

Learning Management in Integrated Learning Environments

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

Abstract

This paper discusses problems of Integrated Learning Environments (ILE) creation. Architecture for ILE is suggested. An approach to learning management organization in such environments is described. The paper considers in details the situations, when the student does not achieve enough success in educational problem solving. In these cases the system sends him/her back to a hypertext textbook to learn theoretical material. Suggested approach is invariant for the broad class of domains. Instrumental tools MONAP-II support this approach.

1. Introduction

Learning management in ILE is a complex multidimensional challenge, which is in the center of attention for many researchers [1, 2]. It is necessary to note, that at present there is no common point of view on ILE architecture. What components have to be included in these environments and how do they have to be integrated [1]. For example, the paper [2] suggests integrating of the hypertext and the expert systems. Thus, first of all to form ILE architecture we have to formulate the purpose of its creation and define requirements, which this environment has to conform to. The purpose of the project, considered in this paper, is development and implementation of instrumental tools MONAP-II, which provide automation of ILE design for maximally broad class of domains. The requirements of maximal invariance for domain impose restrictions on the structure of ILE components. It is suggested that the structure of environment includes hypertext textbook, objective test and ITS as a kernel. Consequently, instrumental tools MONAP-II have to contain corresponding authoring tools for each of components, mentioned above.

2. Learning management

The instrumental tools MONAP-II are the development and extension of more early versions of the instrumental tools for ITS design of MONAP series: MONAP-MICRO, MONAP-PLUS and MONAP'99. Developed mathematical models, algorithms, architecture, software and practical experience of using the instrumental tools of MONAP series are described in details in a number of works of authors of this paper (for example, in [3,4]). Earlier versions of the instrumental tools of MONAP series provided automation of ITS design process and did not contain authoring tools for hypertext textbook and objective test creation. MONAP-II includes such authoring tools. As the base learning trajectory, supported by the instrumental tools MONAP-II, we suggest the following sequence of learning process stages.

Stage 1. Student learns theoretical material in the specific domain with the help of hypertext textbook. Learning control is determined by the structure of hypertext textbook developed by the teacher. Student himself/herself chooses the specific way for theoretical material learning. In this case ILE does not provide adaptation. This imperfection can be partly compensated by suggesting of several hypertext textbooks for different categories of students.

Stage 2. During this stage the system controls student's conceptual knowledge concerning learned theoretical material. Knowledge is controlled by the tests, developed by the teacher. Learning management is defined completely by the test structure. ILE itself does not provide the student with any adaptation. Similar to first stage this imperfection can be partly compensated by suggesting of several objective tests with different levels of difficulty for different categories of students.

Stage 3. This is the main stage of proposed learning trajectory, which is supported by the MONAP-II tools. On this stage student under the control of ITS solves the practical educational problems – acquires the practical skills.

On the each step of this stage ITS identifies the student's knowledge according to his results of problem solving and presents to the student the new educational problem with optimal difficulty value for the next educational step [4]. Thus, on this stage the ITS realizes

an adaptive management of learning process. The didactic basis of this stage is the algorithmic approach to the learning management. The idea of algorithmization of learning process consists in solving of following basic problems:

- development of algorithms of specific educational problems solving and training the students to apply this algorithms;
- development of algorithms of learning process itself, i.e. the algorithms, used by the teacher (human teacher or computer-based tutoring system) during the learning process.

In general case development of algorithmic instruction is feebly-formalized multi-objective problem, solved by the teacher. Variety of the types of operations, which are used by the student solving the problems in specific domain and correspond the algorithmic instruction, is symbolized by

$$Y=[y_1, y_2, \dots, y_j, \dots, y_J].$$

As the main component of student model the following vector is used:

$$P(k) = [P_1(k), P_2(k), \dots, P_j(k), \dots, P_J(k)]$$

where $P_j(k)$ is the probability of correct using the operation y_j at the k -th educational step.

For determination of $P_j(k)$ the system uses the Bayesian approach described in details in the paper [4]. At the each educational step, beginning from the $(k+\Delta k)$ -th one, the system makes checking for abnormal termination. As the abnormal termination we mean sending the student from the third stage (educational problem solving) back to the first stage (learning the theoretical material with the help of hypertext textbook). The abnormal termination is realized if only one operation satisfies the system of inequalities:

$$\begin{cases} |P_j(k+\Delta k) - P_j(k)| \leq \Delta P_1; \\ |P_j(k_1+1) - P_j(k_1)| \leq \Delta P_2, \end{cases} \quad (*)$$

where Δk is the pre-abnormal (critical) number of educational steps, which are accompanied by the situation, when the student's knowledge can be not-increasing;

ΔP_1 determines the first interval of the vector $P(k)$ elements values variation;

k_1 varies from k to $(k+\Delta k-1)$;

ΔP_2 determines the second interval of the vector $P(k)$ elements values variation;

Abnormal termination can be conditioned either by the weak student's knowledge or by the ineffective learning actions (comments on errors) or by both of them. Violating of second inequality in the system (*) prevents abnormal termination in the case, when student's level of knowledge was increasing but an unexpected breakdown took place. The value of this breakdown should be more then ΔP_2 ("threshold of stress") and the first inequality from the system (*), which is the necessary condition for abnormal termination, should be realized. Determining values of considered parameters the teacher expresses his/her own idea concerning the way of learning process realization. ITS will assume various personal characteristics (from "patient" and "tolerant" to "severe" and "strict") depending on parameter values, set by the teacher.

3. Conclusion

Suggested architecture of ILE is characterized by the balanced trade-off between the requirements of adaptation of the system to the specific student and the requirements of "openness" of the system. Realized in ILE learning management is characterized by the different levels of adaptation (to the specific student) depending on the learning stage. Maximal level of adaptation is provided on the stage of educational problem solving. On the each step of this stage ITS provides the student with educational problem, characterized by the optimal difficulty level. If there is no sufficient success in the problem solving, the system will send the student back to learn the theoretical material with the help of hypertext textbook. Considered approach to ILE design has been implemented at the designing of ILEs for Russian and German languages grammar.

4. References

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