as follows:

- The lessons preparation takes too much time;

- As this model is applied to assist the homework mastering, it does not include the answer "I don`t know";

- A model is not applied to the text generation, i.e. to the writing of stories and articles.

Nevertheless, the application of this simple model for visual learnig with the use of concept maps aids speech development, thinking in more abstract ideas and generalization skills. This enabled to reduce some of autism deficites and to achieve better development end a good life in future.

Conclusion

Concept maps are toeels for representing the structure of informetion. Ther are several ways of concept maps application: idea generation, design support,increasin of the information exchange, facilitation of the learnig and estimation. Concept maping application in education allows autisic students and their teachers easily to costruct visual structure of the knowledge from the lessons. This knowledge can be shared and extended and thus to help children with autism to deduct new knowledge from the existing one.

Acknowledgement

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Major Fields of Scientific Research: Web-based applications, Image processing, analysis and classification, Knowledge representation, Buisiness applications, Applications in Medicine and Biology, Applications in Psychology and Special Education, Computer Algebra.