# ITS Design Technology for the Broad Class of Domains

Ildar Kn. Galeev, Sergey A. Sosnovsky, Vadim I. Chepegin
*Kazan State Technological University*
*monap@kstu.ru, chepegin@bancorp.ru*

## Abstract

*The elements of Intelligent Tutoring Systems (ITS) design technology for a broad class of domains are described. Characteristic features of proposed technology are considered. Restrictions on the area of its application are posed. Describing technology has been realized in the authoring tools for ITS design, which are the part of program complex MONAP-II. For a number of domains MONAP-II provides full automation of ITS design.*

## 1. Introduction

Development of authoring tools for ITS design and creation on its basis useful systems, which realize didactically-valid algorithms of education and control the leaning process adequately, is traditionally in the center of attention for many researchers of computer-based learning (see, for example, [1,2]). However, at present these researches have experimental nature. To move ITS from the level of laboratory study to the level of commercial product researchers have to decide a number of serious problems. On of them is high labor-intensity of ITS creation. Unfortunately, we cannot say that authoring tools of ITS design meant for deciding of this problem are completely satisfy these requirements. The most often authoring tools help to create ITS relatively easy in very close domain. The main reason of this is the fact, that to obtain the maximal didactic effect in chosen domain developers of authoring tools frequently create systems possessing subject-dependent architecture and based on the subject-dependent algorithms and models.

Authoring tools, which are the part of program complex MONAP-II, provide the automation of ITS design, realizing the algorithms of adaptive management of the learning process in the chosen domain. Algorithms of educational problem solving are developed on the basis of domain analysis by a teacher and described by means of an aggregate of rules (operations) of type: IF (condition), THEN (action). Authoring tools of ITS design of MONAP series have gone through the several stages of program implementation: MONAP-MICRO, MONAP-PLUS, MONAP'99 (see, for example, [3]). At present time this tools are the main component of program complex MONAP-II. These authoring tools are far less exacting to the nature of domain. However, some set of restrictions on the area of application is imposed.

## 2. Restrictions on the area of application

The problem of learning personalization in *MONAP-II* involves in the assessment of student's knowledge on the each step of learning process taking into account the history of learning process and providing student with problem of optimal difficulty. The difficulty rate of the task $T(k)$ is an average portion of errors anticipated in the task of accomplishing it. This parameter of MONAP model is described in detail in [4] with all computations and bonds with another parameters. The optimal difficulty value is determined by the teacher during the tuning of ITS.

Note that stabilization of difficulty value is possible only in the case when the domain characterized by following features.

A set of vectors $\{L_{rq}\}$ describes the properties of tasks, which can be present for student:

$$L_{rq} = [L_1, L_2, ...L_j, ...L_J], \quad (1)$$

where $r$ – identifies the class of learning task $(r = 1,2,...R)$;

$q$ – identifies the subset of synonymous tasks inside the $r$ class $(q = 1,2,...Q_r)$;

$L_j$ – is the number of operations of $j$ type necessary to be used when solving a task with the identifier $rq$.

Learning tasks are isomorphic regarding the complication rate if their associated vectors $L_{rq_1}$ and $L_{rq_2}$ are interconnected by the following relationship which is true for each $j$:

$$\frac{L_j(rq_1)}{L_j(rq_2)} = 1(q_1/q_2) = \text{const}, \quad (2)$$

where $L_j(rq_1)$ – is the $j$ component of the vector $L_{rq_1}$;

$L_j(rq_2)$ – is the $j$ component of the vector $L_{rq_2}$;

$l(q_1/q_2)$ – a coefficient characterizing the complexity of the vector $L_{rq_1}$ relative to the vector $L_{rq_2}$ complexity.

Thus, if condition (2) is met, learning task, their properties being described by the corresponding vectors $L_{rq}$, will possess the same complication rate for each particular learner at the $k$ step of learning. It is intuitively clear, as they will have one and the same ratio of "badly" and "well" mastered operations.

Consequently, the adaptation to the student as far as the complication is concerned is fundamentally impossible. That is, the less tasks of the learning domain are connected by relationship (2), the higher is the potential possibility to find a learning task (among the available ones) with the complication optimum for the student.

## 3. Automation of ITS design

Generally accepted method of ITS design inevitably conducts us to the inflexible dependence on domain. That is ITS being developed for example, for learning correct writing of German adjective endings, can not be used for learning correct writing of Russian adjective endings (though in this case the grammar rules are similar). The same is true for a more strategic change of domain, for instance, from one natural language grammar component to another. This is stipulated by the need of developing subject-dependent subsystems of ITS, executing the educational problem formation, its solving and diagnostics of student's answers.

In MONAP-II we propose another approach, which is based on the rejection of designing of the subject-dependent components of ITS, such as the generator. MONAP-II uses the base of educational problems (PROBLEMS base) with tools of its creation and maintenance as a subsystem of educational problem formation. Teacher forming the PROBLEMS base has to indicate for each educational problem not only correct using of all operations but also identifiers of every operation. In this case, if the student makes an error, the diagnostics subsystem will be able not only to fix its presence, but also to determine the place where wrong operation has been applied.

Thus, authoring tools MONAP give the teacher possibility of rapid designing all ITS subsystems. The main advantage of such ITS designing process organization is the possibility for the teacher, who is not a specialist in programming, to create automatically an ITS from the beginning to the end without any help for a number of domain. The proposed approach does not negate an alternative method of ITS design with using the educational problem generator, the educational problem solver and the subject-dependent components, containing information about domain. MONAP technology allows to develop automatically an ITS learning control subsystem, and to develop other ITS components independently or to use an existing developments, as it was made, for instance, in [4]. In this case a calling sequence has to be applied for compatibility of all subsystem interfaces.

## 4. Conclusion

Thus, the elements of ITS design technology for a broad class of domains were considered in this paper. Restrictions on the area of application and some characteristic features of proposed technology are posed. Described technology is implemented in the program complex MONAP-II. Authoring tools of ITS design, which are part of MONAP-II provide full automation of ITS creation for a number of domains. At present intelligent CALL-systems for German and Russian languages in the part of adjectives declensions were developed by the means of these tools. In the future we are going to approve the proposed technology in another domains. Besides, the work on transferring of elements of described technology of ITS design to Internet is conducted.

## 5. References


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