Architecture and Functioning Principles of Diagnostic Test-Block of Expert Tutoring System

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Abstract— The results of the development of diagnostic test-block in the expert tutoring system are reflected in the given paper. The architecture of intellectual tutoring systems, worked out principles of diagnostic test block construction in the realized expert tutoring system have been suggested.

Keywords— intelligent system; expert tutoring system; diagnostic test block

I. INTRODUCTION

From the end of last century program technologies have actively started to take root into the training process for transferring of educational material to the pupils and implementing control on its mastering. In the market of software products for last decade there was a considerable quantity of the computer tutoring systems focused on various subject domains and levels of training, beginning from initial level and above by educational vertical.

Now the great interest is represented to the tutoring systems which are based on artificial intelligence technology, allowing to model mechanisms of human thinking with reference to the decision of problems in some problem area. As a rule, the intellectual tutoring system represents a complex of organizational-methodical, didactic, information, mathematical and program software with obligatory inclusion of the human factor - the pupil and the teacher. Thereupon the intellectual tutoring system can be considered as the difficult human-machine system working in a mode of interactive interoperation in the scheme *the pupil — system — the teacher.*

It is necessary to notice that the existing prototypes of intellectual tutoring systems developed by research collectives in the different countries as the author of the products note [3] are still far from the perfection as regarding to their methodical maintenance as in the area of modern tool technologies introduction. Therefore search of approximation ways of computer tutoring process to the real process of training demands the further perfection of methodology of intellectual tutoring systems development. It means that within the limits of intellectual tutoring system it is necessary to organize educational process so that there is a possibility to realize various scenarios of the organization of the latter, i.e. by modeling of separate aspects and fragments of each subject of educational process to organize effective interaction of the teacher, the pupil and training material.

One their most widespread kinds of intellectual automatic tutoring systems is expert tutoring system (ETS) which is capable to simulate work of person-expert in a concrete subject domain. In the present work the architecture of expert tutoring system in the field of foreign languages learning (in this case the target language is English) is offered.

II. ARCHITECTURE OF INTELLECTUAL TUTORING SYSTEMS

Expert tutoring systems can be used as means of knowledge representation, organization of the dialogue between the user and the system capable to present a chain of reasoning on the user's request at the decision of any educational problem as it is acceptable to the trained user. On the first steps of our research general view of ETS based on supra theoretical knowledge [1,2,3] seemed to be formed of the following functional blocks as it is shown in " Fig.1":

• *Knowledge base* - a functional block which contains the formal description of knowledge of the experts, presented in the form of a set of the facts and rules. These rules cover methods and procedures on education process management, diagnostic and control of learning efficiency estimation presented in the form of tests or a different control ways of material mastering gathered in the database. In other words, knowledge base in this case is the block representing the program realizing direct or return chain of reasoning as the general strategy of decision-making. Knowledge base making a basis, define ways of a manipulation the facts characteristic for the given subject domain, i.e. represent a set of solving rules.

• *The database block* - realizes means of information storage on the target subject domain and its training process. As the problem area is described in the form of the facts and rules, these facts forming the maintenance of a database, training expert system, define objects, their characteristics and value. In this case the database contains an educational, information, directory material, the list of trainees, progress etc. Database block contains per level units content based on the vocabulary, drills, grammatical information, various types of exercises and tests.

• *Interface block* is a block which realizes means of audio-visual interaction with the user. By means of the intellectual interface the expert system asks questions to the user and displays the drawn conclusions, representing them usually in a symbolical kind.

In the course of expert tutoring systems development it is considered not only preparation level (low, average, high), but also mastering levels (a cognizance, algorithmic, heuristic, creative), and in certain cases — psychological features, personal preferences of the trainee (for example, a choice of a

mode and rate of work, design of the screen, variants of interactive interaction).

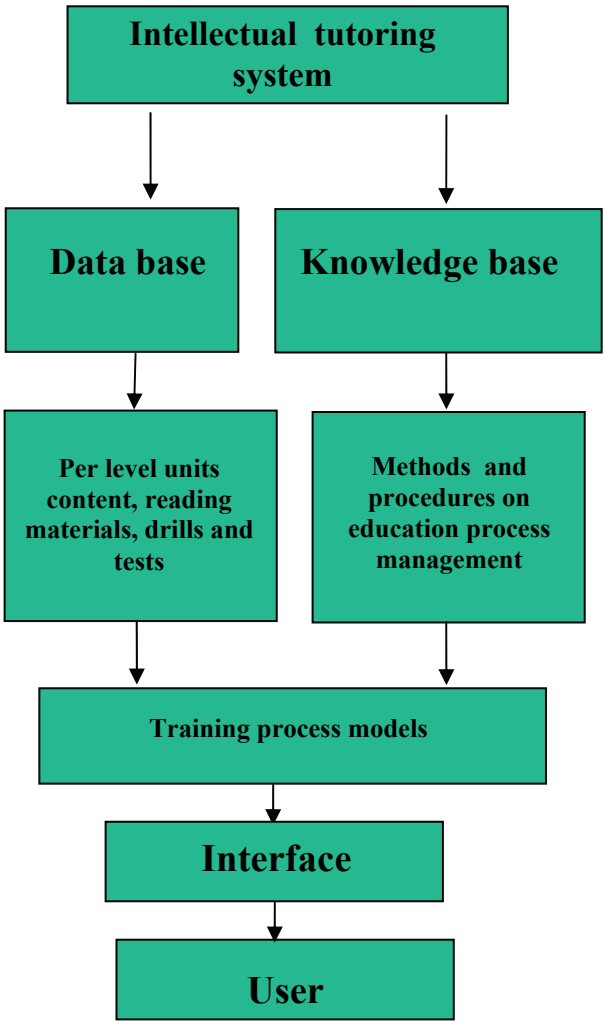

Figure 1. Structure of intellectual tutoring system

Constituents of both bases form certain models of the training process: models of the "Learner" and the "Teacher" (training expert). They concern to the category of the basic components, cooperating among themselves through the formalized space of teaching materials, methods and procedures of education through the "Teacher" model and adequate responses on the accepted information through the "Learner".

Nowadays intellectual systems give opportunity to the expert to make necessary changes and additions to blocks, to bring new educational information, to insert animation, drawings, to change the text of questions and tasks. All blocks are interdependent and independent simultaneously therefore at modification in one of the block the maintenance of the basic parts of others doesn't change.

In the result of analysis of all existing tutoring systems we came to the conclusion that one of the points to be added into the expert tutoring system is diagnostic test-block which full-fill the task of a teacher determining learner's level.

III. THE DIAGNOSTIC BLOCK OF TESTING

In "Fig.2" structure of the offered expert system for English language training is resulted. During the development of ETS we were aimed to grant user with opportunity for English language learning independently, in other words to study foreign language with assistance of "the computer teacher". Differently, first of all, it was necessary to transform computer into "the teacher" capable to explain the given material and to make an objective estimation of the received knowledge, and further according to the results to be able to direct the trainee in the necessary mode for strengthening the gaps, digestion and consolidation of the revised material.

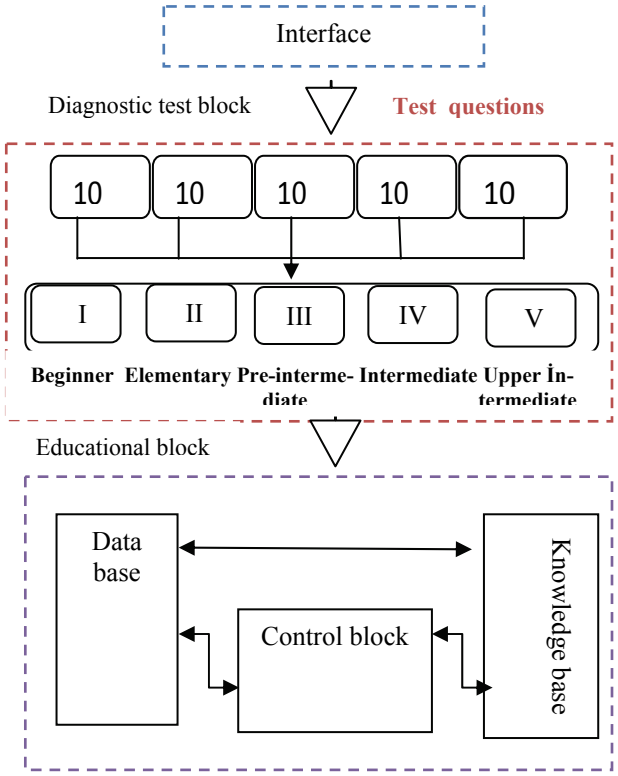

Figure 1. Functioning of ETS system blocks

As it is known, before starting to learn a foreign language the teacher first of all defines knowledge level of the learner which predetermines further choice of a corresponding technique of teaching and the applied teaching materials. On this basis the block of diagnostic testing has been developed for identification of knowledge level of the users applied to the process of training.

The diagnostic block is determined for the evaluation of English grammar knowledge within the limits of 5 levels (Beginner, Elementary, Pre-Intermediate, Intermediate, Upper-Intermediate). For creating Diagnostic test which database consists of 50 questions we were guided by following principles:

1. Classification and selection of grammatical categories of English language by levels.

2. Drawing up of questions taking into account all categories corresponding to the given level. Differently within the limits of ten questions the expert should compile such questions that include several grammatical categories. (for instance, level Beginner covers 18 grammatical categories, so there can be applied from 1 to 3 grammatical categories per question).

3. Expert evaluation of questions by following criteria:

- question complexity factor

- quantity of grammatical categories in a question

- degree of complexity of a question

4. Creation of the knowledge base - subbases for each level.

In "Fig.2" the functional structure of the diagnostic test block is schematically shown. It can be observed that test tasks (test questions) are divided into the consecutive subbases consisting of 10 test questions each. These subbases include certain quantity of rules per each level. In case if the conditions of the previous subbase rules are satisfied the performance of the subsequent subbase tests is authorized. After identifying the knowledge level of the user on the English grammar the user passes into the tutorial block where EST will independently define the training program by the results of knowledge evaluation.

Database, knowledge base and control block within the tutorial block, being in constant interaction, function autonomously from subbases of the diagnostic test block, i.e. diagnostic test block is partially independent working part of the presented expert system. The control block shown in the picture contains questions, tasks, the exercises intended for control of knowledge of the learners. It is necessary to notice that training process at any level will be divided into 2 stages by 10 units each, and we can easily state that such division of the levels enables ETS to implement more precise knowledge evaluation. It is supported by the point that gradation scale is expanding from 5 levels to 9, and some examples given below will clarify the way of functioning of the rules in the subbases.

Rule 1. ***IF*** x_{11} *(user has answered not less than 5 questions of level Beginner)*
OR x_{12} *(user has answered 7 simple /medium questions of level Beginner)*
OR x_{13} *(user has answered 4 simple /medium and 2 complex questions of level Beginner)*
OR *(user has answered 5 simple /medium and 1 complex question of level Beginner)*
THEN y_1 *(user must start training from the first part of level Beginner)*
Rule 2. ***IF*** x_{21} *(user has answered 6 simple /medium and 1 complex questions of level Beginner)*
OR x_{22} *(user has answered 3 simple /medium and 3 complex questions of level Beginner)*
OR x_{23} *(user has answered 5 and 2 complex questions of level Beginner)*
THEN y_2 *(user must start training from the second part of level Beginner)*
Rule 3. *IF* x_{31} *(user has answered not less on 8 questions of level Beginner)*
OR x_{32} *(user has answered 4 simple /medium and 3 complex questions of level Beginner)*
OR x_{33} *(user has answered 3 simple /medium and 3 complex questions of level Beginner)*
THEN y_3 *(user's passed level Beginner and is permitted to perform tests at level Elementary).*

The formalized expert knowledge on English grammar level evaluation within the diagnostic test-block of ETS was realized in Delphi 2009 programming system and the above-stated rules are in the following form view:

1.Pr1: ='if ((k1 <=5) or ((m1+m2 <=7) and (m3=0)) or ((m1+m2=4) and (m3=2)) or ((m1+m2=5) and (m3=1))) then (' training from level Beginner I ')

2.Pr2: ='if (((m1+m2=3) and (m3=3)) or ((m1+m2=5) and (m3=2)) or ((m1+m2=6) and (m3=1))) then (' training from level Beginner II ') ';

3.Pr3: ='if ((k1> =8) or ((m1+m2=4) and (m3=3))) then (' examination at level Elementary ') ' where:

k_1 - quantity of questions which the user has answered;
m1, m2, m3 – appropriate quantity of simple, medium and complex questions of the level answered by the user.
After the answering to all questions of level Beginner on the basis of the factual data and the above-stated rules level of user's knowledge is defined and one of two actions given below is accepted:
1. If the factual data corresponds to rule Pr1 or Pr2 the program performance is stopped and message appropriate to a rule is rolled out;
2. If the factual data corresponds to rule Pr3, program performance is proceeding and user is afforded an opportunity to perform tests of level Elementary.

IV. CONCLUSION

Overall performance and efficiency of intellectual tutoring systems depends on the observance of the following conditions:
• facility of accumulation and application of knowledge results of each learner's training course for individual training influence selection and training process management in order to form of complex knowledge and abilities;
• a validity of criteria knowledge, abilities and skills level evaluation; preparation level (low, average, high) or level of mastering of a material (a cognizance, algorithmic, heuristic, creative);
• possibilities of system adaptation to the condition change of the trainee (the trainee is concerned to be the medium level, but at the given lesson(tutoring course) his knowledge approximates to high or, on the contrary, to low level).

Advantage of diagnostic test block development is the ability of diagnostics of foreign language knowledge level as integral part of expert tutoring system as a separate diagnostic system for level defining. The principles of presented diagnostic test construction can be used in the compiling of similar blocks for various subject domains.

Introduction of intellectual tutoring systems into expert and pedagogical researches, its application into educational process will allow to strengthen emotional perception of the educational information; to raise motivation of training at the expense of self-checking and the individual, differentiated approach to each trainee; to develop processes of informative activity; to search and analyze of the various information; to create conditions for formation of abilities of independent knowledge acquisition.

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