THE AUTOMATION OF ADAPTIVE PROCESSES IN THE SYSTEM OF DISTANCE EDUCATION AND KNOWLEDGE CONTROL

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Abstract: The article reveals a new technological approach to the creation of adaptive systems of distance learning and knowledge control. The use of the given technology helps to automate the learning process with the help of adaptive system. Developed with the help of the quantum approach of knowledge setting, a programming module-controller guarantees the support of students' attention and the adaptation of the object language, and this helps to provide the effective interaction between learners and the learning system and to reach good results in the intensification of learning process.

Keywords: distance learning, knowledge control, adaptive systems, knowledge quantum.

ACM Classification Keywords: information systems education, adaptable architectures.

Introduction

Our society undergoes drastic changes connected with the reconsideration of the whole range of scientific, political, and social aspects. They take place in all fields of social life and concern all public institutions including education. As a result of this, the education system also undergoes changes initiated by the system itself as well as under pressure of the changes in other fields. Among the factors which bring about the changes in the field of education, there should be mentioned the process of informatization of the society. This process promoted the appearance and development of different patterns of distance education. Thus, the appearance of distance education is quite a natural stage of the development and adaptation of education to modern conditions. One of the main advantages of the information technologies in the learning process is the possibility of learning individualization. Effective teaching is characterized by the effective use of such pedagogic means of upbringing, studying, and development that are adequate to students' individual peculiarities and help to achieve set educational goals with high effectiveness.

Nowadays such types of education as individual, adaptive, and individualized are distinguished [Mashbits, 1987].

Individual education is education, which is conducted according to the scheme: an instructor (a teacher or an automated educational system) – one student. Opposite to this one is group learning. Computer education can be both individual and group.

Adaptive education is education, which takes into account age as well as individual peculiarities of students. Adaptation may be based on the information collected by the system in the process of studying taking into consideration the learning history of every subject; it can be programmed in advance or it can be the combination of these two approaches.

Individualized education is education, which is based on a student pattern and initiates control actions taking into account this pattern. Educational process reasoning from the goals of individualized education must provide each student with the possibility of an independent choice of means and ways of educational work; methods and strategies of education; content, way, and form of presenting learning material [Iziumova , 1997].

The adaptive system of distance education with the use of information technologies has a number of advantages:

- it helps to reduce the unproductive work consumption of a teacher who, in this case, turns into a technologist of modern learning process in which the key role is assigned not so much to the educational work of a teacher as to teaching students;
- it gives students good possibilities of free choice of their own strategy and tactics of learning;
- it allows both students and a teacher to have effective feedback in the process of learning;
- it increases the efficiency and objectivity of control and the evaluation of the results of learning;
- it guarantees a continuous connection in the relationship "teacher-student";

– it encourages the individualization of educational work (the differentiation of learning speed, the complexity of educational tasks and so on);
– it helps to use a differentiated approach to students, which is based on the fact that different students have their own previous experience and level because every student comes to the process of gaining knowledge with their own store of knowledge which determines the level of their understanding new material and its interpretation. In other words, there is a turn from the acquirement of the same material by all students to the acquirement of “individual” material by different students;
– it increases the motivation of learning;
– it encourages the development of productive, creative functions of thinking in students; the increase of intellectual abilities; the formation of the operating style of thinking;
– it teaches how to work with modern information technologies.

Learning as an active process

In the given system we can present the conducting of education as control over the process of acquiring “skills.” The traditional approach, which stated that a simple constant revision of material (with the exception of latent learning when a person acts as information storage) might yield satisfactory results, turned out to be not quite effective. Learning is an active process and gives a result only when there is motivation to learning. And what is more, education foresees certain efforts on behalf of a student. Thus, when the “learning system” interacts with a student, learning process is activated.

In traditional learning systems, a student, as a rule, provides an answer to a posed question or learning problem. To be more precise, they choose one answer out of the presented to them multitude of variants and themselves have to assess the “correctness” of each of the proposed to them variants. And though at present there is a great variety of such learning systems, in the view of cybernetics, all such invariable automated learning systems are “automatic controllers.” They suggest the scheme of the feedback of the “known answer” type, which would provide motivation and an unknown (or if learning is based on revision, then – repeatable) set of tasks, which provide studying of certain learning material. Such a method is based on the assumption that there is the best way of learning, and it is embodied in the very system and in the system of finding solutions, which defines the action of the learning system. There are a lot of facts, which are evidence of quite satisfactory results that can guarantee such learning systems. But because of the invariable kernel of such a system, such a method works only for an “average” student, concerning those aspects of the action, which remain invariable even if averaged for a group of individuals.

Thus, the problem of the system adaptation to the needs of a student becomes actual. As the matter of fact, in real life a teacher-instructor, though s/he knows what s/he wants to achieve, has definite cautions concerning the way of achieving the defined aim, and s/he diligently adjusts his/her own methods of teaching to inconstant individual peculiarities of every person. Like a stationary program, s/he also watches students’ answers. However, unlike a machine, a person is able to change the way of taking decisions, even the program of the course, and at the same time the interaction has a logical status of conversation which leads to the compromise between the participants at every stage. A personal teacher-instructor is at least an adaptive controller, and there is every reason to believe that a programming module, which corresponds to it, is more effective in practice than a stationary programming module. It is achieved due to introducing different scenarios, which react to a student’s individual peculiarities revealed in the process of learning.

An Adaptive Teacher

Let a student have a task to process a knowledge quantum (the least indivisible notional piece of information, e.g. original notion, key word, axiom, definition, etc. [Fedoruk, 2005] [Sirozha, 2002]), which foresees performing some set of operations on the given quantum. A student knows the original state of a quantum (when no operation is performed yet), and the final state of a quantum (when the task is fulfilled) is chosen by him/her out of a multitude of variants-answers and is not known before the fulfillment of the task. Let there be four states of additional information: non-present information, α, β and γ; each of the proposed states characterizes the posed problem on a different side or with a different degree of refinement. As time is of critical value, a student is set an object to solve the problem as quickly as possible, and because of that optional value d is introduced; it determines the time needed for the fulfillment of the posed task (in fact, it is time rate which is individually determined by a teacher in future). The result of the fulfillment is calculated index of the fulfillment success $\theta(t)$.

It is not very difficult to define restrictions on $\theta(t)$ under obvious conditions: the value must be minimum, if a student simply guesses the order of task fulfillment, and the value must be maximum, if s/he correctly determined the operations to be performed on the quantum and the order of their fulfillment. Let *i* be one of the typical operations the performance of which on the given quantum is possible. Let $\xi_r(t) = 1$ only when operation i must be performed on quantum r, and it was performed by the student, otherwise $\xi_r(t) = 0$. Let $R_i(t)$ be the value inversely proportional to the pending between the stimulus and reaction of the student. Let p_i be the probability of the appearance of necessity for processing quantum *i* in real life, and let $\chi_i(t)$ be the frequency of the appearance of the given quantum at the current stage of learning process. Then at the moment $t = t_0$, we can determine the average of successful task fulfillment considering all the quanta as well as interval $[t_0 - \tau]$ [Gordon Pask, 1961]:

$$\theta^*(t)_0 = \xi_i(t) \cdot R_i(t)[1 - (p_i - \chi_i(t))^2]$$

It is certain that the magnitude of $\theta^*(t)$ is only one of numerous possible values; in particular, it gives no information about wrong answers (as at the given point of time we do not know the "importance" of mistakes) and has the value only when the right answer was given during the required period of time. Thus, we must introduce additional information to guarantee the possibility of finding the right solution. But if we do this, we will make the solution of the posed problem easier. The right answer given after receiving the additional information must be valued at lower points than the solution found without any additional information (prompt). So, there is the necessity of determining the "cost" of additional information. Let its value be δ, if such additional information was provided, and 0, if no additional information was given (there is no reason to believe that prompts α or β are more important than γ and vice versa)[5]. And finally, let $\theta(t_0)$ be the average of all magnitudes i and of interval $[t_0 - \tau]$ for the value

$$\theta(t)_r = \xi_i(t) \cdot R_i(t) \cdot \left[1 - \left(p_i - \chi_i(t)\right)^2\right] - \delta(t).$$

Learning process in this case looks like the process of a constant search for the right order of performing the operations on the quantum with some volume of additional information, i.e. the sequence of problems. In case of optimally organized learning process, growth level $\theta(t)_r$ will be maximum.

The Adaptive System of Distance Education and Knowledge Control

According to these considerations, let's try and project the work of learning system in such a way that it should "learn" itself to determine the optimal order of learning (processing) separate quanta in order to provide the most effective work. The sequence of performing operations on the quantum determines the successfulness (partial successfulness or unsuccessfulness) of problem solution, and $\theta(t)$ will be used for the positive evaluation of the task fulfillment order. In process of fulfilling the posed problem, a student gets additional information in the form of theoretical material, examples, and previously gained knowledge and acquired skills. Moreover, in case of the correct performance of the $j-$th operation on the quantum, the possibility of operation $j+1$ being also fulfilled correctly increases. Thus, every operation connected with the individual value $\theta_i(t)$ and the system, on the whole, remains stable. There is probability that a student will try to perform operations on the quantum at random; however, the system can report it and set him/her on the right track with the help of additional information. Moreover such a structure of learning creates an additional motivation to study, producing an effect of competitiveness, the award in which is achieving the right answer within the shortest period of time and, consequently, getting higher points for the fulfilled task.

To understand the essence of the process, we should talk about *systems.* The brain has the ability to change in the process of its life, but as any other evolution system, it does not *learn.* A *learning* student is the system, which develops in the brain. When the system is stable, on the whole, its two subsystems (person and machine) are inseparable and use the possibilities of the machine as own brain to solve the problem. However, it does not mean, yet, that physically they are a single whole. "Communication", which can guarantee such a state of things, leads to two formally separated activities [Gordon Pask, 1961]:

1. A controller must "hold" the attention of a student. The student is a system with a given set of allowable operations, e.g. u , that is, the student *is to* pay attention to certain tasks, and u determines the limits beyond which the data of a certain type must be processed. The solutions of a certain type are acceptable in order that the system could be called a "student." Let us assume that a student is able to focus his/her attention on a posed task. Then the diversity of the problem with respect to a student, to put it differently – its "complexity", is a multitude of operations and solutions, which are to be performed in order to fulfill the posed task (let us assume that the choice of necessary operations is made by truncating deliberately wrong variants until one variant of the answer or necessary action is left). Now in order to hold the attention of a student, the controller is to determine the sequence of the tasks in such a way that the average value of "complexity" equals, at least, u . If this condition is not met, a student will not be able to remain concentrated, and his/her attention will be redirected to another process, different from learning; but even the fulfillment of the posed condition does not guarantee that s/he will remain concentrated. However, if the conditions of point 2 are satisfied, $\theta(t)$ will assess how difficult it is to fulfill the task following the posed conditions.

2. Problems must be adequate to a student. At the lowest (elementary) level it is achieved with the help of the sub-controller of additional information. It gives a great deal of information owing to which a student may start performing the task, and it also determines the order of the entry of such information (either α , at first, or β depending on the needs of a student at a given stage of learning) as $\theta_i(t)$ for the $i-$ th quantum increases.

But the problems are not accepted as something separated, their order of delivery is also a part of the "flexible" learning block. In its turn it depends on common rules according to which a controller functions. Any event which may be identified by organism or machine can perform several individual functions concerning probabilities of the behavior of the detector under given circumstances (that works under statistical parameter of the system, which is the detector). This function is its value.

Let's assume that the behavior of a person when s/he makes one decision is determined by matrix of changeable probabilities P_1, when s/he makes another decision – by matrix P_2 , and P , the set of all such matrixes, determines the sensible part of his/her behavior. The fact that the stochastically disturbed system, which represents a person, may be described in such a way means that it is divisible. Thus, let us consider sample function $F*$, which can be controlled from the outside by some system with which a person works together, e.g. an instructor. In this case, some of the instructor's messages, which are meant for the student and aim at changing his/her position, incline him/her to a certain choice from set P. By definition, the meaning of such a message is its sample function regarding P. Let us remark that the meaning causes the appearance of the connection between the source of the message and the receiver. Thus, learning problems are used as a message with a certain meaning, as the process of making a decision can change a student's attitude to the problem and its perception, and under the "flexibility" of the lesson we understand the determination of conditions which can essentially influence the meaning of the message or, in other words, the adaptation of the object language of the learning material to the needs of a student.

Condition 1 cannot be fulfilled practically, if only partially condition 2 is not satisfied, i.e. if learning material is not adequate to a student, as $\theta(t)$ is a random value. It is obvious that condition 2 cannot be met without condition 1. So, everything depends upon a student, and no matter what efforts a teacher makes; there is no assurance that a student will go deeply into the subject. But when the "conversation" already started, the stability, which is the result of two-sided adaptation, inheres in it. A student and a computer reach a compromise.

The consequence of such interaction is the growth of value $\theta(t)$, which determines the assessment of its work; however, the result of reaching a certain desired level of interaction with the system is not less important. No doubt it is difficult to demand information potentialities of a human brain from the synthetically created system, even in communication only. The point is that the system develops not like an embryo, but like an autocatalysis. At the first step the presence of the learning machine gives a stimulus to the whole system, the organization which catalyses the appearance of a similar but bigger system. And it generates another one, also catalytic. In learning systems we demand that the sequence of catalytic systems in its behavior should be directed to the growth of effectiveness, to the development of abilities and skills, in particular.

Conclusion

Using of the proposed technology helps to automate the learning process with the help of the adaptive system. In this system the automated controller should do the following in communication:

1. Hold a student's attention. This action is stimulating, as the widening of the range of problems in t increases the probability that a student will give a wrong answer in t. Besides this induces him/her to studying in order to get higher points at step $t+1$.
2. Adapt the subject language, which for the most part determines the successfulness of interaction.

In practice it is not always easy to separate one from the other; however, it is possible in case of clearly defined step-by-step learning process.

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REMOTE DEVELOPMENT OF DISTANCE COURSE USING VIRTUAL LEARNING SPACE 'WEB-CLASS KHPI'

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Abstract: An approach to a specialized website creation – club of distance courses authors – on the basis of Virtual Learning Space "Web-Class KhPI" is implemented and suggested in the article.

ACM Classification Keywords: K3.1 Computer Uses in Education - Computer-assisted instruction, Distance Learning

Introduction

Nowadays, the majority of distance courses is developed using virtual learning spaces. At the same time the nature of author's work depends mostly on conceptual peculiarities of virtual spaces. If the space operates on basic learning materials as e-book, the work can be done on the author's personal stand-alone computer without any interaction with the learning space. Having some advantages this approach contains a number of considerable limitations which could appear while trying to make changes into the learning materials and the configuration online, to restrict access temporarily to some parts of the course. More problems appear when