Teaching algorithm in adaptive e-learning

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ABSTRACT. Paper deals with teaching methods and teaching styles of teachers, which can be used in electronic form of education. By electronic form of learning we mean individual electronic education, where electronic education and individualization merge. This type of electronic education is controlled by learning management software system - Virtual teacher. The principle of Virtual teacher is as follows. Based on detected individual learning style of student, Virtual teacher optimizes education to student's needs. Virtual teacher contains an extensive database of different learning styles, attributes of students and methodologies of creation of adaptive learning materials. The aim of this paper is the use of teaching methods and teaching styles of teachers, which Virtual teacher applies during individual student's learning. For the student learning via this adaptive form is more effective and beneficial.

KEYWORDS: Algorithm, Optimal style of education, Teaching methods, Teaching style of teacher, Virtual teacher

Introduction

Information and communication technologies are an essential part of today's modern time. E-learning teaching is moving forward at all types of universities, secondary schools as well as primary schools. E-learning may be used in many ways. The main idea of learning management systems is that the computer is able to translate information and display them in many different ways and all activities carried out by a student are logged. The benefits of LMS include a comfortable modification of electronic textbooks, the possibility to compose multimedia elements in electronic materials, compatible use of LMS/LCMS with the space and time and an immediate feedback. Teaching through e-learning has many advantages, however this teaching does not adjust to student's learning characteristics - according to which they would be able to study better, more effectively or economically - and neither it

respects student's studying style.

If the LMS considers the student as an individuality, the teaching support should vary for different types of students. In case the teaching reacts to the student's learning characteristics we call it individual adaptive teaching. This means making the teaching process more effective with the help of adaptive e-learning teaching. Adaptive teaching should be visible at two levels: the fast gaining of new knowledge by students and a more natural way of studying for them, based on the respect of individual characteristic and students' preferences. The optimal adaptive process should respect the students' differences based on their learning style and their evolving knowledge and skills during the studies in a course. Depending on the identification of personal characteristics and qualities, students will be presented with studying material as suitable for them as possible. The adaptive form of teaching is an area nowadays often talked about, however not quite fully explored and practically not yet realized as form of teaching.

Adaptive model of teaching

Adaptive model of e-learning teaching can be seen in Figure 1. Theoretical adaptive model of teaching. The system consists of 3 parts: Student module, Author module and Virtual teacher module. Before the start of every learning process, the student is tested and their learning style is identified. A set of student's characteristics that influence teaching style was defined from thorough research. Experts for this specific issue have created an optimal questionnaire through which a student's learning style is identified based on students' characteristics. This process is usually carried out in the Student module (SM) (right). More information in the publication by K. Kostolányová (2009 and 2011).

Figure 1. Theoretical adaptive
model of teaching
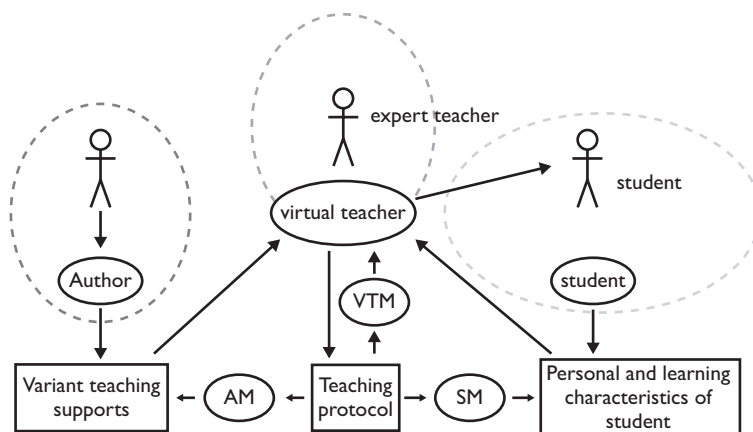
The Author module (AM) (left) is about storing and modification
of teaching supports into created author database. The author
database includes teaching textbooks, images, multimedia, metadata
etc. In the metadata we can find out everything needed for specific
teaching support. In that we find information about a definition or
motivation of a student, the task itself, test questions, etc.

The Virtual teacher module (VTM) (in the middle) is the most
difficult model of the whole system. The virtual teacher must
have all necessary information about a student, a specific teaching
support structure, a selected teaching method, teacher's teaching
style and, based on this information, it builds the optimal way of
teaching. This way of teaching process is not fixed; it does not
always need to be optimally designed. In case the student is not
happy with the way of teaching they may control it and manage
singular parts of teaching themselves.

The Virtual teacher registers all tasks a student carries out
throughout the learning process in a protocol. The protocol includes
time spent on every part of teaching support, managed transitions
to other parts of teaching support, switches from the original way
of teaching by the virtual teacher, time spent on thinking about an
answer, time spent on solving specific tasks, etc.

The Virtual teacher model has the following functions:

- find a teaching style (TS) for a specific student: based on a
  found teaching style the virtual teacher assigns to a student
  a personal teaching style (PTS) that will meet the student's

characteristics and needs,
- apply PTS on a current lesson: set up actual teaching style (ATS) which gives the student a framework from which they choose individual layers, depth and a sensory form,
- level of adaptation (managing system reactions to incorrect answers): in the teaching process it is possible to adapt the teaching at several levels:
    - Immediate reaction to an incorrect answer – the virtual teacher solves this.
    - Long-term reaction to frequent incorrect answers more detailed interpretation will be used.
    - Based on the analysis of the protocol about the teaching process rules which do not work are found, and their correction is recommended.
- Logging of the teaching process - it is to verify that the rules were suitably created. This process takes place in the teaching and every lesson is logged. The protocol analysis about the actual process of the teaching is the feedback, the verification of accuracy of the rules. The protocol structure consists of the student identification, teaching materials and student's activities.

Student module

After extensive analysis of pedagogical information sources have been carried out, attributes, which define learning style of student, influential in e-learning form of education, have been found. After consultations with teachers and psychologists we divided these attributes into the following groups with values:

- *sensory perception*: verbal - visual - auditory - kinesthetic
- *social aspects*: likes to work alone - in a pair - in a group
- *affective aspects*: internal motivation to study, external
- *learning tactics*:
    - systematics with values: preferred order
    - freedom
    - methods with options: theoretical derivation
    - experimentation
    - approach with options: analytical - holistic

- tactics with options: deep - strategic - surface
- *autoregulation with values*: works according to the guidelines - separately.

In order to work with these attributes scientifically we need to identify them and introduce a scale for their measurement. We chose a scale for each attribute (eventually for each value). Scale ranged from < 0, 100 > or < -100, 100 >. These 13 attributes are static, dynamic one is student success. Unlike other attributes we measure success with these values:

2 = average comprehension, sufficient is normal textbook interpretation
3 = reduced comprehension with a need for slower, more detailed interpretation
1 = keen understanding, often with a need for wider, more detailed range of information

For students learning style identification a made-to-measure questionnaire is used. (Czeczotková, Kostolányová, 2013)

Teaching methods

The most detailed teaching method was defined by L. Mojžíšek (1988) as "pedagogical – specific didactic activity of teaching subject and object developing by educational pupil's profile, currently acting as educational in the sense of educational principals. It is to modify content, to simplify activities of the object and subject, to adapt sources of knowledge, procedures and techniques, to assure fixation or test knowledge and skills, learning processes, interests and attitudes". And we start from this definition.

"Teaching methods can be overviewed from different angles or considering different aspects – from the psychological, procession and phase of instruction point of view, considering the logical and organizational aspect, and according to the character of the source of information. Currently so-called activation methods come to attention, among which we include: discussions, educational games, project method,

method of experience teaching, and other.

There is a number of experts who have classified teaching methods according to different criteria. From the best well-known pedagogues dealing with the classification of teaching methods let us mention G. A. Lidner, S. Vrána, L. Mojžíšek, D. O. Lordkipanidze, E. Stračár, Z. Pešek, I. J. Lerner, M. Kořínek, J. Maňák, M. A. Danilov, B. P. Jesipov, O. Kádner, J. Hendrich, I. A. Kairov, A. Vališová, J. Valenta, I. Turek, E. J. Golant, J. I. Perovskij, B. R. Joyce, E. F. Calhounová". (Czeczotková, 2011)

Some authors have created their division of teaching methods, others based it on their predecessors or in some cases they have used the same division only with the change of word order. Based on collected teaching methods according to various authors and classification aspects we have created our own division of teaching methods.

Teaching methods according to the teaching stages in adaptive teaching (Czeczotková, Šarmanová, 2012)

1. *Motivational*: teacher makes the effort to raise students' interest in learning.
Used methods:
- motivational dialogues
- demonstration
- presentation

2. *Expositional*: teacher passes on new knowledge and expertise.
Used methods:
- methods according to the nature of the information source
- methods according to the educational perspective
- methods according to the degree and independence of a student

3. *Fixative*: students reinforce their knowledge and skills.
Used methods:
- methods according to a didactic activity
- methods according to practice, revision and tested subject

4. *Application*: gained knowledge and skills are put into practice.

5. *Diagnostic*: the judgment of students' knowledge and skills occurs.
Used methods:
- methods to find out diagnostic information
- small forms of scientific research on diagnostic methods
- special pedagogical diagnostic methods

For every teaching stage we have assigned teaching methods that may be used for adaptive e-learning teaching. See an example of teaching methods according to one stage of teaching.

Stage of teaching

⇩

Expositional

⇩

Teaching method

⇩

Methods according to the nature of information source

Methods according to the nature of information source

1. Verbal methods: monologic lecture, presentation, narration, explanation, description, deduction.
2. Writing methods: assignment, written exercises, composition, quarterly and semi-annual thesis, graphical work.
3. Book learning methods: self-study using books, work with a book, with text material, and with electronic study material.
4. Observing objects methods (demonstrative): observation of pictures, films, objects and phenomena, demonstration of pictures and objects, static demonstration, dynamic projection.
5. Practical methods: testing with evaluation, skill creation, production methods, movement and working skills, graphical and artistic skills.

Teachers' teaching styles

According to R. Dytrtová and M. Krhutová (2009) teaching style is "formed throughout pedagogical experience and for its particular holder - teachers - it is unchangeable, typical and dependant on teacher's cognitive style".

Based on the above quotation it may be said that the teaching style can be viewed as a typical way of activity in the teaching process. It is reflected in teachers' individual teaching conception as well as into their teaching approach. It is present in teachers' methodical process, in the way of work management and organization, in lessons and in teacher-student interaction.

Teachers' teaching styles may be found in a vast number of pedagogical literatures or journal articles. Many experts have dealt with teaching styles and typologies in relation to various aspects. Typology is divided by various criteria, for example by teacher's personality (C. G. Jung, H. J. Eysenck, R. B. Cattela), by their influence at school (J. Štágl), by pedagogical influence (Ch. Caselmann), by educational styles (K. Lewin, R. Lippitt, R. K. White, R. a A. M. Tausch, C. Rogers, H. H. Anderson), by the connection between pedagogical personality and the pedagogical influence (M. Brekelmans, H. Créton, J. Levy, R. Rodriguez, T. Wubbels, T. Leary), by communication style (M. Brekelmans, J. Levy, R. Rodriguez,) and others.

Teaching styles accord to the style of teaching of each teacher: autocratic, democratic, or liberal. Many experts and teachers continuously deal with this division (Ch. Caselmann, W. O. Döring, M. Brekelmansová, N. A. Flanders, J. Levy, R. Rodriguezová, T. Wubbels Z. Zaborowski, G. D. Fenstermacher, J. F. Soltis, D. G. Ryans, H. H. Anderson, K. Lewin, R. Lippit, R. K. White) and it may be found under various titles. Example:

> "Democratic style (integral, social-integral, cooperative, social, tolerant-autocratic, interactive, supervision, non-directive, facilitative).
> The teacher dictates, decides and manages students less than in the autocratic style. The teacher has a much larger overview of student´s desires and needs, of their individuality and has greater understanding for them. The effort and hard work of students is the reward for the teacher and his/her

approach (when studying results do not correspond). There is a positive emotional atmosphere in the class that helps to develop a socially mature personality of the student. The teacher prefers independence, voluntary cooperation and reasoning.

Students are encouraged to work in independent projects and initiative is supported. Students trust teachers more. The benefits mentioned in the previous styles are the ideal combination for a teaching style applicable in the electronic environment" (Czeczotková 2011)

For the virtual teacher's database of authors we have chosen only those characteristics which can be used in adaptive teaching.

Formal structure of adaptive rules

Optimal personal teaching style may be recognised from:

- learning styles
- teaching styles
- teaching methods

The algorithm for finding the optimal personal learning style:
1. filling the questionnaire by the student;
2. round to the nearest virtual student;
3. selection of learning "method" for each student attribute;
4. counting the number of learning "ways" for each student attribute;
5. organize the counts according to occurrence frequency;
6. list of "ways" of learning: recommended, additional and not recommended(B. Czeczotková, 2013)

Title	Type or characteri-stics	Sensory perception				Affective aspects			...
		Verbal	Visual	Auditive	Kines-thetic	Aversed to study	Shows no interest	...	...
Verbal method	lecture	100	100	100	X	X	- 50	...	...
	explanation	X	100	100	100	100	- 50	...	...
	...	...	...	...	...	...	...	...	...
Practical methods	Kinetic and working skills	X	100	100	100	100	- 50		
	...	...	...	...	...	...	...	...	...
Attributes VS	Focuses on detailed interpreta-tion	100	X	100	X	X	X	...	...
	...	...	...	...	...	...	...	...	...

Table 1: Analysis example Student A [20, 40, 20, 20]; [-100,0,0,0,0]; […]; …

Based on the algorithm we discover if the student is visual, has aversion to studies, etc., so the virtual teacher assigns him a "way" of lecture, explanation, kinetic and working skill, etc.

Other rules
If student desires contact with other people while learning, we assign him/her one of the verbal methods – lecture, explanation, narration, briefing, interview or chat.
If student desires schemes, charts, graphs while learning, we assign him illustrative method.
If student desires logical classification, we assign him scientifical-systematic teaching style.
This is how many rules were established for optimal teaching style. Currently, results are expected and the analysis of given rules will be carried out.

Conclusion

The article discussed adaptive teaching. In the first part of the paper we examined the adaptive model of teaching that consists of three parts: Student model, Author model, Virtual teacher model. In the third chapter, after a thorough research, our own division of teaching methods have been created according to individual stages of teaching which can be applicable in electronic teaching.

In the Teaching styles chapter individual teaching styles have been collected and their characteristics were used: those that can be incorporated into adaptive teaching. Last chapter talks about the algorithm of rules designed to set a style of teaching for students based on their individuality.

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Sintesi

Le piattaforme di Learning Management utilizzate per la formazione online si stanno evolvendo verso forme di apprendimento e insegnamento adattivo (Individual adapting teaching), che permettono di diversificare l'erogazione dei contenuti in base agli stili individuali di apprendimento. Il conseguente miglioramento delle performances di studio può essere ottenuto incrociando un repository dei diversi metodi di insegnamento con la rilevazione in itinere degli stili individuali di apprendimento degli studenti, e gestito in maniera automatica da LMS adeguatamente progettati. La ricerca in questo campo è attualmente molto vivace, sebbene non siano ancora stati definiti modelli ampiamente condivisi di applicazione.
L'università ceca di Ostrava sta sperimentando una struttura di LMS adattivo articolata in tre moduli – Student, Author, Virtual Teacher – e basata su un repository di approcci didattici, creato a partire dall'analisi dei principali modelli pedagogici conosciuti.
I primi due moduli della struttura sono finalizzati alla raccolta delle informazioni relative agli stili di apprendimento degli studenti e agli stili di insegnamento applicabili, dal modello motivazionale a quello espositivo, da quello basato sul rinforzo (fixative), a quello di tipo prettamente applicativo e basato sull'esperienza. I modelli di insegnamento previsti sono, inoltre, declinati a seconda delle informazioni da veicolare. Il modulo Virtual Teacher, fulcro innovativo del sistema, incrocia le informazioni pre-impostate in piattaforma con la rilevazione continua e in itinere delle attività degli studenti, dei tempi impiegati per svolgere un compito e dei risultati ottenuti, e assegna a ciascuno di essi un modello di erogazione personalizzato. Il sistema garantisce, tuttavia, un margine di flessibilità allo studente, che può scegliere di modificare parzialmente le opzioni del sistema associate al suo profilo.