E-learning Form of Adaptive Instruction

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Abstract

Nowadays, we can’t even imagine education in our information society without its electronic form. Some changes has been monitored in the field of study approach, which is gradual individualization of study for students of part-time as well as full-time study. Merging these two trends – electronic learning and individualization – there can be a new connection discussed “individualized electronic instruction”.

This contribution will introduce a complex plan of the whole system for the individualized electronic instruction. The core of the system is a program to control teaching, so called „virtual teacher“ .The virtual teacher automatically adapts to individual student’s characteristics and his learning style. It adapts to static as well as to dynamic characteristics of the student. To manage all this it needs a database of various styles and forms of teaching as well as sufficient amount of information about learning style, type of memory and other characteristics of the student. The information about these characteristics, structure of data storage and use by virtual teacher are also part of the contribution.

We will also outline a methodology of adaptive study materials. We will define basic rules and forms to create adaptive study materials.

In comparison to semantic web and other trends for individualized instruction, our approach in the field of individualized instruction is new and original that helps to adapt study materials to student’s needs.

Keywords


Introduction

Individualized instruction is nothing new in the field of education. This approach in the form of principle has been recommended since the age of J. A. Komenský. The key point of individualized approach is student itself, studying. He is an individual from many points of view:

- his talent differs in different fields of study,
- his entry knowledge of the subject he currently studies can differ,
- he prefers different learning style than others,
- he can have different type of memory,
- his memory is better trained than the memory of others,
▪ he can have different motivation to learn, different family background, different study habits.

The ideal teacher is able to adapt to needs of a student. He knows preferences of the student and his permanent characteristics. He is also able to recognize his current shortage of knowledge and adapt the speed and style of teaching. Taking all this into consideration, there can be an optimal teaching instruction implemented.

In self-study students usually use textbooks. A good textbook can be understood as a different form of a teacher. The author put his optimal teaching instruction, his scope and detail of information presented.

It is necessary to create a teaching system that will take student’s preferences and absence of „alive“ teacher into account when presenting new information. To choose a suitable learning style for a student you need to know his characteristics.

**Principle of making adaptive environment**

These days, LMS systems are used for storage of study materials, control of instruction, evidence of students, evidence of students’ activities and their results. However, LMS systems don’t take learning styles into consideration.

A global approach to deliver a schoolwork to students is provided regardless of learning styles and level of knowledge [Brusilovský, 1998; Brusilovský, 2001]. If a student is not in a face to face communication with a teacher, he uses textbooks to study. The authors usually use global approach to make the structure of topics in the textbooks but neither in this case learning styles are taken into consideration [Kulić, 1980].

The electronic adaptive environment follows behaviour and characteristics of particular student. Before a student starts his study of a particular subject, he fills in a questionnaire to find out his preferences in different areas of study:

▪ sensory perception,
▪ social aspects;
▪ emotional aspects;
▪ learning tactics: ability to be systematic, study approach, study methods and self-regulation.

A study material is prepared for particular users in relation to their abilities, preferences and needs taking learning styles into consideration. To respect a difference among users, the system can’t be anonymous. Data collection about a student will be done in several steps.

The most important step is a self-evaluation of a student. It means that the student will be tested before entering the course (test results will be classified as „constant parameters“) and testing during the course (test results will be classified as „dynamic parameters“). These „dynamic parameters“ will be used for modification of course path.

The objective of adaptive instruction is not only to adapt the instruction to student´s needs. In case the student has satisfying study habits, there is no need to direct his effort. More effective will be to offer him different methods and learning styles that he might find interesting and more effective for his study than those he had used so far. On the contrary, there are students having no satisfying study habits. Their study is superficial without understanding the core of the lesson and
without ability to put into practice what they have learnt. In this case, the task of adaptive algorithms will be to teach the student better learning style.

**Design of adaptive LMS structure**

Electronic adaptive environment consists of three modules – student’s module, author’s module and adaptive module.

![Model of adaptive learning environment](image)

**Figure 1: Model of adaptive learning environment**

**Student’s module**

In this module, a student plays the key role. From all the characteristics of a student we should pay the most attention to his learning style. Nowadays, many classifications of learning styles exist. For this reason, the characteristics to be used in e-learning has been chosen. [Kostolányová, 2010; Kostolányová, 2011b].

The chosen characteristics were classified into these categories:

1) *sensory perception* describes preferred form to deliver the information to the student. Visual type of a student prefers schemes, pictures, tables and graphs. Auditory type of a student prefers spoken language and a contact with other people. Kineasthetic type of a student prefers demonstration, models and practical information. Verbal type of a student prefers information in a text form.

2) *social aspects* are dealing with the most convenient study environment for the student. Does he like to study with other schoolmates? Does he like to study with the help of a teacher? Does he prefer to study individually?

3) *emotional aspects* are dealing with feelings and attitudes of a student influencing the process of learning. The most important characteristics from this category is motivation where two parts can be observed – external and internal one. While external conditions as job or family requirements are the source of external motivation, the source of internal motivation is a student itself.
4) **learning tactics** describe „technology“ of how a student´s study. Ability to be systematic describes how does a student study. Does he study step by step according to the instructions (pole: order) or does he study in random order (pole: free hand)?

5) **study approach** can be divided in two groups. In the first group there are tactics including theoretical deduction. Students who prefer these tactics like to focus on details. In the second group there are tactics including experiments. Students who prefer these tactics like to put their acquired knowledge into practice as soon as possible.

6) **learning strategy** can be divided in the detailed tactics with a focus on small parts of a particular information. From these small parts the whole „picture“ is made. The second is the holistic tactics with a focus on big parts of abstract information so the student works his way to details.

7) **study conception** can be divided in contemplative, strategic and surface learning. In contemplative learning a student aims to understand to what is he learning. In strategic learning a student aims to be effective in his learning and wants to achieve the best results. In surface learning a student aims to accomplish minimal requirements only.

8) **Self-regulation** defines how much is the student able to control his learning process. If he is able to control his learning process successfully, he doesn´t need any external help. If he is not able to control his learning process, he will need an accurate instruction.

**Author´s module**

A learning material is important for a student to be able to learn independently. The program must have different levels of a study conception and a sensual perception to correspond with learning style of a student.

Each chapter of a topic delivers instruction to a student well structured – chapters are divided into subchapters, paragraphs, etc. We call the smallest coherent part representing the unit of information a „framework“. The framework is identical to the lowest level of the text numbered. The particular framework is divided into explanatory part, testing part and others. The explanatory part is further divided into traditional parts of instruction – theoretical, semantic, consolidating and motivational. We get different ways of instruction when we combine the parts mentioned above. For the testing part different categories of questions, exercises and practical tasks have been chosen. Motivational, navigational and a layer of accomplishment are being put in the part „others“ of a particular framework.

![Figure 2: Variations of framework](image-url)
Adaptive module

When we prepare adequate study materials (author’s module) including characteristics of a student (student’s module) we will lay the foundations of adaptive module. The creation of the adaptive module was the most demanding. The most important was to describe the rules. According to these rules the most suitable parts of frameworks are chosen. Afterwards the frameworks will be exposed to a student. His knowledge will be gradually tested in the form of theoretical questions and tasks. If a student finishes the framework successfully, he can continue in his study. Failing that, the student will be offered a different approach to learn what he has not understood. There might be either detailed explanation or further examples with more practice. This way student should be helped to finish the framework successfully.

It is necessary to monitor all study activities of a student to know the progress of his study. Dynamic characteristics recorded from his study activities and from self – regulation should be added to static characteristics of a student entered at the beginning of his study. Information about his study activities will be gathered from progress tests.

Frequency of testing can differ – after each chapter, after a particular topic explained, after a study unit. From the test results we can find out if the student learnt something new or not, if he likes the suggested strategy for his study or not. Monitoring these dynamic characteristics, a good adaptive algorithm can change an instruction approach like changing the way of explanation, different way of practice. Above all that the adaptive algorithm should follow the objective of study and help the student to achieve the objective.

Design of adaptive textbook

Methodology for a design of adaptive textbook proceeds from general teaching principles of Jan Ámos Komenský, situated learning of Gagné and Bloom’s taxonomy of learning objectives. These experts laid the foundation of learning style strategies. They defined the rules and principles suitable for effective instruction.

When creating the methodology for a design of adaptive instruction materials we took all these teaching principles and the methodology of distance-learning textbook design into consideration.

We used the principle of illustration, self-consciousness, systematic approach, adequacy and permanence of Jan Ámos Komenský. Instruction methods follow basic steps of study. The Gagné principle of situated learning was used in adaptive instruction as follows: introduction of the lesson, instruction, practise, testing and the end of the lesson. Bloom’s theory to define learning objectives in adaptive study materials was used with emphasis on cognitive area of knowledge. The objectives are defined in relation to the character of study. There are six categories – remember, understand, apply, analyze, evaluate, create [Gagné, 1975; Komenský, 1947 a 1948].

When considering the possibilities to be used in adaptive instruction we took the design of distance-learning study materials into consideration. One of these ideas is to divide a study material in smaller parts as chapters and subchapters. We call one coherent unit of study a „framework“. In one unit there will be one main topic included. Explanation of a subtopic will be in accordance with the theory of Gagné situated learning. A framework will be divided in smaller parts called „layers“. The layers will make it possible to adapt the style of instruction to student’s needs. A layer of a framework we call a part of a framework that is homogenous from the point of steps of an instruction process (instruction, theory, explanation, practice, testing of knowledge, motivation, control of the lesson) [Kostolányová, 2011a].
Types of layers:

- **Explanatory** – group of layers containing their own explanation of the material covered. This concerns the following layers:
  - **Theoretical** – containing theory: definition, terms, rules, algorithms, etc. In terms of education, this is the most important type of layer.
  - **Semantic** – explaining the introduced terms, formally described theory, containing additional information to the theoretical layer, explaining correlations arising from theory, etc.
  - **Fixation** – with the aid of repetition, other formulations and alternative concepts, implemented into the wider context to make it easier to remember the theory.
  - **Resolved examples** – contains examples of how to apply a theory, resolved “textbook” examples. For students, these are examples for solving given tasks.
  - **Practical** – contains resolution of examples from practice, which use theoretical knowledge.
- **Testing** – a group of layers for regular testing of acquired knowledge, to fixate this theoretical knowledge with the aid of tasks. These layers are:
  - **Questions** – theoretical questions from the material covered. Questions may only serve as checking questions for a student or adaptive algorithms use them to control the next instruction.
  - **Tasks** – “textbook” exercises to be resolved.
  - **Practical exercises** – tasks from practice.
- **Other layers**
  - **Motivational** – motivating information about the subject, lesson or framework, which would justify the benefit of study to the unmotivated student.
  - **Navigational** – didactic or organizational information, a kind of guide of lessons or material covered, recommended study methods, etc.

To understand the content of particular layers, below are the examples of some of them:

**Example of a layer focused on objective of instruction**

After a student finishes his study of a chapter, he will be able:

- to define basic characteristics of vector and bitmap graphics
- when solving practical task to define which type of graphics to use (according to advantages and disadvantages of each type)

**Example of a motivational layer**

Did you know that computers display the graphics either in vector or in bitmap form? Have you seen any difference between these two forms so far? Don’t worry and start our course. If you understand the difference between these two forms, you will become more effective while doing any graphics.

**Example of a theoretical layer**

Bitmap graphics depicts a picture with the help of pixels organized in the form of grid. Each pixel in the grid has a place and color defined so the picture is created as a mosaic.
**Example of a semantic layer**

When we modify a bitmap picture, we change pixels, not line segments and curves. Bitmap graphics depends on resolution because data describing the picture relate to the grid of a particular size. When we modify a bitmap picture, a quality of image can change. The changes can be particularly seen when displaying a picture with a high resolution on a monitor with a lower resolution. The quality of image is low.

Design of adaptive textbook is more demanding than design of a regular text or multimedia instruction support. A template was created for the authors who decided to participate in designing an adaptive textbook. (Picture 1). In this template authors enter the text of instruction material and use of multimedia components [Kostolányová, 2011c].

For one thing an author enters a specialized content of an instruction (the major part of a template) and for another he enters relevant metadata needed to control adaptive instruction (right side of a template).

The authors of instruction materials in adaptive form create text content, well structured into this template. They also enter the use of multimedia components. Detailed scenarios about how to create adaptive instruction materials are part of adaptive textbook in the form of appendix.

**Table 1 – Template to create adaptive study materials**

| Subject: Subject name |
| Lesson: Name of the lesson |

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<th>Rtitle = Framework title</th>
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<tr>
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<tr>
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<td>VForm=Sver,Sviz,Saud,\text{Skin}</td>
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<td>2. text of a layer T</td>
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<td>2</td>
</tr>
<tr>
<td>text of a layer S</td>
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<td>1</td>
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<tr>
<td>...</td>
<td>S</td>
<td>2</td>
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<tr>
<td>text of a layer F</td>
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<tr>
<td>Example:</td>
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<tr>
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<tr>
<td>text of a layer C</td>
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</table>

Answer 1 – correct | 3 | x | A | 1 |
Control of instruction by a virtual teacher

Each framework, divided into particular layers, will be created in four sensory forms (verbal, auditive, visual, kinesthetic) and in three levels of instruction (strandard, with extra support and with extra interesting details for a student). Variants that include a form (sensory forms) and levels of instruction aren’t able to cover all detected distinctions in a style of instruction. The way of instruction must react to other different characteristics of a student. Analyzing these students’ characteristics we concluded that the instruction can also differ in order of particular parts of instruction and revise tests and organizational information if needed.

Adaptive algorithms will form the initial version of optimal instruction style . The algorithms function on the base of predefined rules. The rules are created by experts in the field of pedagogy and in the harmony of pedagogy and psychology principles. Below are examples of these rules:

- If a student’s characteristic in the area of „Study Approach“ = 75 (he is a detailed oriented student), then use the level of instruction = 2 and then the level of instruction 1 in the order defined by other rules.

- If a student’s characteristic in the area of „Motivation“ = -50 (strongly unmotivated), then use the „Motivational Level“ = 3 (describes a practical benefit of this knowledge in details).

etc. [Kostolányová, 2011a]

Intuitive rules are a mainstay to create other rules. The intuitive rules will come of analysis and research concerning of evaluation of instruction and test results. Principles of a good instruction style are defined in the rules. Such an instruction style should motivate students with bad study approach to use more effective methods and study approach.

The „virtual teacher“ is responsible for control of instruction as well as for measuring students’ progress. Measuring students’ progress, detecting their level of knowledge and comprehension of information presented is essential part of adaptive system. The whole instruction process is recorded. Every „click“ of a student, time spent in particular layers, changing of student´s strategy, test results, etc. Data recorded serve as a source to make different analysis.

- to verify settings of student’s characteristics;
- to verify a suitability of instruction support;
- to verify expert rules of a virtual teacher.

Conclusion

There is more to say in the conclusion. The adaptive instruction hasn’t been discussed on theoretical level only. The control system that controls the whole instruction process automatically is being analyzed...
An adaptive LMS is implemented gradually on the base of analysis results and is ready to be tested. When testing the adaptive LMS, there can be some adjustments made in the area of student’s characteristics as well as in the area of virtual teacher rules.

The advantage of this control system is that theoretical parts implemented are of a dynamic and parametrical nature. It means that if some adjustment needs to be made, it will be made by data entry in a database and not by adjustment of the whole structure of the control system. Especially the rules of the virtual teacher are saved in special expert database. Except of standard user roles as „student“, „author“, „teacher“ and „administrator“ there is also a role of „expert“. The „expert“ is a specialist in the field of adaptive instruction having access to records and adjustments of parameters that control adaptive instruction. Then the „expert“ can modify relevant data and instruction on the base of teaching instruction analysis.

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References


