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ADAPTATION OF TEACHING PROCESS BASED ON A STUDENTS INDIVIDUAL LEARNING NEEDS

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Abstract

Development of current society requires integration of information technology to every sector, including education. The idea of adaptive teaching in e-learning environment is based on paying attention and giving support to various learning styles. More effective, user friendly thus better quality education can be achieved through such an environment (Schaik, 2002; Barker, 2009).

Learning can be influenced by many factors. In the paper we deal with such factors as student's personality and qualities – particularly learning style and motivation. In addition we want to prepare study materials and study environment which respects students' differences. Adaptive e-learning means an automated way of teaching which adapts to different qualities of students which are characteristic for their learning styles.

In the last few years we can see a gradual individualization of study not only in distance forms of study but also with full-time study students. Instructional supports, namely those of e-learning, should take this trend into account and adapt the educational processes to individual students' qualities. The present learning management systems (LMS) offers this possibility only to a very limited extent. This paper deals with a design of intelligent virtual tutor behavior, which would adapt its learning ability to both static and dynamically changing student's qualities. Virtual tutor, in order to manage all that, has to have a sufficiently rich supply of different styles and forms of teaching, with enough information about styles of learning, kinds of memory and other student's qualities.

This paper describes a draft adaptive education model and the results of the first part of the solution – definition of learning styles, pilot testing on students and an outline of further research.

Key Words

e-learning, learning styles, study materials, learning management system, multimedia

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Introduction

Motivation for this research in the area is to improve the effectiveness of electronic education. We try to extend the theory of pedagogy and education by designing a theoretical model of individualized adaptable education. We also aim to design an effective methodology of creating adaptive study material to be used in this theoretical model (Bober, 2007).

E-learning in the wider sense means an educational process. It describes and resolves the creation, distribution, management of education and feedback on the basis of electronic courses ("e-courses").

From classic education we know that teaching large numbers of students at once in school slows down and bores some of the students and for others on the contrary it is too fast and they cannot keep up with understanding everything. Other students although satisfied with the pace of the education process may not be satisfied with the educating style of every teacher. They thus close themselves to certain subjects and their results get needlessly worse. (Barker, 2005; Brusilovsky, 1996)

These are all reasons why the need for individualization of education is in the interest of optimizing the learning process of every student. This means teaching each student to match his/her knowledge achieved so far, skills and learning style. We easily realize that it is not possible to teach every student individually in class. In the time of e-learning, internet, SW tools and HW technologies available however, it is no problem to implement such teaching by means of a computer. In technical terms, the computer is capable of presenting information in many ways integrating the actual "counting", working with text, images, sound, and video. It can manage everything, record it, maintain statistics and analyze.

There just remains to design a suitable theoretical model of individualized adaptable education and its implementation.

Adaptive learning

"A learning environment is considered adaptive if it is capable of: monitoring the activities of its users; interpreting these on the basis of domain-specific models; inferring user requirements and preferences out of the interpreted activities, appropriately representing these in associated models; and, finally, acting upon the available knowledge on its users and the subject matter at hand, to dynamically facilitate the learning process" (Paramythis, 2003).

Categories of adaptation in learning environments

Adaptive learning can have many forms that can be divided to following categories (Paramythis, 2003): adaptive interaction, adaptive course delivery, content discovery and assembly, and adaptive collaboration support.

The first category, Adaptive Interaction, adapts the user interface of the learning environment, such as colour schemes, fonts, etc. together with the structure of the user interface and the order of system's actions.

The second category, Adaptive Course Delivery, changes the structure and presentation of the course in a way, that suites user's characteristics and optimizes quality and time of learning. This way of adaptation involves dynamical changes in the navigation elements of the course and its structure and dynamical selection of its suitable parts.

The third category, Content Discovery and Assembly, selects the most beneficial learning material from potentially distributed sources on the basis of users known characteristic and goals.

The fourth and final category, Adaptive Collaboration Support, is focused on the communication between multiple persons and on different kinds of user collaboration. Adaptive techniques can be used to facilitate the communication and collaboration, ensure a good match between users, etc.

This paper is focused on the Adaptive Course Delivery, because other forms of adaptation resemble it in many aspects.

Adaptive hypermedia systems

Adaptive hypermedia systems build a model of the goals, preferences and knowledge of each individual user, and use this model throughout the interaction with the user, in order to adapt to the needs of that user (Brusilovsky, 2001).

In these systems two distinct areas of adaptation can be distinguished: content level adaptation or adaptive presentation and link level adaptation or adaptive navigation support. Adaptive presentation was subdivided into text adaptation and multimedia adaptation technologies; adaptive navigation support was subdivided into link hiding, sorting, annotation, direct guidance, and hypertext map adaptation. Text adaptation can be refined further by dividing it into two essentially different groups: canned text adaptation and natural language adaptation. The main ways of canned text adaptation can now be considered as adaptation technologies: inserting/removing fragments, altering fragments, sorting fragments, and dimming fragments. Adaptation of modality is a high-level content adaptation technology. Modern adaptive hypermedia systems may have a choice of different types of media with which to present information to the user; that is, in addition to traditional text, we can also use music, video, speech, animation, and so on. Quite often fragments of different media present the same content and hence the system can choose the one that is most relevant to the user at the given node. In other cases, these fragments can be used in parallel, thus enabling the system to choose the most relevant subset of media items (Brusilovsky, 2001).

In further described adaptation of teaching process many techniques of adaptive hypermedia systems are used.

Material and Methods

The principle of the adaptive environment creation – module development

Education process employing computers has been applied for a long time. In most general terms it means the use of the internet environment together with the learning management system (LMS) involving education supports, followed by functions for education management and finally, the information system which registers students and monitors their activities and results. (Kostolányová, 2010)

Our goal is to create adaptive e-learning environment – an environment in which student learns through directed self-study. If the student learns through self-study, usually uses textbooks. A good textbook should contain optimal explanatory procedure in terms of scope and detail of the information presented. Classic textbooks supplement direct teachers reading. Textbooks intended to self-study should replace both new learning interpretation and communication with a teacher, learning practicing, etc. Therefore, these books are adequately and appropriately supplemented with didactic presentation elements and elements for self-testing and feedback control.

Adaptive system which is able to respect the diversity of users cannot be anonymous (Šarmanová, 2009). Collection of data

about students will be implemented in several phases. The most important part is the students' self-assessment, i.e. testing before entering the course. The results of this testing will be classified as statically identified parameters. The second type of students testing during the study course (testing is included as dynamic - changing characteristics, crucial for the adjustment of the proposed course route). (Kostolányová, 2010)

The adaptive education system has three basic modules: Student, Author and Virtual Teacher.

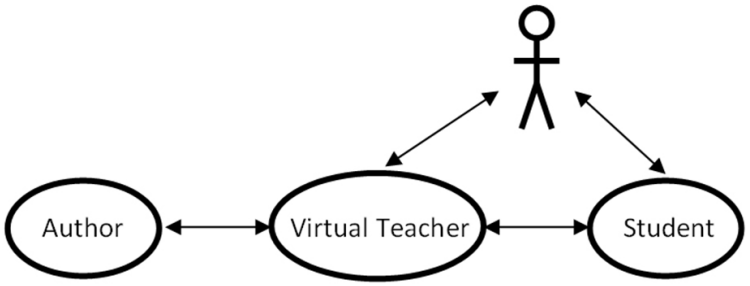

Figure 1 – Basic modules of adaptive education system

The Student Module contains, aside from personal attributes of students, records of their characteristics determining the learning style of each student. The Author Module is to store learning supports in such a manner as to allow selection or creation of different variations of educational procedures, easily handled in the form of e-learning and corresponding with the ascertained students' characteristics.

The Virtual Teacher Module is represented by a system of adaptive algorithms, which, on the basis of the knowledge of the individual type of student, selects the optimum study materials and the optimum teaching style for the student. All modules will be applied in a newly designed and implemented adaptive LMS.

The intelligent education software, adjusting to the individual characteristics of the student, must be capable of substituting a good, experienced teacher in maximum measure, i.e.:

- recognize and record personal characteristics and learning style of the student,
- teaching supports must be structured in such a way that it would be possible to manipulate them based on the student's needs,
- teach the student according to his/her learning style in the corresponding form and procedure,
- regularly check correct understanding of the educational content and test the skills that the students have attained,
- evaluate the long-term results and derive consequences for the next teaching method from them,
- enable various forms of communication of students and tutors,
- maintain necessary records on students, subjects, and teachers.

The first five of these points will be the main objects of our interest, whereas the others are common, routine functions of LMS.

If we include concerned persons and ongoing processes to the former scheme of modules of adaptive education system, we get the theoretical model of adaptive e-learning.

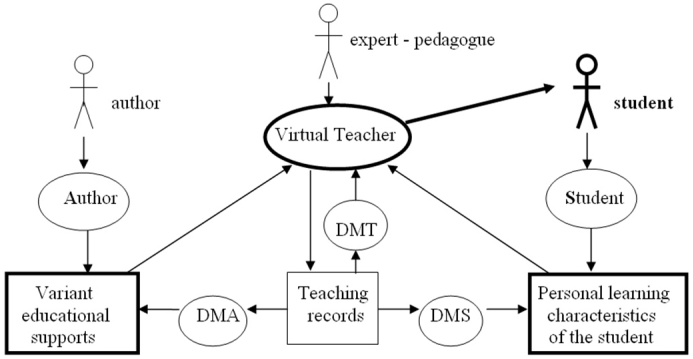

Figure 2 – Theoretical model of adaptive e-learning

DMT = DataMining towards the Teacher, DMA = DataMining towards the Author, DMS = DataMining towards the Student
Teaching records = a protocol of studies, an information database for feedback realization towards the Author, Teacher and Student.

Based on identified personalized approach to learning, optimal variant of passing the e-course will be generated. The user will also be allowed to choose tailored study materials according to his/her actual disposition and level of knowledge. This optimal path will be proposed at the beginning of the static student characteristics which we obtain with initial student's testing with the initial questionnaire. It will be modified subsequently according to the data (dynamic properties) recorded to the protocol during the student's studies (Šarmanová, 2010).

Module student – the student is the target person

Each person is an individual from many points of view. We can divide his/her qualities to each person's qualities, continuous knowledge, the circumstances of study, dynamic qualities, etc.

- They have different levels of aptitude for different subjects;
- They have different levels of knowledge of currently studied subjects;
- They have different learning styles;
- They have different kinds of memory;
- They require different levels of knowledge, understanding, the use and application of the gained knowledge;
- They have different motives for learning, different family backgrounds, different habits of how and when to learn;
- They concentrate and tire in different ways, etc. (Takács, 2009).

To enable the learning management system to react on different students' personalities, we have to choose, describe and suitably store the student's qualities and other attributes, which influence the process of his/her learning. In the whole these qualities will be of several types from their gaining point of view. We can gain one group of qualities straight from students with the help of a suitable questionnaire, next by testing them before starting learning and the third group of qualities we gain by long time monitoring of their study activities. The third group can serve as feedback not only during the current learning, but also for the alteration of the student's qualities, possibly for monitoring of his/her development.

The most important characteristic is the student's learning style. There exists rich, previously mentioned research in this area,

and a number of characteristics are described that determine the learning style. We have performed a detailed analysis of published classified teaching styles and we have selected n-tuple characteristics, which determine the learning style according to various authors (Mareš 1998).

Our aim is to determine the minimum multiplier of characteristics (determining the learning style) that are mutually independent of each other. For new we have defined, after consultation with specialized pedagogues and psychologists, the following list of characteristics selected from publications. We will analyze their independence gradually, until a sufficient number of students, methods of statistics and data mining will be tested. We are currently testing, recording and we are using the following "static", i.e. infrequently changing characteristics:

- type of sensory perception (verbal, visual, auditive, kinaesthetic),
- emotive aspects, level of motivation to study,
- social preferences, prefers to study alone – in a pair – in a group,
- tactics of learning, including:
  - systematic manner, during study the procedure is sequential - random
  - method of compiling information by theoretical deduction – experimentation,
  - procedure of compiling information that is detailistic (from below to above from detail to whole) - holistic (from above down from a general overview to details),
  - the concept of depth – strategic – surface study,
  - auto-regulation, level of capability to manage alone his/her study.

During the course of study a "dynamic" quality is recorded. The "level of comprehension" of taught material is recorded as well. Records are kept for each taught subject independently and they are regularly amended according to current student's answers to questions and assigned tasks.

There exists another theory about types of intelligence; H. Gardner has described nine types. Each field requires a different type of intelligence, and possibly does not require certain others. This information should be recognized in the future, and recorded and accepted during the education process as well (Gardner, 1999).

Another important factor of the education process is the student's initial knowledge necessary for studying new material. For this it is necessary to test the student and this test is already a part of intelligent educational support.

Finally it is necessary to record the course of study of each student, a record made per subject, chapter, and paragraph – about completing their studying, verification of knowledge and quality of result, or about retesting for verifying the resilience of attained knowledge.

All described characteristics data are available to the virtual teacher, which selects the optimum educational style of each student according to these characteristics. (Šarmanová, 2010)

Testing and data analysis of individual learning styles

It would not be useful to theoretically define n-tuple characteristics if we did not know how to determine them for each student. For this it is possible to use a questionnaire, by which students directly describe their characteristics, or appropriate

tests where the students answers a series of questions and a result is determined from the combinations of their answers. We used the combination of published questionnaires VARK, LSI, ILS, TSI, ASSIST, or part thereof, concerning e-learning education (Dunn, 2004; Entwistle, 1996, Felder 2009, Gregorc, 1979, Mares, 1993).

The data analyses were performed on the results attained through this group of questionnaires. The reason was to verify the technical capabilities of analyses and the type of possible results, which will be useful for further development of questionnaires. The questionnaire was conceived so that we would distinguish the answers of secondary school students and university students. We thought that analysis will predict "virtual students" - typical representative of the groups of students. But the analysis didn't discover any significant groups, only number of isolated students.

The first aim was to ascertain possible correlations between defined characteristics and in consequence of this, to decrease the number of characteristics without limiting the scope of resulting information. A factor analysis was used for this. Another aim was, with the help of a cluster analysis, to gain information on the distribution of theoretically possible combinations of characteristics in the actual student population. It would thereby be possible to limit realistic learning styles to a lower number. Finally with the help of designing a decision tree it was researched which characteristics we may consider predictive, i.e. such that on the basis of their knowledge we may predict other characteristics of the given student. (Šarmanová, 2010).

For the future testing a new questionnaire that is tailored to the properties picked by us to characterize the students learning style has been created. Collecting of data by means of this new questionnaire will begin in February 2011.

Module author - Instructional supports and their forms

Source training material is of course necessary for learning. We have already mentioned that for the realization of intelligent education it is not possible to use any textbook or any other source – encyclopaedias, monographs, the Internet data sources. What is more, good distance learning from textbooks in classical way is not sufficient.

The learning management program (=virtual tutor) in order to be able to adapt to different students' personalities, must process the curriculum in many different ways – the same way the experienced tutor reacts on different levels of knowledge, different talents and approaches to study, reactions, habits, and other qualities of every student.

Curriculum is best presented to a student in structured form – subject is divided into chapters, sub-chapters, and paragraphs. Let's call the smallest complete part, a presenting unit of information, the frame. Factually, the frame is equal, for example, to a newly introduced term (motivation for its introduction, a definition, an explanation, an application, an example, testing questions and tasks to solve). Formally, the frame is the text of the lowest level of numbered or in other ways marked paragraphs, or one Internet page including relevant multimedia elements.

To students with abstract thinking and a good theoretical background, it would be effective to present curriculum in a different way than to students, who for good understanding need to try everything first, understand its meaning and importance of this new information and only then they will be prepared to accept the given theory. Similarly it would be suitable to present

the frame in a different form to students who prefer written text; differently to students with acoustic memory, differently to those with optical memory etc. Finally the same frame can be presented on differently detailed levels for different subjects (or for different levels of required knowledge for gaining different marking) (Kolb, 1984, Sternberg, 1999).

We will now focus on the elaboration of the smallest part of study text – frame.

The basic difference in the form of the support will be based on the type of student's **sensory perception**. Therefore each framework will have sensory **variations:** one with high level of text (for verbal type of students), with many pictures, graphs, tables, and animations (for the visual type), spoken words, audio recordings, communications, discussions (for auditive type) and creative tasks, designs, etc. (for kinaesthetic type).

A different division of variations will be based on concepts of students' approach – depth, strategic, superficial or based on the level of comprehension. Every teacher knows this: some students need only the standard explanation, others need to be explained the material more slowly, in greater detail, with more examples. And for still others, in an effort to keep them from being bored, it is advantageous on the contrary to make available a greater scope of information, correlations to a different problematic. We distinguish these explanatory variations as the so-called **depth** of explanation. Each of them may be in various sensory variations as mentioned above.

But still a series of other characteristics influence the learning style. It is not possible to propagate more and more variations. But let's consider in what way the explanation for these further characteristics differs.

The theoretically well-prepared study type would prefer the ordinary classic explanation in the order of explanation (theory – exposition – examples) – verification (control questions – assignments). The unmotivated student would first need motivation to study perhaps for instance by means of motivational practical resolved examples – followed by explanation of the principles of resolution – only then theory – control exercises. The student incapable of self-regulation would need a detailed guide, leadership towards what to study or do first, what next. The holistic student would first need a brief overview of the entire chapter, and only then gradual movement into more detailed information.

Notice that the explanation for all examples of various types of students differs mainly in the **order** of segmented parts of the explanation within each variation. We call these segmented parts **layers** of variations and we then perform an analysis of the types of appearing layers.

The elementary information of the framework corresponds for example to a newly introduced concept, and may contain parts containing motivation for its introduction, definition, the explanation of the used concepts, the fixation of new concepts by giving them context, their application as examples of use, verifying test questions and tasks to be resolved. According to the named parts, we introduced layers entitled Motivational, Theoretical, Semantic, Fixating, Practical, Questioning, and Tasking. Aside from this, the text book was to contain organizational pedagogical information; this can be found in the Navigational layer.

The author of the support must elaborate all variations of the framework and divide them into layers. It is many times more difficult work than compiling a distance textbook. The author must be experienced and creative, capable of putting himself/

herself in the place of various types of students. Of course the sensory variations are only a technological problem, and perhaps under a different title, the content of the depth variations is applied by skilled textbook authors. There remains the division into layers, and this will present no challenge to an experienced author.

Educational supports compiled and structurally imbedded in this way enable flexible changing of the style of education.

Module of adaptation – the virtual teacher and its teaching style

We know the characteristics of the current student and we know his learning style. We have prepared study material in many variants of explanation, tests and tasks layers. What awaits us now is one of the most difficult tasks - to develop rules for assigning appropriate study material to the students with identified learning styles.

Again, those rules should be formulated and tuned by experts and specialist, and an experienced pedagogue and a 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 of his/her activities: time spent over individual frameworks, a necessity of using different optimum frameworks than those selected, asking for next, more detailed reading or other examples and of course, correctly answered control questions. Following analysis of the whole process of learning the adaptive algorithm should respond to all of this information in the course of learning with possible change of student's characteristics.

For the sake of ensuring 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 journaling of student activities and self-reflection. We will learn about them from testing in the course of study. Results of testing will suggest, if the student managed the subject matter or failed, how content he/she is with the proposed course of study, etc. Based on monitoring of those dynamic characteristics a good adaptive algorithm can possibly change the method of presentation, for example by offering a different explanation or other method of practising. However, we should keep on targeting – leading the student to the defined target status of the knowledge of the content of study. (Kostolányová, 2010)

Results

The subsystems Student and Author are currently theoretically resolved on the described level, and the subsystem Virtual Teacher is mostly resolved. Work is being performed on the Virtual Teacher on ambiguous and conflicting situations upon designs of the student learning styles and also on the theoretical model of the protocol and its analysis. Theoretically resolved subsystems have also been implemented. To implement the entire system, the original learning management system (LMS) Barborka was chosen, which has been resolved for a long period of time and is applied at the project partner school, at VŠB-TU Ostrava [Ostrava Technical University]. Its version Barborka 3 provides the mentioned expansion of the subsystems Student and Author and the new subsystem Virtual Teacher, enabling adaptable education.

Results of the Analysis of learning styles

Results of the analysis were published in (Kostolányová, 2010; Takács, 2009). Three hundred-fifty students (32.5% men, 67.5% women) filled in the questionnaire, 23% of which being high school students and the rest university students in various fields of study – pedagogy (59%), informatics (11%), economics (5%), and natural sciences (2%). These results will be now only described by the methods of their having been obtained. Interpretation and consequences of these results will be discussed in a following part of the paper.

Main components

Analysis of main components discovered that the number of mutually exclusive components that represent the results of the questionnaires (in other words the characteristics of the students, see table 1) was three times higher than the number of main components describing the answers to the questionnaires (see table 2).

component name	variability	cumulative variability
PC 1	0.197	0.197
PC 2	0.119	0.316
PC 3	0.092	0.408
...	...	...
PC 26	0.008	0.987
PC 27	0.007	0.995
PC 28	0.005	1

Table 1 – Main components of the student`s characteristics

název komponenty	variabilita	kumulativní variabilita
PC 1	0.067	0.067
PC 2	0.046	0.113
PC 3	0.035	0.148
...	...	...
PC 72	0.004	0.893
PC 73	0.004	0.897
PC 74	0.004	0.900

Table 2 – Main components of the answers to the questionnaires

Analysis of the main components of the sensual types confirmed, that individual sensual types together form the component of multi-modal type.

It has been shown, that the resulting characteristics were mutually dependent. Out of the original 28 characteristics only 18 main components would have be enough to cover the variability of the majority of data (Takács, 2010).

Decision trees analysis

The most interesting results were found in sensual types. The auditive types of students depend strongly on the fact, whether the students are multimodal types or not. If so, then such students are mostly auditive types as well. The same result also came up in visual and verbal types of students. Regarding the kinaesthetic type, the dependency came up slightly differently as shown in Figure 3. We can see, that majority of students (95%) that are multimodal types are also the kinaesthetic types. And every student that is not multimodal is kinaesthetic.

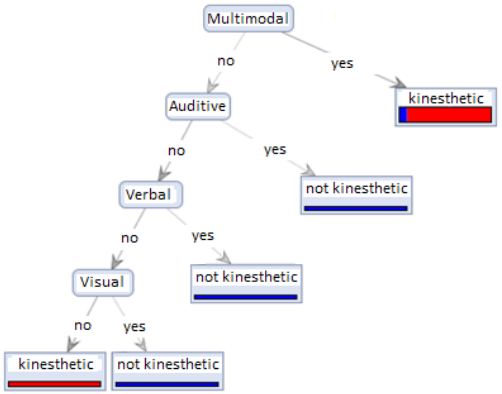

Figure 3 – Decision tree for kinesthetic type

Also a surprising result was the fact which indicated that the students, who exhibit lower responsibility to their studies, prefer to learn with classmates on the contrary to those more responsible.

Furthermore, the influence of student characteristics on their self-assessment was investigated and the results showed that the major influence on positive self-assessment comes from good organization of learning, above all (Šarmanová, 2010).

Cluster analysis

The cluster analysis of all characteristics showed no significant clusters, only a certain quantity of isolated points. Figure 4 shows a clustering tree, so-called dendrogram, illustrating numbers of clusters for individual levels of similarity. Individual students are visualized as horizontal lines, which are at certain levels of similarity connected with vertical lines to clusters. The most significant level of similarities is indicated with a bold line on the upper axis. At this level, only a single sufficiently large cluster appears which includes students with a single common characteristic: the auditive type of sensation.

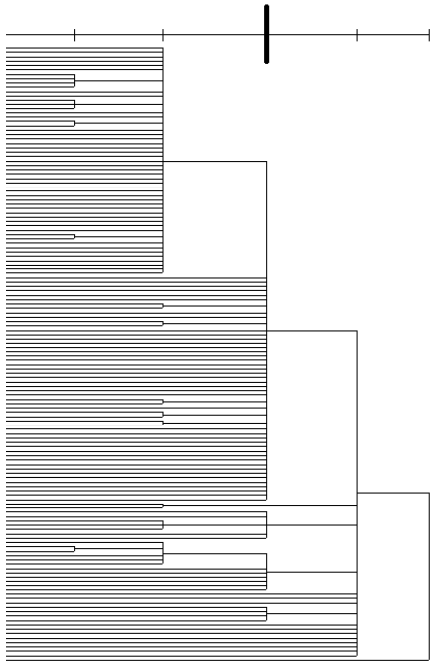

Figure 4 – Clustering tree, so called *dendrogram*, illustrating numbers of clusters for individual levels of similarity

Results on the high-school students group

Further, there is a description of differences in the results of the all students´ analysis (i.e. of the university students of different

majors and the high-school students) and of the just high-school students´ analysis results.

The number of main components detected from the selected answers by the students differed significantly. When analysing the high-school students, the number of main components was half compared to the number of all students' main components.

Out of 28 decision trees, only 5 were slightly similar, and this similarity may be coincidental. The difference is not very surprising, as the majority of results issued by both groups were not very definite and the probability of their general validity was very low. We will describe only the two most interesting differences of two characteristics – the sensual type and the student self-assessment.

When analyzing the sensual types of all-student-group we came to a conclusion that all sensual types are most dependent on the main component called multimodal type, which represents students with more than one sensual type. This dependence applies also to the high-school students, however in the lower scope, especially for visual and verbal type, and therefore the decision trees resulted differently for them.

The self-assessment of the all-student-group is most influenced by their ability to organize their studies, but especially for the high school students, the rate of personal responsibility to their studies bears far higher influence.

Discussion

The results were only crude due to small size of the data and low quality of the data sources. But the main goal of the analysis, verification of methods of analysis and their possibilities, was achieved.

Based on the results of the analysis we can say that:

- The combination of questions from the applied questionnaires is not ideal, because it is too large in size; even though each of the questionnaires was assessed as good and questions not concerning e-learning education were removed, filling out the questionnaire took a very long time and many students answered with diminished levels of concentration. It will be ideal to compile a new questionnaire, made to match the required attributes.
- Methods chosen for analysis of queried data showed to be successful, even though the conclusions from the current data-set may not be considered as sufficiently reliable.

Main components

We presumed that the main components representing the answers would correspond to the evaluated student characteristics proposed by the authors of the questionnaires. But the number of main components turned out to be very different. This significant difference between the numbers of components can be explained by either an inaccurate design of the questionnaires or them being poorly responded to. Considering the fact that the students were not motivated enough to respond to the questionnaire in serious manner and the questionnaires having been individually verified beforehand, we are inclined to think the irresponsible answers to be the reason.

We also found out that the number of student characteristics is greater than the number of their main components. As a result the number of characteristics describing a student could be reduced to the found main components, but the interpretation of such new characteristics would not be explicit. Therefore, it is more suitable to maintain the original characteristics. The reason for this independency of student characteristics may be

the fact that those characteristics arise from several different questionnaires which aim at various groups of characteristics.

Decision tree analysis

Results of the sensual type analysis have been confirmed by the analysis of main components, resulting in the multimodal type as the main component, as well as the decision tree analysis. Based on the kinaesthetic type decision tree it appears that for this data the kinaesthetic sensual type can be completely left out and substituted with the remaining sensual types, multimodal and visual in particular. Additionally, this result is greatly supported, which indicates that the same result could appear even in different data.

Cluster analysis

Results of this analysis suggest that there are no groups of students who would be similar in the majority of characteristics, which can indicate the fact that students are covering the space of all characteristics evenly. But it can also be a result of a small quantity of data related to the number of characteristics, an inaccurate design of the questionnaires, their improper translation or student's poor concentration when responding to large-scale questionnaires.

Results of the high school students group

Great difference of the results of the high school students group analysis can be explained by the high-school students responding to the questionnaires more thoroughly and with greater understanding of the questions than the university students. Still, they were very far from the ideal completion of the questionnaires, which can mean an inaccurate composition of the questionnaires.

The difference in what affects the self-assessment of students can be explained by the fact that high school students follow a tight learning schedule they have to adapt to and therefore, the ability to organize their studies plays less important role than it does at a university (Kostolányová, 2010).

Conclusion

We have described a theoretical model of individualized adaptable education enabling to teach students with regard to their learning styles. From the described principles of intelligent teaching it is clear that it is an extensive project requiring cooperation of several types of experts. In this brief overview of the entire system of individualized education, a number of partial and relating problems, both theoretical and practical, have not been mentioned. Some of them are only named in this project, whereas others are being or have already been resolved.

At the beginning of next year, 2011, the adaptable version of the system will undergo pilot testing on students.

In order to run the testing, it is of course necessary to have educational material elaborated into variations in the described manner. The system development is ongoing in parallel on creation of educational materials. The authors are also supported by the aforementioned ESF project. For the creation of educational supports, several subjects from various fields were chosen: computer science, foreign language, natural science, social science, and technical field. It will thus be possible to test both the aptness of proposed theoretical principles of the structure of educational supports for various types of subjects, and their usefulness for adaptive education. We also want to use the experience gathered within the process of preparing

adaptive educational materials to create methodology for effective creation of adaptive study materials.

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