ADAPTIVE INDIVIDUALIZED EDUCATION IN E-LEARNING

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ABSTRACT
This contribution deals with the proposal on a new learning model based on individual learning styles of students. It consists of three parts – The Student Module, Virtual Teacher Module and Adaptive Module. Within the Student Module, the groups of mutually independent characteristics of students have been proposed influencing the learning process. The stated characteristics can be considered at the development of the electronic learning environment. The Virtual Teacher Module describes the designed procedures of education depending on individual characteristics of students. The Adaptive Module is represented by algorithms which select the optimum study material for individual types of students. The contribution involves a pilot description of the proposed structure, including the description of learning styles analysis and its results, and finally, the next gradual development of the issue being resolved is formulated here.

KEYWORDS
eLearning, LMS, learning styles, study materials, multimedia

INTRODUCTION

Learning of the individual can be influenced by many factors which mainly involve the learning style of the student, their personality as such, and motivation to studies. From that aspect the student can be viewed as an individual. During conventional education the student is a part of the group of pupils and the teacher modifies the education in order to meet requirements of all pupils in the class. At face-to-face education the experienced pedagogue will recognize when pupils loose the thread and will try a different approach.

Another situation occurs at "distant education" via electronic education courses. Even in that area the trend of recent years features successive individualization of study and education according to individual types of students. In very popular and wide-spread electronic education, that issue is being resolved with so-called personalization of education. Intelligent education systems are being designed, thus presenting the content of study in the optimized advantageous sequence and according to the nature and individuality of the student.

THE PRINCIPLE OF THE ADAPTIVE ENVIRONMENT CREATION – MODULE DEVELOPMENT

Education employing computers has been applied for a long time. In most general terms, this means the use of the internet environment together with the learning management system (LMS) involving educational supports, followed by functions for education management and finally, the information system which register students and monitors their activities and results.
If the student learns without direct contact with the teacher, they usually use textbooks. A good textbook can be understood as a different form of teacher. The author put there his/her optimum presentation procedure, scope and the level of detail of presented information. We are aware that

conventional textbooks complement the direct presentation of the teacher, while textbooks for self-study, so-called distant study, are to substitute both presentation of a new study curriculum, and communication with the teacher, followed by practising the content of study, etc.

STUDENT MODULE

The target person is a student. Each person is different from many aspects. We can split their characteristics to static features of the personality, continuous knowledge, circumstances of study, and dynamic characteristics. In general, the students:

- have different motivation towards learning, various family background, different habits in terms of when and how to learn,
- have different preliminary knowledge of the currently studied subject,
- have different levels of talent for various disciplines,
- have different learning styles,
- have different types of memory and differently trained memories,
- need different depths of knowledge, understanding, uses and applications of acquired knowledge,
- can have differing momentary concentration levels, fatigue, etc.

We call the summary of the above-stated student characteristics the "student learning style".
There are quite a few classifications of learning styles, including extensive literature dealing with them. Authors of those classifications often define 2-value dimensions while splitting learning styles accordingly into 4 quadrants corresponding with their 4 combinations. Typically, for example (Kolb, 1984) uses 2-value dimensions called the method of acquiring information and the method of experience processing. The first axis features the following poles: specific experience / abstract visions, while the second dimension features the poles of active experimenting / thoughtful experimenting. Their combinations result in known 4 learning styles: divergent (1a + 2b), convergent (1b + 2a), assimilating (1b + 2b) and accommodating (1a + 2a).

Another example of classification with 2-value dimensions is in (Gregorc, 1979), later (Mareš, 1998). The author defines perception, a tool for taking information with abstract / concrete poles as dimension 1 and dimension 2 as a method of processing information with random / sequence poles. And again, combination of dimensions will result in 4 types of learning styles called specifically sequential, specifically random, abstractly sequential and abstractly random.

Based on analysis and study of the next already published classifications of learning styles according to various authors, the following characteristics have been determined which can be applied in the e-learning area. We divided the stated characteristics into the following groups:

The group of characteristics called ***sensual perception*** describes what form of information suits the student best. The visual type prefers schemes, pictures, tables and graphs. The auditive type prefers spoken word and contact with another people. The kinaesthetic type is aimed rather at demonstrations, models and practical information. And finally the verbal type prefers information in text form. For that group of characteristics, the VARK questionnaire has been applied (Fleming, 1992).
The next group of characteristics called ***social aspects*** deals with the issue of what society suits the student best at learning: whether he/she prefers to learn with classmates, teacher or alone. For that group of characteristics, the LSI questionnaire has been applied (Mareš, 1993).

The group of characteristics called ***affective characteristics*** deals with emotions and attitudes of the student which influence the course of learning. The most important characteristic of that category is motivation where two components can be observed: external and internal. The source of external motivation to learning involves external conditions, such as work requirements, parents, etc. The source of internal motivation to learning is the student alone. For that group of characteristics, a part of the LSI questionnaire has been applied (Mareš, 1993).

The most extensive group of characteristics is ***learning tactics,*** describing "technology" of the student learning. Orderliness of the student learning describes the student learning sequence which can run both in steps which are logically gradually linked (order pole) and almost randomly, without continuity, in big jumps (freedom pole). For that characteristic, a part of the ILS questionnaire has been applied (Felder, 2009).

According to the method of learning, we split tactics into theoretical derivation characterizing the student who prefers thorough thinking about newly acquired knowledge, and into the tactics of experimenting used by the students who prefer to test acquired knowledge in practice, if possible. For that characteristic, a part of the ILS questionnaire has been applied. (Felder, 2009).

According to the learning procedure, the tactics can be split into detailing aimed at small pieces of specific information which are gradually put together to create the overall picture, and into holistic tactics aiming at big parts of abstract information from which it gradually works up to details. For that characteristic, a part of the TSI questionnaire has been applied. (Sternberg, 1999, str. 60-63).

The learning approach of students can be divided in three levels: in-depth, where the student's main interest lies in understanding the subject matter, followed by strategic approach where the student´s main objective is to achieve effectively the best results in study, and finally the superficial approach, whereby the student tries to meet basic requirements. For that characteristic, the ASSIST questionnaire has been applied (Entwistle, 1996).

Self-regulation of learning determines to what extent the student is able to manage his/her learning individually, which then results in his/her need for external control of the course of study, where on one hand he/she welcomes precise hints and on the other hand he/she preferably controls his/her learning individually. For that characteristic, a part of the LSI questionnaire has been applied (Mareš, 1993).
For the above-mentioned characteristics, we used only certain questions from the stated questionnaires, or their parts. Those fragments were put together as one unit and submitted to students for testing. None of the questionnaires were used as a whole, therefore, even successive evaluation is not made for each questionnaire respectively, but it is complex.

TESTING OF STUDENT CHARACTERISTICS – QUESTIONNAIRE INVESTIGATION + ANALYSIS

The pilot testing in which the combination of the above-mentioned questionnaires was used and in general, they were not translated professionally, and involved some 200 university and 150 secondary school students. The study focus of tested students varied. Students study technical disciplines, economics disciplines, humanities and science.

Three types of analyses were conducted with the obtained data, while only fully completed questionnaires were included in processing. Due to the small scope and low quality of data sources, the results presented below can be considered as tentative only. The conducted analyses confirmed that the proposed group of questionnaires is not entirely correct and well-designed.

MAIN COMPONENTS

Data analysis using the main components should suggest if certain questions are mutually dependent. It should possibly define the key for their evaluation, thus specifying the list of mutually independent characteristics of students derived from their answers.

Applied questionnaires or their irresponsible completion (or incorrectly understood questions) by students caused a situation where the number of main components determined from answers to questions is much greater than the number of characteristics determined by the specified evaluation key. So for the time being, the expected result of applied data has not been achieved.

Analysis of main components of sensual types confirmed that individual sensual types come together to form the component of the multimodal type.

Moreover, it was revealed that mutually dependent characteristics existed. Out of the original 28 characteristics, only 18 main components would be enough to cover the variability of the majority of data. Though the number of characteristics describing the student could be reduced to the main components found, the interpretation of such new characteristics would not be obvious. Therefore, it is more advantageous to maintain original characteristics. The reason for those dependencies among the student characteristics is probably the fact that these characteristics originate from several various questionnaires aimed at various groups of characteristics.

DECISION TREES

The most interesting results were found in sensual types. The auditive type of student is strongly linked to the fact of whether such student is the multimodal type or not. If the student is the multimodal type, then he/she is the auditive type as well. A similar result was found for visual and verbal types of students. That finding is even confirmed by the results of analysis of main components, where the multimodal type was found to be the main component.

Moreover, the surprising result suggested that the kinaesthetic type of student strongly depends on whether this student is the visual type or not. If so, then he/she is almost always the kinaesthetic type too. If the student is not a visual type, then the kinaesthetic type exists only in 60% of cases.

The auditive type of student strongly depends on the characteristic of monitoring requirements which expresses what level of attention is paid by the student to teacher requirements. It is true that all students featuring low, medium or very high level of the characteristic of monitoring the requirements are always also auditive types. Students of very low or on the contrary very high level of the characteristic of monitoring requirements are not auditive types in 30% of the cases.

Regarding social characteristics, the data showed the connection to responsibility towards learning as opposed to literature; responsible students prefer to learn individually, while irresponsible ones prefer mates. Additionally, the influence of student characteristics on his/her self-evaluation was investigated and it showed that it is mainly good organization of learning which has the biggest impact on positive self-evaluation.

CLUSTERING

According to all characteristics, no significant clusters appeared except for a few isolated points. This result means that in the tested set of students there are no groups of students who would be similar in the majority of characteristics. That can indicate the fact that students evenly cover the space of all characteristics. But another reason can be both a very low level of data regarding the number of characteristics, and the imperfect design of questionnaires.

The analysis of completed questionnaires by students revealed potential unreliability of applied questionnaires. But the interesting results found provide the basis for proposing a new version of the questionnaire investigation, which we will intensively elaborate with support of doctoral study programme students at the Pedagogical Faculty of the University of Ostrava.

AUTHOR MODULE – DRAFT METHODOLOGY FOR DEVELOPMENT OF ADAPTIVE TEXTBOOKS

Indeed, educational material resources are necessary for learning. For the management educational programme to be able to adapt to various personalities of students, the content of study must be

designed in many different ways – as when an experienced teacher reacts to a different depth of knowledge, different talent and approach to study, reactions, habits and other characteristics of each student.

The best way to present the content of study to the student is by a structured form – the subject is divided in chapters, sections and paragraphs. Let us call the smallest comprehensive part presenting a unit of information the frame – usually such frame in text corresponds to the lowest level of numbered or otherwise indicated paragraphs or a single internet site including relevant multimedia elements.

It will be effective to present the subject matter to students of abstract thinking and good theoretical background differently than to those, who for the sake of good understanding must firstly challenge everything, understand the meaning and significance of new information, and only then they will be willing to accept a particular theory. Similarly, it will be suitable to present frameworks to the student preferring a written text differently than to a student of auditive memory, visual memory, etc. And finally, the same framework can be presented for various disciplines of students (or for a different level of required knowledge to obtain a different evaluation) at differing levels of detail. Therefore, each framework should be developed systematically and formally in several different ways.

We began by differentiating the form of presentation – verbal, visual, kinaesthetic and auditive - according to sensual perception), the level of detail and the presentation procedure. Firstly, we will divide the specific framework into two parts – reading and testing. The reading part will be divided according to conventional phases of education to individual levels – theoretical, semantics, fixation, practical and motivation. We select various options of reading procedure by their mutual combination. In the second – the testing part - we will gradually select categories of questions, a task to find a solution, practical tasks from the field, etc. Each option of the framework will require description by metadata for successive processing with the adaptive algorithm. Work connected with the development of such type of the adaptive textbook is much more demanding than work with a conventional textbook.

ADAPTIVE MODULE – DESCRIPTION OF RULES FOR LMS RUNNING

At this point, teaching materials developed by the stated styles are prepared followed by formats and the level of detail, and sufficient information on the current student and his/her learning style, and finally his/her preliminary knowledge required for the study of the current content of study. Now, the most difficult task awaits us: the description of rules according to which suitable options of frameworks will be selected with respect to the student characteristics and the objective of teaching (according to expected level of his/her knowledge – understanding – analysis – synthesis). Then, the stated frameworks will be presented to the student and their correct understanding will be continuously controlled by theoretical questions and tasks for solutions. If we achieve positive results we should continue, and if we fail, the subject matter should be explained again and differently, in greater detail, followed by presenting more examples, etc. That is the future content of the virtual teacher module. We have started to work on this module quite intensively. We are presently at the beginning of solution while trying to formulate simple adaptive rules.

Again, those rules should be formulated and tuned by experts, a specialist and an experienced pedagogue and psychologist. The rules will become a logical framework for the adaptive teaching algorithm, for the virtual teacher.

The task of informatics will involve implementation of those rules. It will include collaboration of the author database with the expert system recording characteristics of virtual students, metadata recording the student course of learning including ad hoc reactions of the student. It is necessary to monitor all his/her activities: time spent over individual frameworks, the need to use different optimum frameworks than those selected, asking for further, more detailed reading or other examples and of course, correctly answered control questions. The following analysis of the whole process of learning the adaptive

algorithm should respond to all this information in the course of learning with a possible change of characteristics.

For the sake of ensuring a truly individual course of study, it is necessary to monitor all study activities of the student. Static characteristics on the method of study acquired at the start should be complemented by dynamic characteristics obtained from recording student activities and self-reflection. We will learn about them from testing in the course of study. Results of testing will suggest whether the student managed the subject matter or failed, how he/she is content with the proposed course of study, etc. Based on monitoring of those dynamic characteristics, a good adaptive algorithm can possibly change the method of reading, for example, by offering a different explanation or other method of practising. However, we should continue in targeting – to lead the student to the defined target status of the knowledge of the content of study.

CONCLUSION

Until now, we have dealt with the described project in detail in the part entitled Student Module. That is where we analyzed student characteristics, where tools were designed for testing and a pilot test run was implemented. On this basis and following consulting with psychologists and pedagogues, the applied parts of known questionnaires will be modified to the environment of the electronic form of education. During the next period, we would like to work intensively on Adaptive Module and Virtual Teacher Module, thus elaborating the suggested ideas to the very depth. The basic ideas of adaptive learning described above suggest that the project is very extensive and requires collaboration of several types of experts. The resulting high knowledge level of students should then become the main reward. Additionally, it is possible to teach individually any number of students while applying a minimal teaching load.

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PART B: TEACHING AND LEARNING

COMPUTER BASED LEARNING