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Differentiated and individualised teaching mathematics to students of technical universities

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***Abstract* — The article discusses the possibilities of designing the Course of Higher Mathematics, differentiated with respect to psychological types of perception, that uses computer and information technologies. According to the marked leading psychological types of perception the article analyses the content and key highlights in electronic educational resources that are being designed. The features of the Wolfram CDF Technology are meant as a tool for the implementation of this concept. The technology provides many options to design dynamic interactive online educational resources, including those that allow students to use CDF-files during the educational process differentiated with respect to psychological types of perception. The issues of individualization and, in perspective, personalization of the Course of Higher Mathematics are under review here. In this regard a blended learning model, which implies e-learning systems, is put forward. LMS Moodle is proposed to use for individualization of the course.**

***Keywords — blended learning, e-learning, electronic learning resources, Moodle, Wolfram CDF*.**

I. INTRODUCTION

Concepts of differentiation, individualization, and personalization of education are distinguished in modern pedagogics. Individualization means that students study the same material but with regard to their individual abilities and experience. Alternations in learning rate of educational material are also possible. Differentiation stands for setting out the learning process itself, that would be adjusted to personal preferences of different students. The methods and approaches of learning process here are meant to be changed. Various instructions are offered to different groups of students. Personalization assumes adaptation to the specific interests of different students. A fully personalized environment would mean that goals, content, as well as the methods and learning rate are open to be changed (therefore, personalization encompasses differentiation and individualization). [1]

One of the primary tasks of the educational system is to increase learning efficiency. In the context of this article, we would like to hit upon the aspect of designing an educational system that is based not only on the general laws of students' mental growth, but also on their individual habits of perception of information.

II. RESEARCH METHODOLOGY

The success of students during their cognitive activity directly depends on the leading psychological types of perception. Psychological studies show that the cognitive activity consists of several successive steps, the first one is considered to be the object perception step.

"Together with the process of sensory experience, perception brings about an immediate sensory orientation in the world around. Thanks to perception, the identification of objects, events, situations is carried out during recognizing. When one perceives the environment it is possible that the image they have in mind is transformed into a shape suitable for decision-making. Such transformations can help the performer implement his tasks. Thus, perception is not just a passive simulation, of immediate impact, but an active, creative process of cognition."[2]

As a form of sensuous reflection of an object perception includes:

- the object detection in the field of perception;
- the distinction between individual signs in the object;
- highlighting in it information content that is adequate to the purpose of the action;
- creating the image of perception.

In psychology, there are a number of leading representative systems in humans, which allow us to differentiate students according to the prevailing type of representative system:

- visual learners (perceive the world through visual images, pictures; their experience is built from graphic images);

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- auditory learners (perceive information via auditory channel above all; their experience is built from sound images);
- kinesthetic learners (perceive the world through feelings, sensations, and are strongly influenced by emotions; a special feature of this type is that they cannot artificially construct their experience; people of this type of perception are very emotional and receptive, they can react violently to stimuli);
- discrete learners (people with a predominance of this type of perception tend to act logically and maintain an internal dialogue; they often analyze the received data in the mind's eye).

Certainly, it should be said that these representative systems for a particular person are not of exceptional, but only prevailing. Students can carry all of the mentioned systems to a varying degree.

Let us mark out a short list of sensory characteristics that are essential in designing educational resources utilized in educational process:

- Visual: shape, color, location, movement.
- Auditory: timbre of voice, volume, temp.
- Kinesthetic: density, shape, material, location, movement.
- Discrete: internal relations, logical inference, validation.

III. RESULTS

In order to design and put into action a differentiated (with respect to the leading psychological type of perception) approach of teaching Mathematics and, in consequence, proceed to a personalized teaching, we consider electronic learning resources (ELR) helpful during the implementation of the educational process.

The study called "Your views on future education", which had been carried out by the experts from WISE organization, has shown that: "personal or working knowledge is going to be valued more than theoretical knowledge. The so-called Soft skills (capability of speaking out, team working, and adapting oneself to unforeseen events) are gaining in more and more importance at work". [3]

Speaking about education, R. Jessup has stated: "there will be such innovations as e-learning supplied with telecommunications, video and computer facility". [4]

We believe that CDF Technology, developed by Wolfram Research, stands out as one of the most efficient instruments for designing ELR. CDF-files represent a knowledge container that has a computational engine. Its key feature is the ability for dynamic mathematical computation in real time that uses the large number of capabilities of the popular computer mathematics system Wolfram Mathematica, its built-in algorithms and the processing capabilities of highly specialized data. The technology allows to realize the amazing possibilities of interactive work with any content in real-time mode.

For each of the previously mentioned leading psychological types of perception, let us highlight typical characteristics of designing learning materials in ELR:

- for visual learners: extra illustrations are required, as well as visual emphases on key elements;
- for auditory learners: a quality sound accompaniment and sound (voice) emphases that highlight key elements in the learning materials;
- for kinesthetic learners: interactive dynamic models or experiments, "materialization" of abstract concepts;
- for discrete learners: an ability of self-studying, getting priorities straight, a set of instruments to create images and models.

The Wolfram CDF-files are built in Wolfram Mathematica system, however it should be noted that there is no need to install this expensive package on the user's computer in an effort to work with the files. To work with the files one only has to install a free Wolfram CDF Player. CDF-files are easily integrated into web-pages which comes in handy. Starting with version 11, the Wolfram CDF Player has fully integrated support for sound processing, which makes it open to be actively used by auditory learners, too.

As we see, ELR usage, designed with the help of Wolfram CDF, provides each group of learners, that is being discussed here, with the most convenient way of perceiving learning materials. It brings about visualization of mathematical material (graphs of mathematical functions, equations, etc.), a possibility of setting out audio emphases and even "vocalize" mathematical facts (for instance, there are synthesisers that make music out of Pi-numbers), a possibility to carry out interactive experiments with mathematical objects aiming to evaluate their parameter reactions to the changes in the whole object, an ability to perform an independent search and information analysis based on the behavior of the model.

We believe that we should use a blended learning model, which incorporates the advantages of both the traditional learning model, as well as e-learning model, in order to individualize the Course of Mathematics. In general, in modern pedagogics there is an opinion that "blended learning is consistent with the values of traditional higher education institutions and has a proven potential to increase efficiency and productivity of meaningful educational experience" [5].

Foreign scientists give different definitions of blended learning, for example, as “a combination of technology and traditional in-class learning, based on a flexible approach to learning that takes into account the benefits of training and checking e-tasks, but also uses other methods that can improve students' results and save learning expenses" [6] or as "a combination of face-to-face learning (F2F) and calibrated learning (CAL) in a single educational space." [7]

For the purposes of designing of the blended learning we propose using of LMS Moodle platform. Despite the fact that this system is a platform for organizing e-learning, it has long been used as a means for supporting in-class training in a blended learning model [8-11 and others].

LMS platform puts forward wide options for organizing classes in mathematics. It helps to post theoretical material in various formats, including previously mentioned CDF-files

(integrated into web-pages), as well as work with TeX-format formulas; students can collaborate and form groups; it allows to organize current and final checking of efficiency and productivity using various formats (performing tests, sending typical calculations by students to the professor with the possibility of feedback, etc.).

The posting of educational material in LMS Moodle allows students to independently choose the pace and order of study material, including the possibility to return to the previously studied material. Extensive communication opportunities in the student-professor system also contribute to the individualization of the learning process. At the same time, despite the fact that all the necessary educational content is built in the system, traditional classes still have place which allows to implement the concept of Blended Learning.

Practice shows that the following blended learning models can be set up in higher education:

For intramural mode of study:

- Face-to-Face Driver – way of delivering educational material from the teacher to the students in class. The resources placed in the LMS Moodle are used only to consolidate knowledge;
- Self-blend – a traditional (full-time) way of learning of educational material. Resources and courses hosted with LMS are used if they are of increased interest;
- Online Lab- students use virtual laboratories, including Wolfram CDF-formats, where they carry out experiments and solve educational cognitive tasks under the supervision of a teacher in computer classes.

For intra-extramural mode of study:

- Rotation model – the alternation of full-time and online learning: implies a self-studying at first, using the SSO, which is followed by consolidation under the supervision of a teacher in full-time model, and vice versa.

For extramural mode of study:

- Online Driver — students master the material remotely in the SSO using all of its resources. If necessary, face-to-face consultations with the teacher can be organized.
- Flex model — the priority is given to mastering the program of the course through the SSO. In this model the teacher is supposed, rather, to be a coordinator. He must keep track of topics that are difficult to understand and master, in order to discuss them in a group or individually, when it comes to intramural model.

Cooperative usage of individualising and differentiating points, that have been discussed here, brings us to designing a personalized concept of learning process.

IV. CONCLUSIONS

Nowadays, in the system of Russian higher education there is a problem of designing personalized training courses. For the compulsory course of mathematics, we suggest using the options of its differentiation with respect to the leading psychological types of perception for which, as it seems to us, it will come in handy to use the means of information technology. To realize these options, we suggest that the Wolfram CDF technology is to be used for designing electronic educational resources that can be effectively used in the Moodle SSO, which also makes it possible to implement the principle of individualization of the mathematics course.

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