Adaptation of E-learning Using Virtual Teacher

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Abstract— **This paper deals with automatic adaptation of e-learning courses. The adaptation tailors the course content in given situation to the student's learning styles. This paper describes the Virtual Teacher that uses a set of rules to automatically adapt the teaching style. These rules compose of two parts: conditions on various students' properties or learning situation; conclusions that specify different adaptation parameters. The rules can be used for general adaptation of each subject or they can be specific to some subject. The rule based system of Virtual Teacher is dedicated to be used in pedagogical experiments in adaptive e-learning and is therefore designed for users without education in computer science.**

Keywords— **e-learning; adaptation; virtual teacher; teaching style; learning style**

I. Introduction

These days we can see a lot of teaching using computers without presence of teacher. For example, some significant universities provide some of their courses for free in eLearning form. And there are also some commercial self-improving courses in purely electronic form. So it's surely worthwhile to study different approaches of making eLearning more effective. We will focus on individual teaching in this paper. The way of teaching is adapted to each user and his different properties, learning styles and needs.

A. *Adaptive Teaching Environment*

Teaching environment is considered adaptive if it can monitor and interpret user activities, deduce user requests and preferences from these activities and then dynamically alter the teaching process on the bases of this information [1].

Adaptation of teaching can have many forms that can be divided to these categories:

- Adaptation of user interface
- Adaptation of learning content
- Adaptation of searching
- Adaptation of learning content assembly and adaptive collaboration support

First category, adaptation of user interface, changes for example color scheme of teaching environment, font, structure and order of user actions.

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Second category, adaptation of teaching content, changes content and presentation of teaching so it is appropriate for the user properties and optimizes quality and time of teaching.

This kind of adaptation uses for example dynamic change of structure of learning content, adaptation of navigational elements and dynamic selection of different parts of learning content.

Third category is adaptation of searching and assembly of learning material. From distributed sources of learning materials are chosen the most appropriate materials for the user on the basis of user characteristics and goals.

Last category, adaptive support, is focused on communication between users and on different kinds of group activities. It also makes the process of communication and collaboration easier and ensures good combination of users in group [2].

This paper focuses on adaptation of learning content because it is the main source of educational information for student in electronic environment and should have significant impact on the learning process.

B. *Existing Systems*

1) AHA!

System AHA! (Adaptive Hypermedia for All) is monitoring student's knowledge during his learning. Author can insert conditional parts of content that can be viewed only after certain condition is met [3].

Authors of courses create HTML pages with special tags and relatively complex conditions. The author has to know how to create the web pages and how to write conditions in programming language. The authors need to design both content of learning and way of adaptation.

Here is example of conditioned content [4]:

```
In Xanadu
<if expr="myapp.xanadu.knowledge==0">
<block>
(a fully distributed hypertext system,
developed by Ted Nelson
at Browsn University, from 1965 on)
</block>
</if>
there was only one protocol, ...
```

2) GALE

GALE [5] is general architecture of adaptive system that that can be complemented with custom designed modules for various kinds of adaptation. But to accomplish the adaptation, authors has to insert a lot of complicated code. It uses GALE code that is based on Java language with shortcuts to access models:

```
{ #[visited]:Integer `0` {
event `if (${#suitability} && ${#read} <
100) #{#read, 100};
```

```
else if (!${#suitability} && ${#read} <
35) #{#read, 35};`}
#knowledge:Integer !`GaleUtil.avg(new
Object[]
{${<=(parent)#knowledge},${#read}}).intVal
ue()`
#[read]:Integer `0`
#suitability:Boolean `true`
event `#{#visited, ${#visited}+1};` }
```

3) **Comparison**

In existing adaptive systems author has to develop also the way of adaption and he is required to do it by entering the code. Adaptive system that is further described differ in separating the creation of content of learning and adaptation mechanism. The authors can than focus on creation of learning content that only need to be filled in with additional metadata.

The design of way of adaptation is also simplified and doesn't require any coding. It consist of designing a set of rules that are defined by using user interface, where author selects conditions, conclusions and writes numeric values.

II. **Adaptive System**

We have developed adaptive system Baborka 4, where the author can focus only on design of learning content. The author can still design his own way of adaptation, but he doesn't need to code it, he can define all rules by using user interface.

There are three actors in the process of teaching adaptation (see Fig. 1): student, author and expert. Author designs adaptive learning materials i.e. formatted text with multimedia and some metadata.

Expert designs rules that defines the way of adaptation. And student is learning from the adaptive materials and all his actions are logged.

Expert module deals with definition of rules and also performs some data analysis. The main part of expert module is Virtual Teacher that uses rules to adapt and control the learning process.

On Fig. 2 is simplified diagram of Virtual Teacher (VT) and its inputs and outputs. VT reads Student model to get students' properties that are significant to his learning. Another important input is Learning material model that holds all the metadata about study materials. The work of VT is controlled by set of rules that can be general (general rules), specific to certain students (student rules) or some learning domain (author rules). VT uses all these inputs to adapt the existing study material and display it to the student. VT also adapts the processing of student reactions that can also result to alternation of student model. All student actions are logged and can be analyzed later to provide feedback.

The core of Virtual Teacher is set of rules inspired by different adaptation methods:

Conditional layer method shows some fragment of text if the condition is met. Layer can be selected by the type of layer, depth, sensing type or specifically by its ID. The conditions when to show the selected layer involve different student learning styles, level of his knowledge and current learning situation.

Change of layer order method selects layers by the type of layer, depth, sensing type or specifically by its ID. Conditions that selects when to use what order of layers involves student learning style.
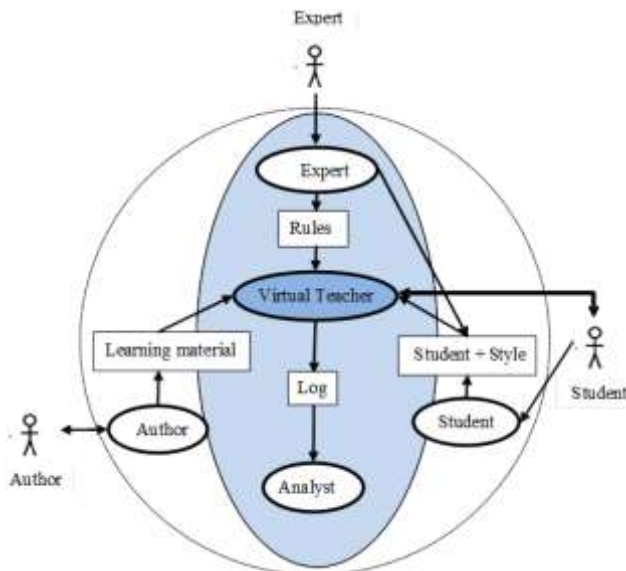

Figure 1.   Diagram of expert module and its surroundings

The material is divided hierarchically to chapters, frames, variants and layers. Each variant has its depth i.e. level of difficulty and sensing type. Layers has its order and type.
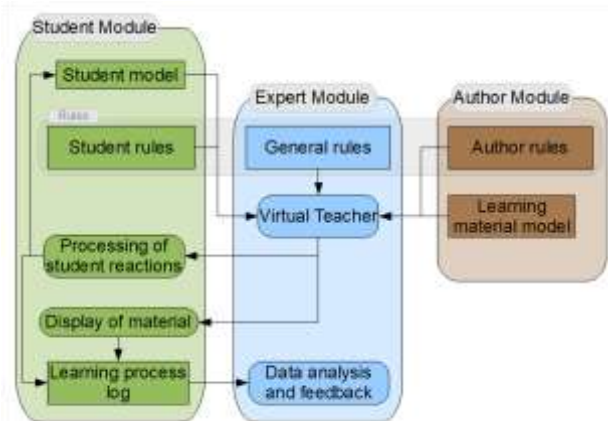

Figure 2.   Diagram of Virtual Teacher and its inputs and outputs

Next method changes variant of frame or layer. If used on frame, this method changes sensing type or depth of every layer of the frame. But this method can also change depth or sensing type of some layers that are selected by the type of

layer, depth, sensing type or specifically by its ID. The conditions when to use the variant involve different student learning styles, level of his knowledge and current learning situation.

It is also possible to change the order of chapters and frames on the basis of students learning styles, his knowledge and specific chapter or frame metadata.

Automatic frame assembly method creates new frame from existing layers. In this method we define when, where and from what layers will be the frame created.

System Baborka 4 is currently used for pedagogical experiments in which is important to have precise control over the adaptation of teaching. That is why is the system allows to change the way of adaptation without changing its source code. This setting of adaptation is done by adding and changing rules that defines the way of adaptation for different students in different learning situations. The rules are designed to be easy to understand, create and change.

There are many types of rules but experimenter usually use only small part of them. Therefore it is important to divide the rules to several categories. Generally we can divide rules by these criteria:

1. By learning content (e.g. general, for subject …)

2. By learning mod (e.g. view, study, repetition choose)

3. By adaptation context i.e. what is adapted (e.g. frame order, frame content, test) or in what situation it is adapted (e.g. reaction to students answer)

A. *Rules Divided by Learning Content*

Adaptation can be vary by its content e.g. English lesson can be adapted in different way than Mathematics or Psychology. But there also can be some general rules that apply to all subjects. Therefore we divide rules to these levels:

1. General rules used in all subjects and containing general pedagogical principles.

2. Rules for group of subjects e.g. field. These rules will be used in all subjects of chosen group and perform adaptation specific for this group e.g. learning languages.

3. Rules for specific subject e.g. Mathematics or Psychology.

4. Rules for group of frames e.g. first chapter.

5. Rules for specific frame, variant or layer.

6. Rules for group of student e.g. study and control group or class of talented students.

7. Rules for specific student e.g. rules that the student defined for himself to learn more efficiently.

It is sufficient to use only one level of rules for adaptation of teaching. It's not necessary to use all the levels.First, confirm that you have the correct template for your paper size. This template has been tailored for output on the US-letter paper size. If you are using A4-sized paper, please close this file and download the file for "MSW A4 format".

B. *Division of Rules by Mode*

Student can choose his actual mode of learning that changes the way of adaptation. Each mode has its set of rules that alters the way of learning. Some rules can be used in multiple modes. Specific way of adaptation of each mode depends purely on the rules.

There are currently these modes:

1. First reading (for fast overview of study material).

2. Learning

3. Repetition (focuses on questions and tasks, explanation is shown only after wrong answer).

4. Classical test.

5. Adaptive test (the difficulty of the next question depends on the previous answers).

C. *Rules Divided by Context of Adaptation*

Adaptation of teaching can be divided to five areas with rules for every area:

1. Subject navigation changes the order of chapters

2. Frame navigation changes order of frames, can insert new frames or skip one.

3. Frame content chooses appropriate variants and order of layers.

4. Testing chooses next question by the student last answer.

5. Reaction to student's answer chooses appropriate system action after student's wrong answer.

6. Reaction to change of variant chooses appropriate variant of layer.

Adaptation of frame content is the most detailed area in system Barborka 4. It has many types of rules that chooses the best variant and order of layers in the frame. Student can still the variant he likes.

Adaptive learning materials often contains some questions and tasks that can be automatically evaluated. It is very important how the system reacts to wrong answer so this reaction is set be rules. They use information about student, his learning style and knowledge, correctness of answer and how many times student already answered. System has also some reactions: show correctness of answer, show hint, show explanation, show solving procedure and show right answer.

D. *Description of Rules*

The rules for adaptation consist of three parts:

- Heading that contains name of the rule, type, priority, mode, description and other informations.

- Conditions that specifies when should be the rule used.

- Conclusions that indicates what should be done.

Example of rules:

- If student has visual style of learning, than use the visual variant of content.

- If student has given the wrong answer for the same question for the third time, show him the right answer.

- If student has experimental type of learning, show him the examples and applications first, definitions and theory later.

III. **Conclusion**

This article describes different ways of adaptation of learning content. It also describes the design and implementation of adaptive learning control system that is based on:

- Learning properties of student.

- Structure of adaptive teaching support.

- Pedagogical and psychological goal of author of adaptive learning support.

This system allows to:

- Implement almost all known methods of learning content adaptation.

- Easily expand the system with new adaptation methods.

- Conduct learning experiments and analyze their results.

- Detect problematic parts of learning support.

Current adaptive learning systems are based on some form of programmed learning. Author of learning support has to:

- Create the content of learning support.

- Design which part of support will be used to what type of student.

- Prepare reactions of system in different learning situations.

These adaptive learning systems offer various tools that helps author with this tasks, but it is still too difficult for author without education in informatics [3].

This work describes different approach to this problem. Author of learning support creates only the content of learning support in different variants and divides them to layers. The Virtual Teacher will then use these metadata about learning support and information about student to adapt the learning content. The Virtual Teacher uses general pedagogical and psychological principles formalized in set of if-then rules. The system also allows the researchers (mainly Ph. D. students and employees of pedagogical faculty) to design and experiment with their own set of rules.

This system was already successfully used in practice for two pedagogical experiments conducted in Ph. D. theses [4, 5] of students of field Information and Communication Technology in Education.

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