JOURNAL
OF
APPLIED
QUANTITATIVE
METHODS

MODELS AND SYSTEMS FOR STRUCTURIZATION OF KNOWLEDGE IN TRAINING

Nicolae PELIN
PhD, Information Technology Department,
University of Applied Science of Moldova, Kishinev, Moldova

E-mail: pelin_nicolae@yahoo.com

Serghei PELIN
PhD Candidate, Faculty of Computer Science,
State University Alexandru Ioan Cuza , Iassy, Romania

E-mail: serghei.pelin@yahoo.com

Abstract: *In this work the problems of the automated structurization and activation of the knowledge, saved and used by mankind, during the organization and training, and also that knowledge which are generated by experts (including teachers) in the current activity, are analyzed. The purpose - the further perfection of methods and systems of the automated structurization of knowledge and their applications for creation: the automated workplace of the lecturer (environment for the automated structurization of a lecture material), the virtual lecturer assistant (system for the automated dialogue with students), environments for preparation by students of reports, explanatory notes to course and degree works, the virtual adviser and knowledge tester for students testing during training, for other applications. Developed by authors "the matrix of elements of knowledge" - became acting system of the automated structurization of knowledge in training, it present interest for its use in other spheres.*

Key words: *knowledge; presentation; structure; element; matrix*

1. Problem status

The analysis of a problem status was already marked by us in [1][1]. There it was marked, that the human knowledge which has been accumulated up in many millenniums, are brought up to now on such physical carriers as the papyrus, paper and others. The most widespread form of representation of this knowledge is the text. On modern representations, the access to the necessary text, labour-consuming and rather long procedure. In the

computer century there is a necessity of the decision of knowledge formalization problem already saved up by mankind and, formalizations of again appearing knowledge, on the one hand, a kind convenient for their direct use and, on the other hand, in the form of electronic knowledge bases. This problem is evidently showed on the block diagram presented below (fig.1).

Importance of a problem of knowledge formalization and their representations in the form of base is conclusive. However complexity of adequate display of knowledge in the knowledge bases, expected cost and time expenses compel to search for a new ways of full or, at least, partial formalization.

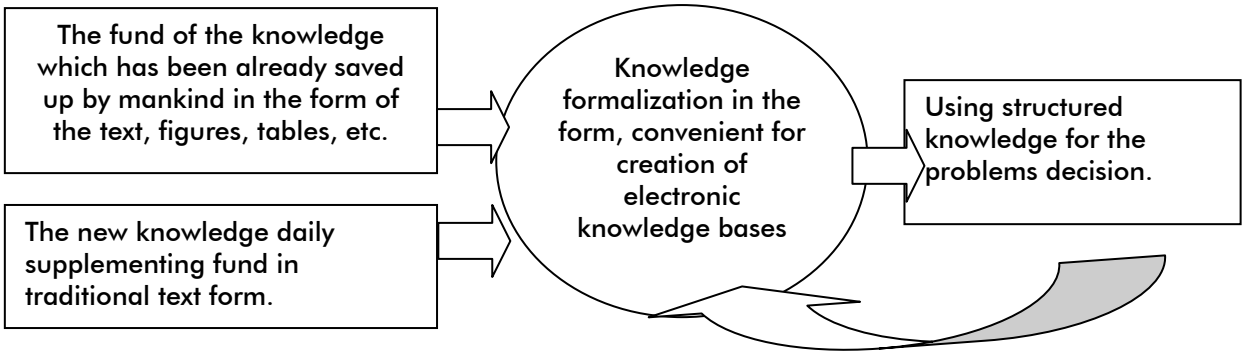

Figure1. Knowledge formalization and their using for problem solving

The following decision could be effective: if during human activity, at each compelled reference to world funds of knowledge, the mechanism of their transformation and in the form of electronic knowledge bases was simultaneously realized. The more often references to funds of human knowledge, lead to the more effectively process of transformation of knowledge in knowledge bases.

Spheres of human activity where there is the most frequent references of the person to knowledge it, first of all, manufacture, science, education. We [1,2,3,4,5] investigated the questions of knowledge structurization in some subject domains. In the present work we shall analyze within the limits of education, only training, as a process of transfer and studying of knowledge, skills, skills of activity, the basic means for preparation of the person for a life and work. While training there is the most intensive reference to the saved up and accumulated knowledge. The society purposefully invests in this process huge means, thus all the saved up human knowledge repeatedly, again and again are displayed and fixed in memory of millions people, closely and carefully structured and restructured by teachers of educational institutions for their more evident representation to the pupil. The cycle of repeated viewing and ordering of knowledge by the teacher of an educational institution seldom exceeds duration in one year.

Intuitively, educational process in which one of leading roles is played by the teacher could be one of a source of the structured knowledge which has been saved up and stored by mankind in a passive kind. We shall consider this process in more details.

Training - the bilateral process including activity of training (teacher) and trained (pupils). Training is characterized by interaction of the purposes and maintenances of training, teaching and the doctrine, i.e. activity of the pupil on mastering by knowledge. We

believe at formalization of knowledge during training the questions connected with formation of the purposes and maintenances of training will not undergo essential changes.

If it would be possible "to build in" a knowledge former (structurer) in a contour of process of knowledge transfer and familiarization for their subsequent representation and in the form of electronic knowledge bases, then the problem of structurization of the knowledge, main in the present work, could be solved. We shall consider possible models of systems which could be used for structurization of knowledge of the various nature.

2. Models of systems for knowledge structurization

In Fig. 2 we shell schematic present the process of knowledge retransformation from passive form in active [6], listing the main actions which will be necessary in executing the process of automated knowledge structure in knowledge bases for their using in contemporary education.

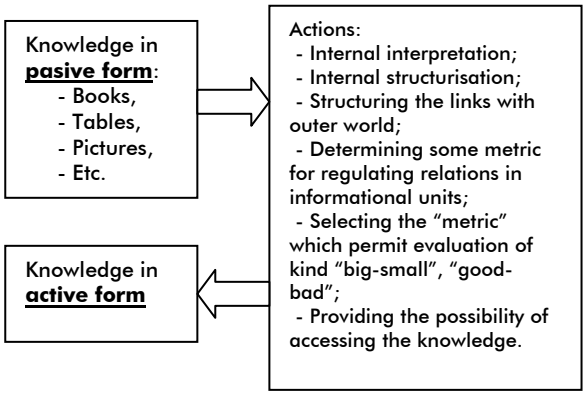

Figure 2. The process of knowledge transformation from passive to active

Active knowledge is that which we can memorize (for example, in computer) and will have access to "make" possible a conversation (for example, as it is made in "ELIZA").

A good part of actions provides from the problem of knowledge structurization. From existent methods of knowledge presentation (structurization), the most popular are logic based presentation, semantic networks and frames. For example, in logic presentation, as indivisible element for interpretation is the elementary clause. More complicated clause, such as phrases, texts are presented by using mote times inductive steps. Schematic this process is presented in Fig. 3.

Unconditionally, logic presentation permit adequate transfer of reality, but need more time and more expenses, high qualification of specialists and reliable methods of control of process of formalization. For resolving problems of mankind knowledge structurization using logic based presentation, we'll need ages, the facts which make us to search other solutions.

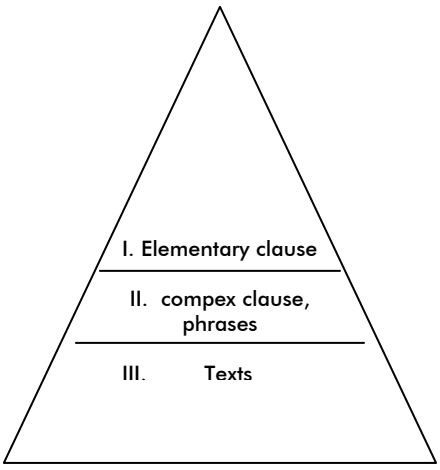

Figure 3. The process of knowledge structurization

Retransformation of existing knowledge and those which are newly created in structured knowledge, in our vision, can be realized through three separate models (Fig. 4 a,b,c).

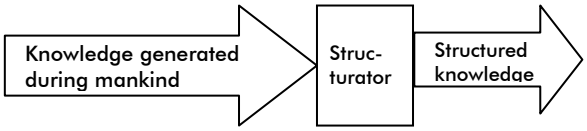

Figure 4a. Model for knowledge structurization generated actually

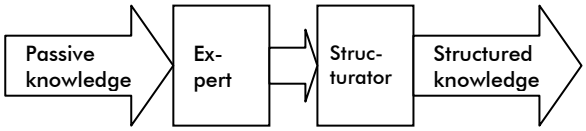

Figure 4b. Model I for knowledge structuration from books, tables, etc., accumulated in previous period

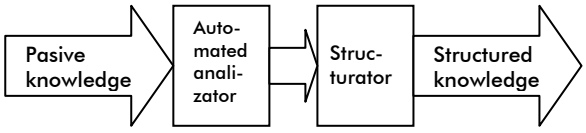

Figure 4c. Model II for knowledge structuration from books, tables, etc., accumulated in previous period

Knowledge structurization in the base of model presented on Pic.4. in the near future it is improbable. The ways of problem solution in the base of this model, are not discussed in this article.

The model presented on pic.4a represents the big interest because of its urgency. Annually the volume of the information accumulated by mankind practically is doubled. But also now, a significant part of the knowledge, again registered a symbolical kind, have no precise structure, that already by definition classify them as passive knowledge.

The model on Pic. 4b is interesting if to see the teacher and as the expert, i.e. the specialist which is independently capable to generate new knowledge and which represents in a traditional kind, i.e. in the form of scientific articles, books, etc.

3. Model of knowledge representation by the lecturer during preparation and the proper educational process

Let us consider in more detail concept "teaching". The basic functions of teaching - prompting to the doctrine, a statement of the maintenance of a studied material, the organization of activity of pupils, the control of knowledge and skills. Teaching has two important stages: a preparatory stage and a stage of realization.

The teacher, according to the professionalism and teaching art, structures the material which is a subject for studying. Formulates the next question, specifies if necessary its sense, borders of its distribution (applicability). Then forms the answer to this question so that it has been apprehended and comprehended by that group of pupils for which the material prepares for studying. The true answer to a question, as a rule, is compared to close concepts (answers), but the validity already being behind borders outlining a right answer on a question. The teacher cares of that the explanation of the formula of the answer to a question has been given, i.e. to explain, why such formula of the answer is true. Often during an explanation of a problem the teacher results definitions of those or other applied special terms, the comment in relation to the some definitions is sometimes done, at a sight of a modern science (or at a sight of the teacher), is not true in relation to a studied problem. The basic and additional references are resulted. Such approach corresponds to requirements on the organization and conducting employment in a higher educational institution.

However uniform, precise requirements to the text structurization of the lecture, preparing the teacher for a statement in an audience, as a rule, are not present. The teacher is free at own discretion, to establish sequence of steps on structurization of the text.

At the same time, if the uniform system of knowledge structurization would be established, then at presence of corresponding computer system (program) for registration of knowledge under this script, it would be a real variant (method) of the decision of a problem on knowledge formalization. Such way could accelerate considerably process of carry of knowledge, from traditional physical carriers (books, tables, etc.) on electronic carriers and simultaneously would allow to formalize knowledge in knowledge bases. These problems were repeatedly discussed by authors at various international and local conferences [1,2,3,5].

At distance education appear one of difficultly surmountable problems - difficulty of direct dialogue of the teacher and the pupil (time delays, throughput of the channel, etc.). It will not be possible obviously, completely to solve this problem. It is a payment for the received convenience: to have an opportunity of system training of the pupil, being on the certain distance from the educational center (university, college, lyceum, school, etc.) or the educational center in which the pupil (trainee) studies, from the teacher (training). It partial decision sees in development of training intellectual systems which will partially compensate absence of opportunities of natural dialogue of a trainee with the teacher, for example, during the moments of time delays of communication networks, cost and other restrictions. A part of the functions which are usually carried out by the teacher during conducting of

employment in an audience with pupils, at presence of such intellectual component, can automatically be carried out, the so-called virtual lecturer assistant, partially unloading during remote training the teacher and network channels, and other resources.

The system developed and described in [1,2,3], realizes a method of structurization of the lecture and practical material [5], preparing by the teacher before the audience, allowing simultaneously to represent this material in the form of the electronic knowledge base and to use it at remote training through the Internet.

The open access to any of parts of the knowledge base, at any moment allows the teacher to work, fill or supplement effectively with data any of cells of the knowledge base for which during the concrete moment of time there was suitable information. Whether results such method of representation of a lecture material in deterioration of preparation of lecture? Apparently from lead above the analysis the teacher approximately and should structure the text of lecture, anyway, such method can take place without drawing damage to quality of preparation.

The lecture and practical material is formed by the teacher in so-called to "the matrix of knowledge elements" [5], described in following section.

4. „The Matrix of knowledge elements"[2]

For describing some problem qualitative and full it is necessary to dispose of good training and capabilities of creation. But, having all mentioned capabilities, starting from conclusions made in psycho-pedagogical sciences, time constrains, creativity is rather limited if there is not made morphological analysis[7], for example, such as method of G.S. Alitsuler uses in invention, if it is not taken in consideration and not are used permanently another "knowledge about knowledge", methods of structurization and activations. Aristotelian categories [8] are another important instrument which contributes form knowledge structuration and activation.

Definition 1: "The matrix of knowledge elements" is some working environment for more complete description of some problem and raising of creativity, efficiency of work of expert, specialist, student, any separate man (next user) with the possibilities of consulting, interactively remembering, about multiply of possible questions which can be given and need answers.

Possibilities: "The matrix of knowledge elements" considerably reduces the risk of chaotic thinking of user, and thus contribute to increasing his creativity, systematizes process of work, structurize knowledge for a possibility of their activation and use by means of a computer in training systems. On every of given questions (given automatically) in the matrix environment is possible to registry in separate element, an answer with finite sense. The multitude of formulated by user answers is introduced separately in respective element of matrix, can be consulted separately by a command or assembled in a text, forming integral explanations of **some** content (such as problem, object, situation, etc.)

Definition 2: "The matrix of knowledge elements", is a module of some system for formation structure and registering knowledge about something in a base [5,10], which consist from some multitude of elements $\alpha_c(i,j)$ from A_c for launching description of knowledge elements $E_c(i,j)$ about this **something**. Every of elements $\alpha_c(i,j)$ is intended for description of knowledge elements $E_c(i,j)$, with finit sense, component part of whole C_p (those **something**), such as description of some problem, some object, situation, etc. Every

knowledge element $E_c(i,j)$ in matrix C_p is marked thought question $Q(i,j)$ which is forming from some word such as "**Describe**", to which the name of row i is added, and the name of a column j (or vice versa j,i - in accordance with logic of language, sense) and is added the name of a problem (object, situations) which can be described in an element $a_c(i,j)$.
Formal model of "the matrix of knowledge elements" can be presented as follows:

$$M = < A_c, C_p, R, s_0, d>,$$

where, A_c – finite multitude of states (A_c={ $a_c(i,j)$ }),
C_p – finite multitude of entry symbols, designate together that **something** (C_p={ $E_c(i,j)$}),
R - relation, between A_c X C_p and A_c
s_0 – initial state, element from multitude A_c,
d – finite state , element from multitude A_c.

Questions given in the environment of matrix, are formulated without being dependent from the domain area or concrete scientific problem. Matrix provide registering the user answer on the given in separate element $E_c(i,j)$ question, which in future can be accessed directly to edit it or use it for consultation and other goals. The matrix environment permit permanent visualization, of all questions $Q(i,j)$ and answers formulated in $E_c(i,j)$ (at least initial phrases, depending of monitor resolution and text volume introduces in respective cell). The capacity of the activated cell can be increased in 2 or 10 times [10].

5. Restrictions in functionality

Integrity of knowledge registered in the respected element, do not need demonstration, and it is considered true, next **T**, and an the element where knowledge are not registered, the element is empty, it is considered false, next **F**. The text thought which are stated the knowledge, in the element can not be divided in components and identified as [**T**, **F]** (the case when the a_{ij}, element is not the matrix row**)**. Questions given to the user in the matrix are considered **correct**. In order not to limit the creativity of matrix user, in the process of explanation of some problem, can be stipulated the fields and strings of matrix which are not noted, or with the access to modify and mark them, by the user [10].

6. System functioning

The "QUEST" system (where the matrix is the base module aimed for introducing knowledge in activated element and long storing them in this element, to be consulted by necessity) with all active functions, permit:

- to get direct access to the knowledge, previously registered in some element of matrix, considered (as it was mentioned above) – "correct knowledge" T (True);
- to combine two or more elements of matrix to receive more full knowledge about some aspects of **something**;
- to combine all elements of knowledge registered in the matrix and their identification corresponding to restrictions mentioned above, as T, to receive an answer considered in this system "full" and correct T, referring to that something;

It is considered that real fullness of knowledge a priori registered in matrix, and their quality depends of sense and content formulated and described by user – creator of knowledge base.

A variety of questions ***Q(i,j)*** given to the user - the knowledge base former , are in the dependence of value ***i, j***, remembering the fact that in existent version of matrix:

i – is the marker of each row in correspondence with Aristotelian categories [8] {"essence", "quantity", "quality", "in comparison with", "where", "when", "state", "possession", "action", "support"};

j – is the marker if each column in correspondence with psycho-pedagogical aspects, such as:

"abstract"- concretization of aspects which will be explained for category ***i*** regarding the essence of something;

"what is" – the definition, such as - what is essence, quality and quantity etc. of that something; *"why"* - demonstration of essence definition which is correct; "how, for whom" – examples(methods), how it is made, for whom, etc; *"opposite opinions"* - alternative opinions, about definition given in columns "what is", "why", "how"; *"substance"* – the materia which constitute described form in columns "what is", "why", "how", "opposite opinions"; *"new terms"* – glossary, the field which in future can serve as link between different matrixes, where the terms will be described fully, which definition is placed in this field; bibliography.

The system interface in the matrix environment, present a extended on screen area table[10], with the direct access for the user for every of the elements of the matrix, for example, in one mouse click. Rows **i** and columns **j** of the matrix are accordingly marked, being a good help for the user, the indicators of components from which virtually proceeds the question ***Q(i,j)*** and shows the address of the element where can be placed the knowledge element about that **something**.

7. Logic of "the matrix of knowledge elements"

Environment in which knowledge in "knowledge elements matrix" are structured, we can schematically represent using table below (Fig. 5)

Categories of Aristotle	Abstract (what about?)	Definition (what is?)	Demonstration (Why?)	Example (How ?)	Example (whom for?)	Associations (with what?)	Other opinions (refered to " what is?")	Material (what is made of? ?)	Glossary (external or internal elements?)	Bibliography (whom described?)
Sense	a_{00}	a_{01}	a_{02}	a_{03}	a_{04}	a_{05}	a_{06}	a_{07}	a_{08}	a_{09}
Quantity	a_{10}	a_{11}	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}	a_{17}	a_{18}	a_{19}
Quality	a_{20}	a_{21}	a_{22}	a_{23}	a_{24}	a_{25}	a_{26}	a_{27}	a_{28}	a_{29}
Relation	a_{30}	a_{31}	a_{32}	a_{33}	a_{34}	a_{35}	a_{36}	a_{37}	a_{38}	a_{39}
Where ?	a_{40}	a_{41}	a_{42}	a_{43}	a_{44}	a_{45}	a_{46}	a_{47}	a_{48}	a_{49}
When ?	a_{50}	a_{51}	a_{52}	a_{53}	a_{54}	a_{55}	a_{56}	a_{57}	a_{58}	a_{59}

State ?	a_{60}	a_{61}	a_{62}	a_{63}	a_{64}	a_{65}	a_{66}	a_{67}	a_{68}	a_{69}
Possession	a_{70}	a_{71}	a_{72}	a_{73}	a_{74}	a_{75}	a_{76}	a_{77}	a_{78}	a_{79}
Action	a_{80}	a_{81}	a_{82}	a_{83}	a_{84}	a_{85}	a_{86}	a_{87}	a_{88}	a_{89}
Support	a_{90}	a_{91}	a_{92}	a_{93}	a_{94}	a_{95}	a_{96}	a_{97}	a_{98}	a_{99}

Figure 5. Scheme of matrix interface, in the mode of structuring knowledge about ***something***

Every element of set a_{ij} are accessible for text introduction, which, as it is underline above, may be identified only as ***T***. In cases when element a_{ij} is a list, then all list elements are interpreted as ***T*** too. As text notion we understand the set of characters c_k, where $k=1,2,3,...$. Text of element a_{ij} can be modified, but element identifier will remain ***T***. Element a_{ij} in which wasn't introduced the text ($k=0$) will be automatically eliminated from the knowledge base and identified as ***F***. User (expert, specialist, lector i.e. creator of knowledge from respective domain) can manually identify as ***F*** an element or set of elements from a_{ij}, for cases when respective elements wasn't complete enough or wasn't verified, but matrix content (knowledge base with already recorded elements) need to be useful in the concrete system.

Knowledge base using starts after filtering and eliminating all elements interpreted as ***F***. Knowledge base in the form of matrix can be successfully used, for example, for organization of the dialogs "student - virtual lector assistant" in the process of the distance learning throw the Internet.

8. Dialogs

The "QUEST" system, including base matrix module, was developed using logic programming language Prolog. Dialogs structure determines work principles of respective "QUEST" system function. We'll use logic programming formalism approach to demonstrate models of a different dialogs. As it is well known [1,7] using Horn clauses in logic programs are presented:

- facts a_{ij}**:-.**
- rules a_{ij}**:-** $a_{lm,}$ **... .**Where, ***l*** şi $m=0,1,...,9$**.**
- questions **?:-** $a_{lm,}$ **... .**

Using a set of the facts and rules we can describe real world. Facts and rules are written in program text in form of declarations in the base. Using questions we can appeal to this base with help of:

- the respective search strategy (depth-first search, breadth-first search etc),
- resolution an unification principles,
- notion of empty clause for resolving program stopping and output result problem

According to this take place calculation process of translation in the logic program and its interpretation by the Prolog interpreter.

Facts are always true by the definition and can be identify only by ***T***. The fact (or set of the facts same by the category and aspect form a list) may be conform only to the respective matrix element.

Quantity of the matrix elements in version described in this article can not be exceeded 100 elements (from a_{00} to a_{99}). Every single fact can be consider as the "virtual lector assistant" answer ("QUEST"-system answer) to the simple question from the set ***Q(i,j)***,

for example by a student using the system in mode of consultation. As one correct and complete "QUEST"-system answer we can consider such answer, which represent to the user all facts in one string (continuous text) in the case when a_{ij} element contains list of facts.

Every answer, for example given by the student in the closed form for the "virtual lector assistant", in the mode of examination can initiate student answer in the form [yes, no].

It is possible, as mentioned above, to address complex questions to the "QUEST"-system using the same facts with the help of propositional logical connectives. For example, the question "Please give me definition and the sense of the ***something***" has an formal representation in system:

$$?:- a_{01}, a_{02}.$$

System answer will combine content of matrix elements a_{01} şi a_{02}.

It is possible to generate new knowledge's from the set of elements a_{ij} using other type of Horn-clauses - definite clauses (rules). For example on the question "Please give me full description of the something's state", formally

$$?:- state.$$

answer will be generated with appellation to the rules

$$state :- a_{60}, a_{61}, a_{62}, ..., a_{69}.$$

With this method can be generated some other new knowledge from the set of knowledge elements organized in matrix. A dialog "student - virtual lector assistant" on the concrete problem, which represented in the form of matrix, can last a long time, but such dialog has a little difference from the traditional dialog "student - lector". If we'll use Turing artificial intelligence test, proceeding from mentioned above, we'll consider that "QUEST"-system is an system with intelligent behavior.

9. Practical results

Introduction of the first version of system "QUEST ", allowed the authors to solve in current 1997-2003 at the University of Applied Sciences of Moldova the following problems:

1. to pass to the written knowledge control of all students of university over system " QUEST " with an opportunity of remote control by teachers, the texts of examination answers of students.
2. to prepare for subject matters for the organization of self-training and training through the Internet of persons distanced from university.
3. for students to develop in "QUEST environment course works and, at the same time, to study to structure knowledge, developing thus the logic of thinking to store them, providing effective access to them, including for the remote control and an assessment of works.
4. to control the knowledge of students over a mode "testing" of system "QUEST ", allowing to realize iterative dialogue "computer-student" (up to 4-5 mutual references).

5. Administrations of university to develop criterion of an estimation of quality degree of teachers preparation to the lecture, prepared in the environment of system "QUEST". The offered technology of preparation for lecture by means of the described system enables all collective of teachers of an educational institution better to be prepared for employment, to use at certifications and the examinations, alternative forms of the knowledge control, is direct on employment to use a computer and multimedia means for displaying already worked material to the screen and carrying out of necessary explanations.

10. About the prospects of knowledge structurization by means of "the matrix of knowledge elements"

During the next periods (beginning approximately with 2002-2003) and down to present time we carry out researches connected with knowledge structurization in bases, using on the one hand the psycho-pedagogical aspects, partially described in higher sections of present clause, on the other hand, categorical representation about objects, events and the phenomena in sense of Aristotelian, Kant, Hegel and others, and also our contemporaries living during an era of information of a society [5].

For practical realization of "the matrix of knowledge elements" the choice has fallen on Aristotelian categories, as a most convenient for knowledge structurization of different subject domains. As is known, their ten: essence, quantity, quality, the attitude, where, when, a condition, possession, action and suffer. These categories are the name of matrix rows. Columns of a matrix are named accordingly: concretization (it is short about what is in a category i?), definition (that?), the proof (why?), examples (as?, to whom?), alternatives (other opinions), a matter (from what?), a glossary and the literature (whence?).

In one matrix it is possible to describe one concrete problem, event, object, etc. Each crossing of columns and rows in a matrix "generates" the question on which there can be an answer. For example, the column "definition" and a line "essence" "generate" a question of type: "That is …?".

"The matrix of knowledge elements" has been used by students of some HIGH SCHOOLS of Republic Moldova and from abroad at a writing of reports, course and degree works. Results are unequivocally positive. Students penetrate into essence of the phenomena more deeply. Practically completely it is possible to exclude "blind" copying of a material from the Internet. It is easier for the teacher to estimate works of students objectively.

11. Summary

Carried out researches and the received practical results give the basis to speak about the real contribution to the problem decision of a stage-by-stage knowledge structurization in knowledge bases and their uses in systems of artificial intellect of the future. Knowledge structurization in "the matrix of knowledge elements" and systems "QUEST" as a whole enable the following:

- for the expert (trained) "to preserve" the (received) knowledge of concrete essence in the structured mode, quickly to activate this knowledge in case of need in the future;

- for the teacher of an educational institution to form electronic lecture by its preparation for employment and simultaneously to structure knowledge in base;
- for the student to carry out researches of internal structure of knowledge at course and degree working, at writing of dissertational work by PhD candidate;
- at presence of the filled knowledge base on a concrete subject domain to realize information system for consultation of interested students, teachers, etc.;
- to realize the process of training, self-training and the knowledge control, resulting the results of a knowledge estimation of one or on group of trainees;
- using the knowledge base for other purposes in systems of an artificial intellect;
- carrying out a comparative estimation of activity of the faculty during the activity on a number of criteria.

References

1. Alitsuler, G. **Algoritm izobretenia,** Moscow, Mosc. rabocii, 1973, p. 296
2. Aristotle, **Categorii, vol. 2,** Moscow, Misli, pp. 51-90
3. Cadrasina, E., Litvinteva, L., and Pospelov, D. **Predstavlenie znanii o vremeni i prostranstve v intelectualinih sistemah,** Moscow, Ed. fizica si matematica, 1989, p. 328
4. Pelin, A. **Nota explicativa la proiectul Matrix. P.II.,** Kishinev, USAM, 2006, p. 43
5. Pelin, N **Elementi loghicescogo programirovania,** Ed. Nestor, Kishinev, 2000, p. 171
6. Pelin, N., and Pelin, S. **Pattern of Modern Expert and Outlooks of Using Prolog, the Language of Logic Programming,** Informatin Tehnology: "The Proceedings of the Fourth International Symposium on Economic Informatics", Bucharest, Romania, May 1999, pp. 777-784
7. Pelin, N., and Pelin, S. **Method of automated structuration of theoretical and practical material, prepared by teachers before it's presented to the auditorium and using it in distance education,** Information Society: "The Proceedings of the Fifth International Symposium on Economic Informatics", Bucharest, Romania, May 2001, pp. 74-80
8. Pelin, N., and Pelin, S. **Referitor la formarea mediului –sistem expert in invatamint,** Tez. Ref. A IV-a conf. Stiin-metodica si Practica a prof. Si stud., 19-20 mai 1998, "Stiinte Aplicative in Perioada de Tranzitie", Kishinev, USAM, 1998
9. Pelin, N., Pelin, S., and Pelin, A. **The matrix of knowledge elements" effective tehnology for knowledge management,** in the "Procedings of the International Conference Knowledge management: Projects, Systems and Tehnologies", Volume I, Nofember 9-10, 2006, Bucharest, the 2nd special issue of the review Informatica Economica, Vol. X, pp. 63-71
10. Thayse, A., Gribomont, P., *and others*. **Approche Logique de L'Intelligence Artificielle: De la Logique Classique a la Programmation Logique,** Bordas, Paris, 1988, p. 432

[1] Codification of references:

[1]	Pelin, N., and Pelin, S. **Method of automated structuration of theoretical and practical material, prepared by teachers before it's presented to the auditorium and using it in distance education,** Information Society: "The Proceedings of the Fifth International Symposium on Economic Informatics", Bucharest, Romania, May 2001, pp. 74-80
[2]	Pelin, N., and Pelin, S. **Pattern of Modern Expert and Outlooks of Using Prolog, the Language of Logic Programming,** Informatin Tehnology: "The Proceedings of the Fourth International Symposium on Economic Informatics", Bucharest, Romania, May 1999, pp. 777-784
[3]	Pelin, N., and Pelin, S. **Referitor la formarea mediului –sistem expert in invatamint,** Tez. Ref. A IV-a conf. Stiin-metodica si Practica a prof. Si stud., 19-20 mai 1998, "Stiinte Aplicative in Perioada de Tranzitie", Kishinev, USAM, 1998

[4]	Pelin, N **Elementi loghicescogo programirovania,** Ed. Nestor, Kishinev, 2000, p. 171
[5]	Pelin, N., Pelin, S., and Pelin, A. **The matrix of knowledge elements" effective tehnology for knowledge management,** in the "Procedings of the International Conference Knowledge management: Projects, Systems and Tehnologies", Volume I, Nofember 9-10, 2006, Bucharest, the 2nd special issue of the review Informatica Economica, Vol. X, pp. 63-71
[6]	Cadrasina, E., Litvinteva, L., and Pospelov, D. **Predstavlenie znanii o vremeni i prostranstve v intelectualinih sistemah,** Moscow, Ed. fizica si matematica, 1989, p. 328
[7]	Alitsuler, G. **Algoritm izobretenia,** Moscow, Mosc. rabocii, 1973, p. 296
[8]	Aristotle, **Categorii, vol. 2,** Moscow, Misli, pp. 51-90
[9]	Thayse, A., Gribomont, P., *and others*. **Approche Logique de L'Intelligence Artificielle: De la Logique Classique a la Programmation Logique,** Bordas, Paris, 1988, p. 432
[10]	Pelin, A. **Nota explicativa la proiectul Matrix. P.II.,** Kishinev, USAM, 2006, p. 43

[2] sections 4,5,6,7,8 and 11 was written with support from Alexandru Pelin, 4th year student, Faculty of Computer Science, Unviversity A.I. Cuza, e-mail: apelin@infoiasi.ro