

# Cognitonics as a New Science and Its Significance for Informatics and Information Society

Vladimir A. Fomichov

Department of Mathematical Methods and Programming for Information Processing and Control Systems, Moscow State Institute of Electronics and Mathematics (Technical University), 109028 Moscow, Russia;  
Department of Informational Technologies, K.E. Tsiolkovsky Russian State Technological University – “MATT”, 121552 Moscow, Russia  
E-mail: vdrfom@aha.ru; [http:// www.geocities.com/vladfom.geo](http://www.geocities.com/vladfom.geo)

Olga S. Fomichova

State Educational Center "Dialogue of Sciences",  
Universitetsky prospect, 5, 119296 Moscow, Russia  
E-mail: vdrfom@aha.ru

**Keywords:** cognitonics, cognitive preconditions of introducing children to computers, culture-oriented computer programs of a new generation

**Received:** July 24, 2006

*An updated definition of Cognitonics as a new science which, in particular, is studying and looking for the ways of improving cognitive mechanisms of processing information and supporting and developing emotional sphere is introduced. The paper outlines a possible structure of Cognitonics and describes its formal tool. It is the notation of conceptual-visual dynamic schemes (CVD-schemes) - an extension of the notation of semantic nets, being popular in the artificial intelligence theory. A general approach to the use of CVD-schemes for inventing effective analogies in order to introduce difficult pieces of studied theoretical materials is illustrated. The optimal preconditions of successful introducing young children to computers are formulated as a consequence of discovering by the authors of a possible way of achieving in teaching the goals of Cognitonics. With this aim, the concept of the ‘Thought-Producing Self’ of the child is defined. The paper describes a scheme of the proposed method of the harmonic humanitarian development of the child allowing for realizing the ‘Thought-Producing Self’ of each normal, average child by the age of seven - nine, where the starting age is five to six years. The method has been personally tested by one of the authors during 16 years, the total number of successfully taught young children and teenagers exceeds four hundred. Finally, a new, large-scale goal for the software industry is formulated: to construct a new generation of culture-oriented computer programs (in the collaboration with educators, linguists, art historians, psychologists) – the programs destined for supporting and developing creativity, cognitive-emotional sphere, the appreciation of the roots of the national cultures, the awareness of the integrity of the cultural space in the information society, and for developing symbolic information processing and linguistic skills, associative and reasoning abilities of children.*

*Povzetek: Opisana je kognitonika kot nova zvrst znanosti.*

## 1 Introduction

Since the middle of the twentieth century, Informatics (or Computer Science) has been one of the most quickly progressing fields of professional activity. Of course, today many leaders in the software industry are only-profit-oriented, that is why we see so many computer games of aggressive character being sold in various countries. However, there are also the leading professionals in the field with a broader mental outlook, analyzing the social role of Informatics in the modern world and looking for the ways of increasing social significance of the technical progress in the field. For instance, Bill Gates in an interview shown on the Russian

TV in fall 2006 expressed the intention to pay a considerable attention to stimulating the progress in education and to increasing the contribution of informational technologies to this progress.

This paper, going beyond the scope of Informatics, indicates new problems for Informatics, in particular, for the software industry in such a way that solving these problems would contribute to supporting and developing creativity, cognitive-emotional sphere, appreciating the roots of the national cultures, and, as a consequence, to compensating the observed shift in the people’s systems of values from eternal to commercialized values, to creating appropriate cognitive preconditions of the ongoing process of globalization in the modern information society.

On the level of every-day life, a lot of people believe that there is a connection between the state of minds of people in a society and the development of the society. This vague idea received a scientific treatment, was considerable deepened and refined in the paper (Hiwaki, Tong, 2006). The analysis carried out in this paper by Prof. K. Hiwaki on the example of the current situation in Japan showed that a long-term negligence to national culture, the lack of efforts (on the state level) to teach the young generation to appreciate the values of national culture, the desire to mechanically adapt the values of a different, market-oriented culture may have a severe negative influence not only on the moral state of the society but also on its economics.

Proceeding from our analysis of the increasing gap between the intellectual and spiritual development of many people in the modern information society, of the evolution of the systems of values of people towards commercialized values (such gap and evolution have numerous negative consequences – from underdeveloped ecological consciousness to the failures in the personal life), of the problems encountered by national cultures in the age of globalization, and from the analysis carried out in (Hiwaki, Tong, 2006), we substantiate in this paper the necessity and possibility of creating a new science called Cognitonics. This problem was formulated for the first time in the papers (Fomichova, Fomichov, and Udalova, 2004, 2005)<sup>1</sup> and was analyzed in the works (Fomichova, Fomichov, and Udalova, 2006; Fomichov and Fomichova, 2006; Fomichova and Fomichov, 2006).

This paper is a considerably modified and expanded version of two our papers presented at the Third International Workshop “Developing Creativity and Broad Mental Outlook in the Computer Age – CBMO 2006” in conjunction with the 10<sup>th</sup> Conference of the International Society for the Study of European Ideas - ISSEI 2006 (University of Malta, Malta, July 24 - 29, 2006).

In this paper we formulate an updated definition of Cognitonics as a new science conducting, in particular, to overcoming an increasing gap between spiritual and intellectual development of the person in the new reality of swift changes in the modern information society, technological challenges, and globalization. This new science is to study and look for the ways of improving cognitive mechanisms of processing information and supporting and developing the emotional sphere of the personality – the ways aiming at compensating some negative shifts (analyzed below) in the system of values of people and, as an indirect consequence, for the ways of developing symbolic information processing skills of the learners, linguistic mechanisms, associative and reasoning abilities, being important preconditions of

successful work practically in every sphere of professional activity in information society.

Then we outline a possible structure of Cognitonics as a science consisting of seven interrelated components. Two of these components are directly connected with Informatics. The first one is formed by the studies aimed at finding an optimal age (or a diapason of ages) and cognitive preconditions of systematic introducing children to computers. The second component is theoretical foundations of designing computer information technologies and systems of a new generation aimed at supporting and developing creativity, cognitive-emotional sphere, appreciation of the roots of the national cultures, and developing symbolic information processing and linguistic skills, associative and reasoning abilities.

We propose in this paper not only an updated definition and possible structure of Cognitonics but also its formal tool. This tool is *the notation of conceptual-visual dynamic schemes (CVD-schemes)*, introduced in our papers published in Informatica (Fomichov and Fomichova, 1994; Fomichova and Fomichov, 1996) and in (Fomichov and Fomichova, 1995). The notation of CVD-schemes is an extension of the notation of semantic nets, being popular in the artificial intelligence theory. The CVD-schemes allow for inventing effective dynamic conceptual mappings, or correspondences, between a bright fragment of the inner world’s picture of the learner and the mental representation of a piece of theory to be studied, so the CVD-schemes help to invent effective ways of introducing difficult pieces of learned theoretical materials (in other words, help to find effective teaching analogies).

We managed to find one possible way of achieving the goals of Cognitonics in practice. It has been proved by successful 16-year-long educational experiment carried out in Moscow by one of the authors. The total number of successfully taught young Russian children and teenagers exceeds four hundred, the age of the students varies from 5 years to 21 years.

These practical results are based on our *Theory of Dynamic Conceptual Mappings (the DCM-theory) and the Methods of Emotional-Imaginative Teaching (the EIT-methods)*; the starting basic papers on the DCM-theory and the EIT-methods were published in Informatica (Fomichov and Fomichova, 1994, 1997; Fomichova and Fomichov, 1996). Now the DCM-theory and the EIT-methods are presented in over forty our publications in English; the principal references are (Fomichov and Fomichova, 1994 - 2006; Fomichova and Fomichov, 1996 – 2006). Besides, the ideas of the DCM-theory and the EIT-methods are presented in (Fomichova et Fomichov, 2001; Fomichova, 2000, 2002).

Since the DCM-theory and the EIT-methods provided the theoretical basis for finding one possible way (among, it seems, many possible ways taking into account the peculiarities of the national culture of the learners) of achieving in practice the goals of Cognitonics, we formulate in this paper the hypothesis that Cognitonics does already exist, and its current configuration is formed by the publications on the DCM-

<sup>1</sup> The second paper was presented at the 17<sup>th</sup> International Conference on Systems Research, Informatics and Cybernetics held August 1 – 7, 2005 in Baden-Baden, Germany and received The Outstanding Paper Award of The International Institute for Advanced Studies in Systems Research and Cybernetics.

theory and the EIT-methods. Such different fields as Philosophy, Artificial Intelligence Theory, Cognitive Linguistics, Cognitive Psychology, Cognitive Biology have contributed to the birth of Cognitonics.

We describe in the paper the scheme of one, found and well tested by us, possible way of achieving in practical teaching the goals of Cognitonics. This way can be considered as a realization in practice of a new, humanities-based method of developing the personality of the child: his/her creativity, symbolic information processing skills (including linguistic skills, the ability to decode metaphors), associative and reasoning abilities, emotional sphere (see, in particular, Fomichov and Fomichova, 1997, 1998, 2001).

However, it turned out to be that this humanities-based method has much to say about the social role of Informatics in the modern world. There are numerous evidences of the tendency in various countries to permanently diminish the starting age for introducing children to computers, even to use computers in pre-school education (see, e.g., Tatkovic, Ruzic, Pecaric, 2006). But our observations and the observations of our colleagues in many countries show that too early, not thoroughly thought over acquaintance of young children with computer very often negatively influences the development of the personality of the child, his/her creativity and curiosity, hampers the development of the emotional sphere. The principal problem is that the young child, as a rule, has no tasks of creative character to be investigated and solved, using a computer as a good assistant.

That is why, unfortunately, for too many young children in the world the main direct consequence of early acquaintance with computer is the access to computer games (often provoking the aggressiveness) and, as a result, the hampering of the child's creativity and curiosity, "eating up" the time needed for normal education and additional activities developing the personality of the child (reading, music, painting, foreign languages, sport, etc.).

In the final part of this paper we describe the discovered optimal preconditions for introducing young children to computers; this part of the paper gives a new angle of look at this problem. With this aim, we use the concept of Thought-Producing Self, introduced in our papers (Fomichov and Fomichova, 2000; Fomichova, 2000; Fomichova and Fomichov, 2000).

We say that the Thought-Producing Self of the young child is realized when the child has received an experience of observing a delight, a pleasure, an approval, etc. of his/her peers and/or adults caused by an original, beautiful thought just born in the mind of the child. From this moment, the child begins to appreciate the work of his/her mind and begins to look for the ways of experiencing once more the wonderful moments of generating new, socially significant thoughts.

The essence of the new look at the problem of finding optimal cognitive preconditions of introducing children to computers can be formulated as follows: it is necessary to develop the personality of the child until the stage of realizing the Thought-Producing Self and only

after this moment to systematically introduce the child to computer. The final part of the paper schematically describes one possible way discovered and well tested by us during 16 years to realize the Thought-Producing Self of practically each Russian child with normal, average abilities by the age of seven-eight. Since the essence of the first step of this discovered way is early teaching children to fluently read and discuss complicated texts in English as a second language, to use a very rich sublanguage of English for expressing the impressions from the beauty of the nature (in particular, by means of metaphors), this way (after some adaptation) can be used practically in every country in order to escape a damage from too early, not thought-over acquaintance of children with computer.

Finally, we outline a new, large-scale goal for the software industry. This goal is to construct a new generation of culture-oriented computer programs (in the collaboration with educators, linguists, art historians, psychologists) – the programs destined for supporting and developing creativity, cognitive-emotional sphere, the appreciation of the roots of the national cultures, the awareness of the integrity of the cultural space in the information society, and for developing symbolic information processing and linguistic skills, associative and reasoning abilities of children.

## 2 Three Shifts in the System of Values

The quick technological development of modern civilization has brought a lot of precious things to the millions of people: nice cars, TV, cell telephones, etc. However, every coin has two sides. One of the most important negative aspects of the quick technological development is the observed shifts in the system of values of people. Let's define three main shifts.

*The first shift* is the shift from the eternal values to commercialized values. This shift has been noticed by many scholars, in particular, by Professor K. Hiwaki from Tokyo International University (Hiwaki, 2003; Hiwaki and Tong, 2006) and by many other participants of the symposia on Sustainable Development of the Global Community and of the symposia on Personal and Spiritual Development in the World of Cultural Diversity in conjunction with the International Conferences on Systems Research, Informatics and Cybernetics (InterSymp conferences) in Baden-Baden, Germany.

*The second shift* is a consequence of the underestimation of the value of national cultures in contrast to the overestimation of the on-going processes of globalization by the young generation, in particular.

*The third shift* is dealing with the existing gap between the intellectual and spiritual development of the personality. The notion "human being" can't be regarded without considering such notions as "body", "soul", "spirit". The expanding gap destroys the integrity of the human nature. Spiritual values are rooted in the developed emotional sphere of the personality. The emotional sphere is closely connected with the sensitivity. Modern education is focused on the

development of cognitive mechanisms being necessary for improving the information processing abilities of the child. As for developing the emotional sphere of the child, there is no *evident* necessity for it. Informational technologies *don't require* the spiritual development of the person. But it is clear that every intellectual discovery should be followed by equal to it spiritual discovery, lest the present time and challenging prospects should split off the eternity.

### 3 The Definition of Cognitonics

We believe that the modern information society has accumulated a lot of such problems concerning the development/underdevelopment of the personality that for solving these problems it is necessary and possible to elaborate a unified, fundamental approach. This approach is to be the creation of a new science which may be called Cognitonics. In (Fomichova, Fomichov, and Udalova, 2004, 2005), Cognitonics is defined as a new branch of the humanities which is studying and looking for the ways of improving cognitive mechanisms of processing information with the aim of creating cognitive preconditions of sustainable development of the global community. This new science is to be based on the symbolic approach to teaching language (natural language, language of poetry, language of painting) as a tool of thinking. It is to combine the achievements of philosophy, psychology, linguistics, and artificial intelligence theory (because it explicates many mechanisms of human thinking) and to use literature, poetry, and painting as the basic material for revealing Self, because Self lies at the center of mental life and spiritual development.

Taking into account the above said, we would like to update the definition of Cognitonics as follows. Cognitonics is a new science aimed at keeping the integrity of the nature of the human being (that is the integrity of body, spirit, and soul) and, consequently, conducing to overcoming a gap between spiritual and intellectual development of the person in the new reality of swift changes, technological challenges, and globalization. Cognitonics is studying and looking for the ways of improving cognitive mechanisms of processing information and emotional sphere of the personality – the ways aiming at compensating three indicated shifts in the system of values and, as an indirect consequence, for the ways of developing symbolic information processing skills of the learners, linguistic mechanisms, associative and reasoning abilities, being important preconditions of successful work practically in every sphere of professional activity in information society.

Cognitonics as a new science grew out of the necessity to answer the challenge of Time in the field of education. The task of Cognitonics is to combine the material and ideal levels of the one and the same process of globalization in the consciousness of people, young generation in particular. The application domain of Cognitonics are Education and Informatics. It means that with the help of the new approaches elaborated under the framework of Cognitonics and based on the ideas of

constructivist theory it appears to be possible to put into practice the achievements of Cognitonics.

Before discussing the proposed structure of Cognitonics, let's analyze in more details the mentioned three shifts in the system of values. This analysis will help to explicate a number of ideas underpinning our vision of the structure of Cognitonics.

### 4 The Changed Look at Time and the Shift to Commercialized Values

An important peculiarity of the 21<sup>st</sup> century which Cognitonics is dealing with is a transformation of such fundamental notion as “time”. The perception of the category of time is changed. The existing perception of time as a flood of images in the race of events prevents humans from spiritual development. We are not sipping the information – we are gulping it. We are plunging into another culture, regarding it as a new source of information, without perceiving it in a philosophical way; we are careless with language. We are not walking – we are racing; we are not living in space and time, but the space is transformed to a virtual space, and time is becoming the most precious present we may afford.

The perception of the world is closely connected with the perception of time. In the time of antiquity humans addresses God, and time for them was equal to eternity. When Leeuwenhock, a famous Dutch scientist, discovered in 1673 the moving world in the drops of water, blood, the perception of the world changed, and the painters immediately started “twisting” time” on the canvas (for example, Magnasco, 1667 – 1749, an Italian painter). At the end of the XIX<sup>th</sup> century, the impressionists tried to catch a moment. Nowadays the mental representation of time is transferred into the flood of images, and it is revealed, for instance, in a great number of art installations.

Poetry, literature, painting, philosophy help the students to see and realize the flood of time and to understand the difference in perception influenced by the way people regard time. It is a thought-provoking impression stimulating integral perception of the situations and the process of thinking in general. Creativity is rooted in the combination of contemplation and action. It correlates with the necessity to have self-paced activity regardless to the rapid changes of the society and to be skillful enough to keep pace with time. On the other hand, regarding the human being as a point of intersection of *two worlds – eternal and temporal* makes it easy to *restrain the extension of the existing shift from eternal values to commercialized values*.

### 5 Cognitonics and Globalization Processes in the Modern Information Society

It is clear that the system of education should be adapted to the modern civilization and should meet the requirements of the new information society, revealing

strong tendency to globalization. But on the other hand, the humanity shouldn't start from the "tabula rasa", and the young generation shouldn't be pushed to denying its own culture in order to be inscribed into the global world. On the contrary, the process of entering the global world and searching for a sounder and more satisfactory lifestyle for our global community requires an appropriate response in the field of education.

The human being is a precondition of thought and the center of the human thought in general. The thought is regardless to the national belonging and time. The ever existing creative space with the circulation of the ideal entities, such as thoughts, images, metaphors, ideas embodied in scientific discoveries, sculpture, painting, music, poems, literature, architecture is recognized by the humanity as a pulsating alive spring of creative energy.

This ever existing creative space may be defined as a reflection of globalization on the spiritual level. Globalization is a material pragmatic process, and the creative space existing on the spiritual level and being ideal is manifested in the masterpieces created in all the fields of science and art and is being appreciated by the humanity. The integrity of the cultural space is clear, and *it should be clearly reflected in the digital space of information society.*

The task of Cognitonics is to combine the material and ideal levels of the forthcoming process in the consciousness of people, young generation in particular. It makes possible to create cognitive preconditions of sustainable development, when a person realizes him/herself as a link between generations, who has to maintain the chain of generations by means of placing him/herself in the space of the human thought and spirit.

## 6 The Structure and Current Configuration of Cognitonics

The ideas stated above and in our previous works on the Theory of Dynamic Conceptual Mappings and the System of the Methods of Emotional-Imaginative Teaching (Fomichov and Fomichova, 1994 - 2006; Fomichova and Fomichov, 1996 -2006; Fomichova, 2000, 2002) enable us to outline the following structure of Cognitonics. This new science includes the theoretical foundations and methods of:

- (1) teaching natural language (mother tongue and foreign languages), focusing on language as a tool of thinking and a tool of constructing social reality (see Searle 1995) but not only as a tool of communication;
- (2) realizing the unified symbolic approach to teaching both natural language and symbolic language of art (mainly, painting), in particular, for supporting and extending the figurative reasoning skills of the learners, their symbolic information processing abilities, and for enabling them to decode the messages conveyed by the world-known masterpieces; that provides the possibility to plunge

into the world of art and to establish mental and spiritual ties with the masterpieces;

- (3) the stimulation of effective knowledge acquisition by the learners, in particular, by means of creating the formal means and methods destined for helping to invent effective teaching analogies;
- (4) inscribing the notions of beauty, harmony into the conceptual pictures of the world (first of all, into the system of values) of children, teenagers, and college students, where the beauty, harmony are understood in a maximally broad sense: as the beauty of thoughts, acts, interrelations of people, etc.;
- (5) improving the system of values of the learners by means of realizing an integral, going right through all ages (from early childhood to the college years) approach to the analysis of poetry, literature, painting, and sculpture, i.e. by threading the various mental representations and images revealing eternal values on the system of values of the learners; one of the principal aims is the formation of the feeling that a person is only one link in the long chain of previous and future generations as an important precondition of sustainable development;
- (6) finding an optimal age (or a diapason of ages) and cognitive preconditions of systematic introducing children to computers without damaging the creative abilities of children (because the dominant part of the users do realize the given algorithms while working with the computers);
- (7) opening new prospects for the modern computer informational technologies on the way of implementing a part of the methods elaborated in the directions (1) – (5), creating special computer programs destined for supporting and developing creativity, cognitive-emotional sphere, the appreciation of the roots of the national cultures, the awareness of the integrity of the cultural space in the information society, and for developing symbolic information processing and linguistic skills, associative and reasoning abilities, for correlating painting and literature, architecture and poetry, poetry and mathematics, etc.

The philosophical basis of Cognitonics in its current stage is formed by the ideas of the famous Russian philosophers Nikolay Berdjajev (1874 – 1948), Vladimir Solovyov (1853 – 1900), and Vyacheslav Ivanov (1866 – 1949); partially this basis is reflected in (Fomichova, Fomichov, and Udalova, 2004, 2006; Fomichov and Fomichova, 2006). The ideas of these thinkers have no national coloring. For instance, the following fact illustrates a broad humanitarian significance of these ideas: in 1947, Nikolay Berdjajev received the degree "doctor honoris causa" from the Cambridge University, UK.

One of the principal goals of this paper is to show that the idea of creating a new science – Cognitonics – is constructive, workable. We would like to say even more: in fact, the initial configuration of Cognitonics does already exist; it is given by our Theory of Dynamic Conceptual Mappings (the DCM-theory) and the System

of Methods of Emotional-Imaginative Teaching. These new theory and methods of teaching are described in over 40 our publications in English, in three papers in French, and in two monographs in Russian.

We believe that our theory and the results of a 16-year-long large-scale experiment (totally over four hundred students – young children and teenagers) on realizing the ideas of the DCM-theory in practice convincingly prove the possibility of achieving the goals formulated in the definition of Cognitonics.

## 7 Conceptual-Visual Dynamic Schemes as a Common Formal Tool for Cognitonics and the Scholarship of Teaching and Learning

Not all sciences have formal means, especially this applies to the branches of the humanities. However, usually the scholars appreciate the emergence of formal tools playing an essential role in a science. Though it may sound surprisingly, one of the fields contributed to the birth of Cognitonics is the Artificial Intelligence theory. The principal contribution of this field to the development of Cognitonics consists in providing a starting point for the elaboration of its formal tool.

Let's agree that the term "a teacher" may designate a school teacher or a university professor or the author of a textbook, etc., so this term is considered in a generalized meaning. In such situations when the existence of a considerable gap between the inner world's picture, or conceptual system (CS), of a teacher and the CS of a learner is obvious in the context of introducing a new piece of knowledge, a teacher is to go beyond the set of notions traditionally used for introducing the information of the kind and is to invent (better preliminary) some new ways of explaining the material to be studied. Looking for these new ways, a teacher is to take into account the knowledge about the full CS of a learner. A teacher must try to find in the CS of a learner such fragments which reflect situations being similar (or isomorphic) in some generalized sense to the situations taking place in the materials to be grasped.

As a rule, it is possible to do. If such similar situations are discovered, a teacher must invent the ways being clear for a learner (the learners) and enabling him/her to establish the correspondences between each such generalized situation and the situation expressed by the teaching material. Then a teacher should select or invent such an analogy which seems to be an optimal one from the standpoint of introducing a new piece of knowledge pertaining to the studied discipline.

We propose here the special formal means for helping teachers to invent effective dynamic correspondences between an existing fragment of the CS of a learner and the fragments to be created in the mental model of the learner and corresponding to the introduced piece of knowledge. With this aim we introduce below

the notion of a conceptual-visual dynamic scheme, proceeding from the notion of semantic net.

In the Artificial Intelligence theory, one uses most often semantic nets (SN) for visual representing conceptual structures and knowledge about the world. A SN is defined as an oriented graph with marked vertices and edges. The marks of vertices correspond to the things, situations, concepts, the values of colours, the numbers, etc. The marks of edges denote the relations between things, concepts, things and concepts, the functions, the relations between the meanings of the fragments of natural language texts. During more than thirty years, numerous variants of SN have been elaborated; in particular, conceptual graphs proposed by J. Sowa (Sowa, 1984) can be interpreted as a particular kind of SN. A survey of conceptual graphs and of earlier versions of semantic nets can be found, in particular, in the Chapter 6 of (Luger, 2002).

Following the works (Fomichov and Fomichova, 1994, 1995), we define the notation of *conceptual-visual dynamic schemes* in the following way.

1. We'll use the blocks with single contour to designate: diverse physical objects, situations, processes; concepts qualifying objects; sets of objects, sets of concepts; the names of functions, the names of relations between the objects, concepts or between the objects and concepts; the names of relations between the meanings of the fragments of texts.
2. The inner visual images of diverse objects and situations are a very essential component of the inner world's pictures, or conceptual systems, of people. Consider the following example. Let Collette and Mary be two friends from the first grade, and they go in for swimming together. Mary has the beautiful rose dress and the blue dress. Then the inner world's picture of Collette contains, in particular, the following components A, B, C, D, E: A and B denote respectively the concept "a girl" and the friend Mary; C is the inner visual image (IVI) of Mary in the rose dress, D is the IVI of Mary in the blue dress, and E is the IVI of Mary in the swimming dress. That is why we'll use the blocks with double contour for denoting the inner visual images of objects.
3. Let X be the set of components of the conceptual system of a person and include, in particular, (a) the representations of concepts and objects, (b) the IVI of objects. Then for designating a binary relation R between some elements of X, we'll use a single arrow  $\rightarrow$  with the label R. Let's agree that one of possible representations may be an arrow intersecting a block with the label R. Such a label R may designate, e.g., the relations "Part-Whole", "Agent of an action", "Property".
4. We propose to employ double arrows  $\Rightarrow$  for designating *dynamic conceptual mappings, or correspondences*. The orientation of an arrow of the kind doesn't matter to us: a block in the

beginning of such an arrow denotes an entity (an object, a concept, a situation) perceived quite clear by a learner (being well known to a learner or being a very bright just created fragment of the conceptual system), and a block in the ending of the arrow denotes an entity which is to be inscribed into the inner world’s picture of a learner.

The configurations built in accordance with the items 1 – 4 will be called *Conceptual-Visual Dynamic Schemes (CVD-schemes)*. This notion was introduced in the work (Fomichov and Fomichova, 1994).

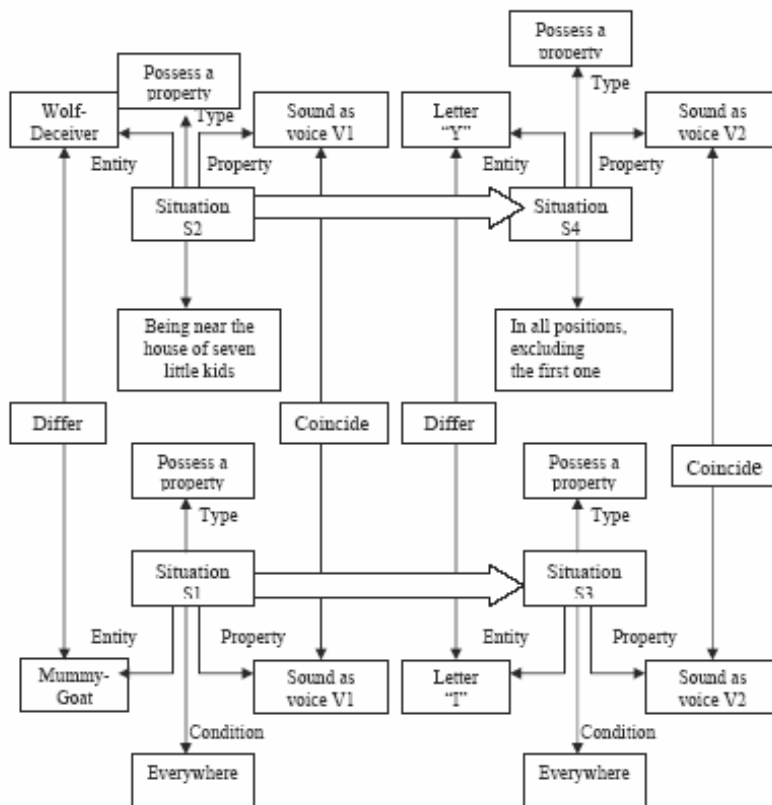
**Example.** The figure 1 contains a CVD-scheme elaborated for the study of one element of the English language phonetics – explaining the pronunciation in the words of the letter “Y”. It is known that the rules of reading form a complicated component of the syllabi of teaching young children to read in English as a second language. However, it was necessary to teach the six-year-old Russian children to read, because it was the only possibility to give them from the very beginning the confidence of successful progress in learning English. The difficulty consisted in explaining in a way being clear for five-six-year-old children why the different letters “Y” and “I” denote the same sound in the words “time”, “ice”, “cry”, “fly”, etc. (let’s assume that by this moment the children already know the rule of reading the letter “I”). The given CVD-scheme establishes an

analogy between a situation from the known fairy-tale about the Wolf and the Seven Little Kids and the studied piece of theory.

Only several years ago a new field of academic activity called the scholarship of teaching and learning received a formal status. Proceeding from the works (Boyer, 1990; Glassick *et. al.* 1997; Schulman, 1993), the scientists write about the necessity of seeing the academic work in a broader context which incorporates four distinct types of scholarship: the scholarship of discovery research; the scholarship of integration, including the writing of textbooks; the scholarship of service, including the practical application of knowledge; and the scholarship of teaching.

One of the principal tasks of Cognitonics is to contribute to the progress of the scholarship of teaching and learning by means of delivering effective methods of preparing not only future teachers working with children and teenagers but also specialists in various fields aimed at enhancing the ethical component in their every-day professional activity, the responsibility for the future generations.

It is impossible not to agree with the following idea: “We believe the aim of scholarly teaching is ... simple: it is to make transparent how we have made learning possible.” (Trigwell *et al.* 2000, p. 156). That is why the notation of conceptual-visual dynamic schemes seems to be of high significance for the scholarship of teaching and learning, because it can be used in practice as formal



**Figure 1:** A conceptual-visual dynamic scheme used for inventing a way to teach young Russian children to pronounce in the words the letter «Y».

tool of inventing effective dynamic correspondences between the existing or just created but a bright and stable fragment of the conceptual system of the learner and a fragment being a mental representation of the piece of knowledge to be introduced.

## 8 Cognitronics and Optimal Cognitive Preconditions of Introducing Children to Computers

### 8.1 General Characterization of One Discovered Way of Achieving the Goals of Cognitronics in Practice

We've managed to discover one possible way to achieve the goals of Cognitronics. The other scholars can find new ways with respect to the peculiarities of their theoretical background and national culture. The notation of CVD-schemes introduced above became a starting mechanism for obtaining a chain of scientific and practical results enabling us to say today about the workability of the concept "Cognitronics".

Proceeding from the DCM-theory, we elaborated an original, highly effective extra-scholastic program of harmonic humanitarian development of the child. The program is destined for teaching children during twelve years, where the starting age is five to six years. The program has been personally tested in Moscow with great success by one of the authors over a period of 16 years. It includes the following series of lessons: (1) a two-year course (the age of learners is 5 to 7 or 6 to 8 years) of studying foundations of reading and speaking English as a foreign language (FL), including learning basic elements of English grammar (Present Simple and Past Simple Tenses); (2) a course on understanding the language (a part of FL) of describing the nature and feelings evoked by nature; (3) a course on understanding the symbolic language of painting; (4) a course on understanding the language of poetry (with the accent on understanding metaphors and descriptions of nature); (5) a course aimed at (a) first acquaintance with sciences and (b) developing the abilities to argue their own opinion, to raise objections, etc.; (6) a course on improving the knowledge of English grammar (during mainly the fifth year of studies). In fact, the lessons of courses (2) to (6) may interchange.

The kernel of our program is an original method of teaching 5-6-year-old children to read fluently in English as a FL and to discuss complicated texts written in Present Simple or Past Simple Tenses. The key to achieving this success was given by the notation of CVD-schemes: the analogies provided by the specially composed fairy-tales enable a teacher to establish effective correspondences (or dynamic conceptual mappings) between a situation from a fairy-tale or everyday life and the studied fragment of English grammar.

The EIT-methods have been successfully used during 16 years in Moscow in extra-scholastic teaching

English as a second language, the symbolic language of poetry and painting, literature and poetry in Russian and English, communication culture. The total number of successfully taught students exceeds four hundred, their age varies from 5 to 21 years.

### 8.2 The Realization of the Thought-Producing Self as the Cognitive Precondition of Introducing Children to Computers

The fact of a deep penetration of computers and information technology into the system of school education and, in some countries, into the system of pre-school education should be recognized, because it is embedded in the language of modern life. Indeed, a new word has emerged: "screenager" instead of "teenager". Specialists in cognitive science, education theory, and computer science should *jointly* take responsibility for introducing children to computers in an optimal way. Primarily, they should help the pre-primary educational system and school system to support and extend the creative potential of the young generation so as to equip them to use computers as tools to support and extend their thinking.

In recent years, the problem of discovering and creating optimal cognitive preconditions that enable children successfully to interact with computers has acquired a high social and political significance. This is due to government policy in several economically well-developed countries (e.g., in Japan and U.S.A.) to acquaint primary school students with computers. They even recommend the use of complementary interactive Internet-based learning tools in the classrooms with children as young as 5-6. This paper presents a new constructive look at this problem, extending the ideas set forth earlier in (Fomichov and Fomichova, 2000; Fomichova and Fomichov, 2000). For this, the concept of "Thought-Producing Self" is introduced and analyzed.

Psychologists define a number of Selves, such as Ecological Self (it emerges as a result of interactions with the environment), Interpersonal Self (the self defines itself as a social being through social interactions), Self-Narrative (around the third year children become interested in the past and in the future and begin to acquire the memory skills on which narrative depends), and the Emotional Self (Snodgrass and Thompson, 1997).

But it appears that this definition does not include one of the most important Selves, the "Thought-Producing Self." The importance of it is now clear at the beginning of the XXI century - a century of the new information society, of screenagers, and of computers as integral members of the domestic family. *The "Thought-Producing Self" defines itself in the mirror of our appreciating ourselves.* The child has to understand that his/her brain produces *socially important thoughts and rationalisations.* This moment is the beginning of defining himself/herself as a personality who is able to think in such a way that the result of his/her thinking causes appreciation and praise.



It should be stressed that the “Thought-Producing Self” is defined here *not* as the ability of the child to understand that he/she can think. By definition, “Thought-Producing Self” is realized in the child *only* if he/she is able to generate ideas that have a relatively high social significance. As such, they are greatly appreciated by other persons (usually, adults), because the ideas are, for example, nice, bright metaphoric descriptions of some situations or pictures or because they help to solve some practical problem. In all cases, the action of producing thoughts receives a positive response. This stimulates the child to continue to think in this way.

The intensive use of computers by the child *before* the realization of his/her Thought-Producing Self may prevent the child from being able to develop as a creatively thinking personality. The role of the computer in information processing can retard and restrain the child’s cognitive development, for example, as in the use of calculators in mathematics. That is why we put forward the *hypothesis that realizing the “Thought-Producing Self” of the child is the principal cognitive precondition for the successful, systematic involvement of the child with the computer.*

If this precondition is satisfied, systematic interaction with computer will not prevent the child from realizing his/her potential of creative thinking. In our opinion, this hypothesis needs to be widely discussed by computer scientists, cognitive scientists, educators, because it is of great importance for new information society.

Our sixteen-year-long large-scale study enables us to believe that our methods of emotional-imaginative teaching allow for realizing the “Thought-Producing Self” of each normal, average child by the age of seven - nine, where the starting age of extra-scholastic studies is five to six years. It has been achieved within the context of language-enriched lessons in language, literature, poetry and art - the areas of studies generally accepted as central to young children’s cognitive development.

### 8.3 The Scheme of a Discovered Way of Realizing the Thought-Producing Self of the Young Child

Our starting point was as follows. We believed that natural language is the principal tool for introducing beauty into the conceptual picture of the world of the child. We put forward the hypothesis that the age five – six years is an optimal one from this standpoint (later we proved this hypothesis). For achieving our goal, we proposed a way seeming to be a paradoxical one: the way of introducing beauty by means of a second language (English in our study) with the final goal to enable the students to find and appreciate beauty in nature, in poetry and literature both in mother tongue and in foreign languages, in painting and sculpture.

While finding this paradoxical way of solving our problem, we proceeded from one idea of the famous Russian psychologist Leo Vygotsky (Vygotsky 1982). He wrote about two stages in the process of cognition: the formation of *spontaneous notions* and the formation

of *scientific notions*. The directions of the development of these two processes are different. The first one is going from the bottom to the top, that is from the identification of the concrete thing from every-day experience to the generalization (for instance, from a concrete table to the notion of furniture). The direction of the formation of scientific notions is opposite: it is going from a defined general notion back to the every-day experience; for example, from the notion of etiquette to the “good morning” greeting.

Vygotsky indicated the peculiarity of mastering a mother tongue (MT) and a foreign language (FL). He said that the child is mastering the MT unintentionally, but as for a FL, it happens vice versa. The child does it on purpose, the starting point of this process is that he/she is learning FL deliberately. Consequently, the acquisition of the MT is going in the same direction as the formation of spontaneous notions – from the bottom to the top, that is from a concrete thing to the notion in general. As for the acquisition of FL, it is going in the opposite direction – from mastering a model (a notion) back to the everyday practice.

So the first step of achieving our goal was to invent a way to teach five-six year old Russian children to read rather complicated texts (the fairy-tales containing over five hundred words) in English as a second language (SL), to master the rules of using Simple Present and Simple Past Tenses and the rules of putting and answering questions. For solving this problem, we invented effective analogies for introducing the pieces of theory. The CVD-schemes helped us to invent such analogies (see Fomichov and Fomichova, 1994, 1995; Fomichova and Fomichov, 1996). It should be stressed that this formal tool can be used in every field of studies, with the learners of every age (the starting age is 5 – 6 years) for finding the ways of stimulating effective knowledge acquisition by the learners.

Our approach to learning a SL is conditioned by earlier forming scientific notions (in comparison with the period of time recommended by Vygotsky) as an answer to the challenge of time. Such kind of activity is grounded on the strong curiosity of children, on the one hand, and on positive responses to an intellectual activity, on the other hand. This intellectual activity in its way evokes strong feelings, stimulates the development of emotional sphere. And as for the spiritual values, they are rooted in the developed emotional sphere of the personality.

We’ll show schematically what new prospects were opened by the basic obtained result – teaching children to read and discuss complicated texts in second language.

Reading and discussing complicated texts in English as a SL at the age of 5 –6

- mastering a rich sublanguage of SL for expressing the beauty of nature and the feelings evoked by nature
- development of figurative reasoning + development of the awareness of the social role of Natural Language
- understanding poetical metaphors
- creating metaphors
- understanding the symbolic language of painting

- development of the ability of decoding the messages conveyed by the masterpieces
- improvement of the feeling that a person is a link in the long chain of previous and future generations.

The experience accumulated by one of the authors during 16 years of extra-scholastic teaching shows that the elaborated method of the harmonic humanitarian development of the child allows for realizing the “Thought-Producing Self” of each normal, average child by the age of seven - nine, where the starting age is five to six years.

## 9 Culture-Oriented Computer Programs of a New Generation

We must underline that the formulated optimal preconditions of introducing children to computers concern the dominant part of existing computer programs. However, there are reasons to believe that it is possible and expedient to create a new generation of computer programs which may be called *culture-oriented programs*. A subclass of such programs can be destined for contributing to the realization of the Thought-Producing Self of the child by the age of seven – nine. The “intellectual filling” of these programs can be based on the fairy-tales, thrilling stories, landscapes, seascapes, portraits, etc.

The computer systems *Addizionario* (Turrini, Cignoni, and Paccosi, 2001) and *AddizionarioPlus* (Turrini, Baroni, Paccosi, 2006) can be considered as the examples of the culture-oriented programs of a new generation contributing to the realization of the Thought-Producing Self of the child. *Addizionario* is a multimedia tool suggesting innovative and appealing ways for improving the linguistic and cognitive development of primary school children. It is a hypermedia linguistic laboratory in which children being from 5 to 12 years old can study the Italian as their native or second language at various levels of difficulty and from different points of view. *AddizionarioPlus* is a multilingual version of *Addizionario*, it was implemented in 2003 and allows the user for customizing the tool in his/her own language or dialect, starting from the already available languages (Italian, English, French, Spanish, and German).

Children taught in accordance with our methods of emotional-imaginative teaching during five, seven, or more years have one distinctive feature concerning their attitude to computers. These children are used to enjoying the intellectual activities; in fact, they consider intellectual activity as a game. That is why these children are interested in the work with only such computer systems which have an “intellectual filling”. Besides, these children highly appreciate the existence of ethical and aesthetical components in the computer programs.

Proceeding from these observations, we can conclude that a large-scale realization in practice of the goals of Cognitonics will create a demand for *the culture-oriented computer programs of a new generation* – with an “intellectual filling”, ethical and aesthetical components, supporting and developing the creativity of

children, broad mental outlook, figurative thinking, the appreciation of national culture, the understanding of different cultures.

## 10 Conclusion

The ongoing processes such as a shift from eternal values to commercialized values, globalization, the lack of balance between spiritual and intellectual development condition the change in the conceptual picture of the world of the young generation. The process of entering the global world and searching for a sounder and more satisfactory lifestyle for our global community requires the appropriate responses both in science and in the field of education, including e-education.

Education has the advantage to provide the opportunity for self-paced activity and improves the skills being necessary for keeping pace with time. If education is successful in fulfilling the social task to reproduce culture and make the child “to fly with two wings” (that is spiritual development and intellectual development), then the global information society may expect from the person a response which meets the requirements of sustainable development and takes into account the interests of future generations.

Cognitonics, appealing to the achievements of Philosophy, Artificial Intelligence, Linguistics, Psychology, Art, applies these achievements to the process of learning in order to make an endeavour to compensate the on-going systemic shifts to commercialized values, globalization in its vulgar way, and intellectual discoveries without equal to them spiritual ones.

The notation of conceptual-visual dynamic schemes (or CVD-schemes), considered in this paper as a formal tool of Cognitonics, can find numerous applications in Web-based distance education. The many-year experience of Web-based distance teaching mathematics accumulated by one of the authors has shown that a considerable part of online university students encounter difficulties while studying theory by means of a textbook and Web-based topic notes. We suppose that the CVD-schemes can be used for inventing effective teaching analogies in various disciplines in order to make easier successful learning for online students. In the same way, the CVD-schemes can help to invent thrilling teaching analogies for the use in Intelligent Tutoring Systems (as components of Web-based E-learning systems too).

Under the framework of Cognitonics, a solution is suggested to the fundamental problem of formulating and creating the optimal cognitive preconditions of introducing children to computers. The concept of the “Thought-Producing Self” of the child is described. A way of realizing the “Thought-Producing Self” of average 7-9 year olds is outlined. The key idea is the early development of children's symbolic information processing skills, creativity, and emotional sphere, where the basic elements are natural-language-processing abilities and figurative thinking. The suggested approach has been successfully used during 16 years of teaching

totally more than four hundred 5 - 21 year old pupils in languages (mainly English and also Russian), literature, poetry, and art. Underpinning this approach are the Theory of Dynamic Conceptual Mappings (the DCM-theory) and the System of the Methods of Emotional-Imaginative Teaching. The creation of DCM-theory was influenced by the ideas from Artificial Intelligence theory, Philosophy of Language, Cognitive Linguistics, Cognitive Psychology, and Cognitive Biology.

We believe that the concept of Cognitonics will stimulate the educators, scholars working in the humanities and natural sciences, and the designers of computer informational technologies and systems to join the efforts for better understanding of the advantages and disadvantages of the computer age in order to put together the cultural and digital spaces from the very initial stage of introducing children to computers up to the age of spiritual and intellectual maturation. One of the principal ways of achieving this goal can be the creation of the culture-oriented computer programs of a new generation.

## References

- [1] Boyer, E. L. (1990) *Scholarship reconsidered: Priorities of the professoriate*. Princeton, NJ, The Carnegie Foundation for the Advancement of Teaching.
- [2] Fomichov, V.A. and Fomichova, O.S. (1994) The Theory of Dynamic Conceptual Mappings and its Significance for Education, Cognitive Science, and Artificial Intelligence; *Informatica. An International Journal of Computing and Informatics (Slovenia)*, Vol. 18, No. 2, pp. 131-148.
- [3] Fomichov, V.A., Fomichova, O.S. (1995) The artificial intelligence theory and highly effective methods of teaching young children foreign languages. *Cybernetica (Namur, Belgium)*, Vol. XXXVIII, No. 4, pp.321-344.
- [4] Fomichov, V.A. and Fomichova, O.S. (1997) An informational conception of developing the consciousness of the child. *Special Issue "Consciousness as Informational Phenomenalism: An Informational, Phenomenological, Philosophical, Neural and Quantum-Mechanic View. Informatica. An International Journal of Computing and Informatics (Slovenia)*, Vol. 21, No. 3, pp. 369-388.
- [5] Fomichov, V.A. and Fomichova, O.S. (1998) A new theoretical and practical approach to early positive developing child's consciousness. In R. Trappl (Editor), *Cybernetics and Systems'98. Proceedings of the 14th European Meeting on Cybernetics and Systems Research*. Vol. 1, Austrian Society for Cybernetic Studies, Vienna, pp. 276-281.
- [6] Fomichov, V.A. and Fomichova, O.S. (2000) The social responsibility of computer science specialists for the creative potential of the young generation. *International Journal of Artificial Intelligence in Education. Special Issue on AIED 2010*, Vol. 11, No. 2, pp. 208-219.
- [7] Fomichov, V. A. and O.S. Fomichova (2001) A Many-Staged, Humanities-Based Method of Realizing the Thought-Producing Self of the Child; *International Peer-Reviewed Online Journal "Consciousness, Literature, and the Arts"*, Vol. 2, No. 1, available online at <http://www.aber.ac.uk/tfts/journal/archive/fomichov.html>.
- [8] Fomichov, V.A. and Fomichova, O.S. (2006) The Contribution of Various Disciplines to the Birth of Cognitonics. *Proceedings of The Third Intern. Workshop "Developing Creativity and Broad Mental Outlook in the Computer Age – CBMO-2006" in conjunction with the 10<sup>th</sup> Conference of the Intern. Soc. for the Study of European Ideas – ISSEI 2006 (University of Malta, July 24 - 29, 2006)*.
- [9] Fomichova, O.S. (2000) *Up-Bringing of the Successful Child in the Computer Age*. Association of the Russian Higher Institutions of Learning, Publishing House "Ghelios ARV" (in Russian).
- [10] Fomichova, O.S. (2002) *Education as Revelation (From Ideas of Baroque to a New Approach in Education)*; Moscow, Association of the Russian Higher Institutions of Learning, Publishing House "Ghelios ARV" (in Russian).
- [11] Fomichova, O.S. and Fomichov, V.A. (1996) Theoretical foundations of a new method of teaching children effective information processing. *Informatica. An International Journal of Computing and Informatics (Slovenia)*, Vol. 20, No. 3, pp. 381-399.
- [12] Fomichova, O.S. and Fomichov, V.A. (1999). Semantics of learning transactions: intelligent tutoring systems for improving the understanding of linguistic representations. *Special Issue "Intelligent Tutoring and Learning Environments", Educational Technology Magazine*. Englewood Cliffs, New Jersey, Sept./Oct. 1999, Vol. XXXIX, No. 5, pp. 33-35.
- [13] Fomichova, O.S. and V.A. Fomichov (2000) Computers and the Thought-Producing Self of the Young Child; *The British Journal of Educational Technology*, Vol. 31, No. 3, pp. 213-220.
- [14] Fomichova, O.S. et Fomichov, V.A. (2001) Evaluation constructiviste en apprentissage des langues. *Actes du Colloque International "Constructivismes: Usages et Perspectives en Education", Republique et Canton de Geneve, Departement de l'Instruction Publique, Service de la Recherche en Education (SRED), Cahier 8, Septembre 2001, Vol. 1, 297 P., Vol. 2 (CD-Rom), pp. 336-340.*
- [15] Fomichova, O.S. and Fomichov, V.A. (2006) Introduction to Cognitonics as a New Branch of the Humanities. *Proceedings of The Third Intern. Workshop "Developing Creativity and Broad Mental Outlook in the Computer Age – CBMO-2006" in conjunction with the 10<sup>th</sup> Conference of*

- the Intern. Soc. for the Study of European Ideas – ISSEI 2006 (University of Malta, July 24 - 29, 2006).*
- [16] Fomichova, O.S., Fomichov, V.A. and Udalova, L.D. (2004) The Ways of Cultural Interaction and a Personal Response to It; In *Personal and Spiritual Development in the World of Cultural Diversity* (ed. by G.E. Lasker and K. Hiwaki;), Vol. 1. *Addresses and Papers from the 1<sup>st</sup> International Symposium on Personal and Spiritual Development in the World of Cultural Diversity, July 30, 2004, held at the 16th International Conference on Systems Research, Informatics and Cybernetics – InterSymp-2004, July 29 – August 5, 2004, Baden-Baden, Germany;* The International Institute for Advanced Studies in Systems Research and Cybernetics, University of Windsor, Ontario, Canada, 2004, pp. 47-51.
- [17] Fomichova, O.S., Fomichov, V.A. and Udalova, L.D. (2005) Forming Scientific Notions in Childhood as a Precondition of Successful Personal Growth and Equal to It Spiritual Development. In *Personal and Spiritual Development in the World of Cultural Diversity* (ed. by G.E. Lasker and K. Hiwaki;), Vol. 2. *Addresses and Papers from the 2nd International Symposium on Personal and Spiritual Development in the World of Cultural Diversity, August 2, 2005, held at the 17th International Conference on Systems Research, Informatics and Cybernetics – InterSymp-2005, August 1 - 7, 2005, Baden-Baden, Germany;* The International Institute for Advanced Studies in Systems Research and Cybernetics, University of Windsor, Ontario, Canada, 2005, pp. 51-55.
- [18] Fomichova, O.S., Fomichov, V.A., & Udalova, L.D. (2006) Cognitive Traps on the Way of Spiritual Development of the Individual. In *Personal and Spiritual Development in the World of Cultural Diversity* (ed. by G.E. Lasker and K. Hiwaki;), Vol. 3. *Addresses and Papers from the 3rd International Symposium on Personal and Spiritual Development in the World of Cultural Diversity, August 9, 2006, held at the 18th International Conference on Systems Research, Informatics and Cybernetics – InterSymp-2006, August 7 - 12, 2006, Baden-Baden, Germany;* The International Institute for Advanced Studies in Systems Research and Cybernetics, University of Windsor, Ontario, Canada, 2006.
- [19] Glassick, C., Huber, M. & Maeroff, G. (1997) *Scholarship Assessed: Evaluation of the Professoriate.* San Francisco, Jossey-Bass.
- [20] Hiwaki, K. (2003) Sustainable Development: Functional Guideline for a Multi-Dimensional Approach. In *Sustainable Development and Global Community. Vol. IV* (ed. G.E. Lasker and K. Hiwaki); *Papers from the 15th International Conference on Systems Research, Informatics and Cybernetics – InterSymp-2003, July 28 – August 2, 2003, Baden-Baden, Germany;* The Intern. Institute for Advanced Studies in Systems Research and Cybernetics, University of Windsor, Ontario, Canada, pp. 1 – 5.
- [21] Hiwaki, K. and Tong, J. (2006) Credibility Trap: Japan Today and China Tomorrow, *Human Systems Management*, Vol. 25, No. 1, pp. 31-50.
- [22] Luger, G.F. (2002) *Artificial Intelligence. Structures and Strategies for Complex Problem Solving* (4<sup>th</sup> ed.). Fourth Edition. Addison Wesley.
- [23] Schulman, L. S. (1993) Teaching as community property. *Change* (November/ December), 6-7.
- [24] Searle J. R. (1995) *The Construction of Social Reality.* The Penguin Press.
- [25] Snodgrass J G and Thompson R L (Eds.)(1997) *The Self Across Psychology. Self-Recognition, Self-Awareness, and The Self Concept.* The New York Academy of Sciences, Annals, Vol. 818.
- [26] Sowa, J.F. (1984) *Conceptual Structures – Information Processing in Mind and Machine.* Addison-Wesley, Reading, MA.
- [27] Tatkovic, N., Ruzic, M., Pecaric, D. (2006). Pre-school Teachers' Informatics and Information Literature. In *L. Bakic-Tomic and V. Simovic (Eds.), Pre-Conference Proceedings of the Special Focus Symposium on Communication and Information Sciences in the Knowledge Society (August 9 – 10, 2006) in conjunction with the 18th International Conference on Systems Research, Informatics and Cybernetics – InterSymp-2006, August 7 - 12, 2006, Baden-Baden, Germany,* Zagreb, pp. 18-22.
- [28] Trigwell, K., Martin, E., Benjamin, J., and Prosser, M. (2000) Scholarship of teaching: a model. *Higher Education Research and Development*, Vol. 19, No. 2, pp. 155-168.
- [29] Turrini, G., Baroni, P., Paccosi, A. (2006) *AddizionarionPLUS: a Creative Approach to Linguistic and Intercultural Education. Informatica . An International Journal of Computing and Informatics (Slovenia)*, Vol. 30, No. 4.
- [30] Turrini G., Cignoni L., Paccosi A. (2001) *Addizionario: a Pupil's Innovative Tool for Language Learning. Special Issue of the International Peer-Reviewed On-line Journal "Educational Technology and Society"*, Vol. 4, No. 2.
- [31] Vygotsky, L.S. (1982) *The Problems of General Psychology.* Moscow, The Publ. House "Pedagogy".