

Smart Educational Environment as a Platform for Individualized Learning Adjusted to Student's Cultural-Cognitive Profile

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Abstract In this paper, the authors attempt to describe a possibility of an individual approach to learning within multicultural electronic educational space. To solve this problem the authors proposed criteria for determining learner's cultural and cognitive profile and ways of adaptation of educational content and interface as a pre-requisite for creating "smart educational environment". An important factor in the design of educational media environment is to focus on the personal and socio-cultural approaches to learning information typical for a selected cultural group, resulting in the possibility of constructing an individual educational trajectory. The authors propose to design a prototype of "smart educational environment" whose interface and content could be adjusted to a student's cultural-cognitive profile.

Keywords International educational communication · Personal cultural-cognitive profile · Adaptation of interface

1 Introduction

Global education combines different educational systems and models, which are based on differentiated cultural, ideological, religious, philosophical, and axiological worldviews. Undoubtedly, integration processes are an integral part of globalization - the world becomes "integrated" one way or another. Formation of a unified educational space is one of the priority tasks of the near future. However, this is not an

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easy task, which is based on the dichotomy of, on the one hand, preserving national identity, and processes of cultural and educational integration, on the other. Now we can observe the transition of a number of educational processes into the online context and, as a consequence of openness, the acquisition of partially or completely multicultural principles. Of course, in a multicultural context, cultural enrichment, expansion of general and professional outlook, teachers and students face a number of problems, mainly with pragmatic reasons. Despite the processes of globalization and integration, culture of each country, anyway, is reflected in the educational process and, in many respects, its causes, which, in turn, entails the specificity of training content, values and objectives of education, teaching methods, pedagogical discourse, the specifics of building educational trajectory, etc.

Today's concept of education means lifelong learning. These processes cause the knowledge-based approach in education to be gradually replaced by competence-based one. Nowadays we can witness a number of educational processes migrating into the Internet and, consequently, their becoming more transparent and more or less multi-cultural.

Currently, a significant part of educational process transforms into online format. Obviously, in the modern Educational Environment (EEE), tutor's didactic functions will be modified, and the problem of an individual approach, motivation and commitment of student in the process of learning will rise most sharply. The learning process in the MEE is mostly auto-didactic. So it is necessary to determine the manner, in which an individual approach may be realized in EEE, where the nature of communication is predominantly mediated, before designing an individual educational trajectory. In our opinion, an individual approach in a multicultural e-Educational space will look like an adaptation of content and interface to a student's personal cultural and cognitive profile. The purpose of moderne education is to create conditions in which educational path could be formed and adjusted with the help of a trainee. We believe it is appropriate to establish the criteria for determining cultural cognitive profile of a person, in order to make possible further technical and methodical adaptation of educational content and interface. Control of knowledge and qualification boundary will be realized by "competence-based profile of students". It is also possible to create advisory service facilitating "build-up" of professional competence according to cultural-cognitive profile of an individual. To improve "cultural intelligence" of tutors, we suggest to use online cultural assimilator.

2 On Communicative and Didactic Aspects of Mapping an Individual Study Pathway in Electronic Educational Environment

It is obvious that with the application of Electronic Educational Environment (EEE) the didactic functions of a tutor will be changed, and the whole educational process will become autodidactic. And, before mapping an individual study pathway,

one must decide how this individualistic approach will be applied in EEE where there is no immediate communication between students and tutors. When studying via the information technologies, a student is supposed to develop individual learning skills and to get well acquainted with the up-to-date on-line education technologies, which means that the student's self-motivation becomes a more important factor.

A tutor's role here will be taken by the EEE itself. However, for this purpose it is necessary to select and set the criteria for running individual study process (for in-stance, a student's cultural and cognitive profile, consisting of the emotional and activities components).

Individual Study Pathway (ISP) should be mapped and adjusted through recommendation services which will suggest best suitable courses for a student and, if a student decides to take courses outside the recommended range, identify possible pitfalls. Evaluation of task and study materials in the major courses of the education path can be done similarly. Thus, the mastering of a course is supposed to follow the path best suitable for a student's information processing skills. We must also point out that this evaluation method can be applied when assessing both major and out-side-the-range courses, thus formulating recommendations for the student on how to develop their competence profile on the basis of the courses provided in the system, as well as doing those in free access. Summing it up, implementing the individual study pathway will produce a specialist's competence profile.

Developing and implementing ISP is a complex process that includes the following components: (1) Forming an individual information space. (2) Personalizing educational resources. (3) Personalizing educational objectives and finding means for their achievement. (4) Adapting educational content and interface in EEE. (5) Achieving synergy effect through combining individual reflection and self-organization capacities.

In order to develop custom approach in education for an electronic education platform it is necessary to set several modules (stages) for composition of most optimal model of education for each student. In the first stage of interaction with digital educational platform, it would be most appropriate to conduct criterion-oriented test, which would not only determine cultural-cognitive profile, but also collect information about other basic characteristics, such as: motivation, educational back-ground, informational and communication technology skills, professional interests. However, it is necessary to take into consideration the possible dynamic nature of before mentioned variables. It would be rational to retest an individual periodically, and make corrections to the selected education course. Collected information should be used to compose custom courses with most appropriate educational method selected for each student.

As for didactic functions of EEE we would like to point out a possibility for a student to "teach" the system. One variant of such system is when intellectual component of system analyses both collected data from conducted tests and student's reflections about courses he/she has completed. If necessary, it amends selected educational strategy based on analysis results. Further aggregation of statistical parameters in database will allow to perceive various trends. Moreover, accumulated data would be used in the process of tailoring education experience to

new students in the earliest phases of customization. In other words, it would be used in the stage of adaption of learning method and content with a consideration of peculiarities of cultural cognitive profile of a student. We assume that educational content in EEE would be presented according to personal output rules, formed by cultural cognitive profile of students.

Principles of Personal Cultural-Cognitive Profile Design. In our opinion educational activities consist of operational and cognitive components. In order to describe cross-cultural differences we have to consider cultural models by G. Hofstede [6], R. Nisbett [9], E. Hall [5], M. Kholodnaya [7] etc. [1, 3, 4, 8, 18, 19].

We can define a number of the following parameters, underlying analysis of the culture-related aspects of behavior, mentality, activity and determining specificity of cultural-cognitive personality profile (Fig. 1): specific nature of activity; specific features of information representation; specific features of mentality and attention; specific features of social communications; dominant values.

	COGNITIVE STYLE	Reflexive	Blended	Impulsive
Cognitive parameters	Specifics of working with information	<i>Attention to context: Hi</i> <i>Information structure: trees</i> <i>Type of thinking: holistic</i>	<i>Information structure:</i> blocks with a surface bond	<i>Attention to context: Low</i> <i>Information structure:</i> systematically organized by atomic units <i>Type of thinking: analytical</i>
	Attention specifics	Attention to «a frame»	Attention to objects into a frame. Frame plays linkage function	Attention to objects
	Decision-making specifics	Orientation to the authoritative opinion, the inclusion of others in the decision-making process, uncertainly avoidance	Orientation to the free choice of a permitted framework of society	Orientation to their own opinion, loyalty to the uncertainty
	Creativity specifics	Interpretation within the existing tradition	Creating a new, more advanced in framework of tradition	Innovativeness
Contextual parameters	Discourse specifics	Unity with collective, maintaining harmony	Variability	Expression of individuality
	Relation to the rules	Universalism	Variability	Particularism
	Relation to code of conduct	Closeness	Variability	Openness
Activity-related parameters	Specifics of activity	Reactive	Polyactive	Monoactive
	Relation to time	Time – nonlinear value (Cyclical)	Understanding the limitations of time as a resource. Cost of time: Low	Time – linear value. Cost of time: High
	Attitude to society	<i>Type of culture: collectivist</i> <i>Power distance: high</i>	<i>Type of culture:</i> hierarchical structure <i>Power distance: average</i>	<i>Type of culture:</i> individualism <i>Power distance: low</i>
	Status specifics	Significance of the origin	Depends on the situation	Significance of personal achievement
	Specifics of communication	<i>Attention to context: high</i> <i>Style of communication:</i> branched argument. <i>Reasoning: deduction</i> <i>Genre: narrative</i>	<i>Attention to context: average</i> <i>Style of communication: mixed</i> <i>Reasoning: intuitive</i> <i>Genre: mixed</i>	<i>Attention to context: low</i> <i>Style of communication:</i> cognitive, linear reasoning based on facts. <i>Reasoning: induction</i> <i>Genre: discussions and debates</i>

Fig. 1 Basic parameters of cultural-cognitive personality profile design

In fact, advanced “cultural intelligence” is an important component of adaptive educational process [14, 15]. Teacher with mature “cultural intelligence” will be able to identify cultural-cognitive profile of person and find appropriate communication strategy, and in case of strategic planning - an individual approach to education with suitable methods and training materials. Since we consider mainly the educational processes of e-learning environment, we are also interested particularly in those possessing “cultural intelligence.” In our opinion, e-learning environment with “cultural intelligence” will enable adaptation of interface and educational content to a cultural-cognitive profile of the individual.

3 Models and Techniques of Interactive Didactic Support of Learners in Virtual Learning Environment

Support of modeling individual educational trajectory is mainly aimed at forming an environment for mapping a personal success as professional fulfillment through the following [16]:

- Forming virtual educational space which interlinks off-line courses, off-line events and on-line materials and events, generated by active experts and practitioners.
- Tutor’s support in forming a specialty’s competence profile and modeling the labour market.
- Forming a student’s competence profile and modeling this profile on the basis of targeted preferences.
- Personalizing the educational environment and content.

The major service function for each user or participant group (Fig. 2) in the active learning process is to form a virtual educational environment as a system of interrelated study courses through interlinked competence profiles of the courses and important events both for a university campus, and for online experts in a course’s field of application [15].

3.1 Basic Models for Realizing The «Smart Tutor» Service

Model of educational program, $MK_p(U_i, K_o)$, includes a system of study courses U_i , interlinked with each other and with the specialty’s competence profile. [17]

Model of competence profile of curriculum $MK_p(U_i, K_o)$ includes: (1) Model of relations between courses U_i from the perspective of mastering certain competence. In particular, for such a multidisciplinary profession as “business informatics”, oriented to prepare a range of specialists - this would be presented as a network model that can be constructed using the methods of data-mining, handling text courses.

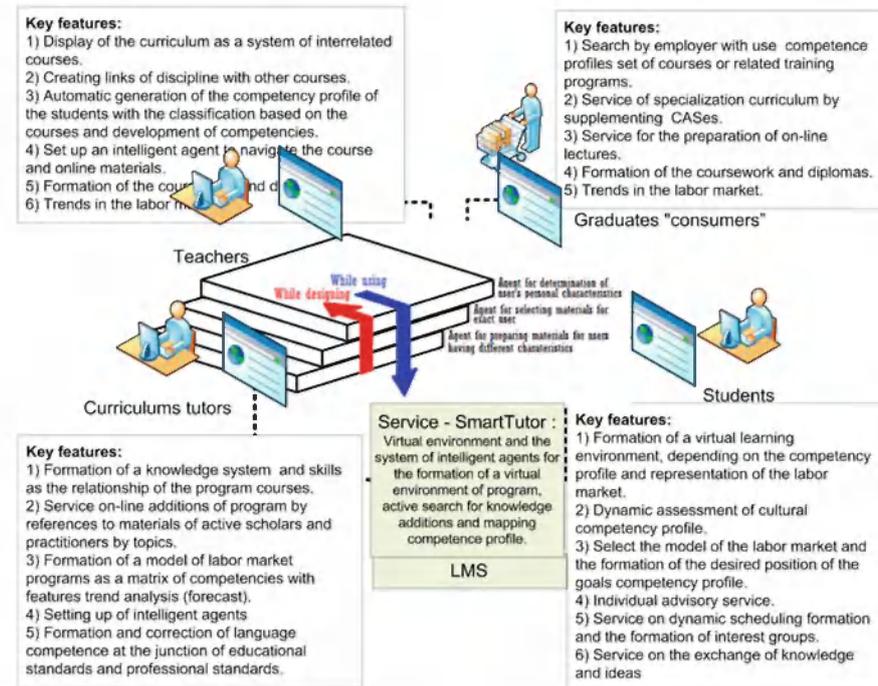


Fig. 2 Major service function for each users or participants group

(2) Model of accumulation of amount and quality of competences in relation to each of the possible specialization of labor market of a particular course; (3) Model of competence profile of curriculum U_i is a model of the relationship between knowledge, skills obtained and competencies. (4) Model of competence-profile of labor market of the curriculum graduates is a “summary” of competencies that determine the possibility of taking every competence on the labor market.

Accordingly, if the selection criteria of various academic disciplines are inputted, it becomes possible to receive a slice of the full set of vacancies. Specific professions on the market can be considered as a qualitative scale, which measures the level of professional success. Moreover, apart from such representation of the future professional activity of the student, we would like to implement a system that would take into account some personal parameters associated with the psychological, cognitive, communicative personality characteristics, which influence the choice of life goals.

At the same time, every study course of the program, U_i , must be represented within the three-element model of knowledge and skills, connected with the competences, K_i : knowledge and skills of the major course; additional theoretical knowledge and skills related to the course’s objectives and based on competences, generated by active groups of experts currently developing theoretical and practical knowledge; practical knowledge of the level of application of skills, formulated by

typical organizations representing the market (Fig. 2). In particular, the major university departments, being representatives of the labor market for the graduates, provide synchronization of competences acquired during the education, with those demanded in the market.

Developing a set of models of a study course's competence profile must be based, on the one hand, on the ontological approach to designing a model of the courses' links with each other, and on the other, on the methods of the decision taking theory for building a student's motivation function with flexible selection criteria, and on the association network theory for describing the principles of forming a student's knowledge model.

The following major methods of artificial intelligence have been analyzed: knowledge representation methods, argumentation modeling methods, education modeling and methods of knowledge acquisition by intellectual systems. The most suitable approach to solving creative tasks is the logics-semantics approach, showing a task as a structured model with links between elements [2, 10–14].

Application of up-to-date scientific and didactic approaches allows a regulating of the workload of a student. At the same time, the course presentation form must also change: the traditional linear structure must be substituted by hypertext and hypermedia form, allowing increase in the volume of the course materials, more forms of its' presentation, as well as better search for the necessary information. These approaches help develop self-study and creativity skills.

The basic knowledge representation models have different ideas underlying them. Empiric models are based on studying into the principles of human memory and task-solving processes. The second group of models is theoretical ones. They are based on formal logics and combinative models. A semantic net is a directed graph. Its nodes are concepts and objects, its edges are links between objects. Semantic networks fall into extension and intension ones. Intension semantic network describes names of object classes. Extension one describes the relations in a given situation.

The proposed approach to structuring and classifying educational tasks contributes to a student's forming knowledge system in the field of physics and mathematics. In the course of the research, we have developed semantic models for nature studies disciplines, providing rational sequence of developing study path models, fulfillment of requirements of the curriculum of certain courses.

Here is an example of semantic network on the topic "Matrices and their operations", "Linear Algebra" course (Fig. 3). Semantic model, representing the logical structure of the study materials and links between the concepts, allows better understanding of the topic. The model represents major concepts and causality relation between them.

In open education systems it is necessary to design an environment capable of integrating resources of various automated educational systems. This environment is called an information educational system for open learning. Such systems can be represented by a system of university departments and sub-faculties, educational institutions and training courses (majors).

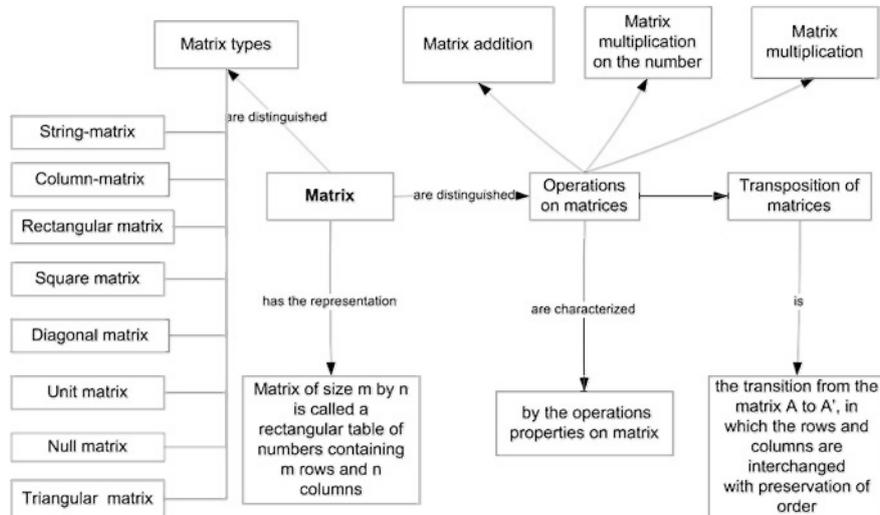


Fig. 3 Semantic model of structured knowledge for "Linear Algebra", topic "Matrices and their operations"

Interactive e-courses are an important means for a student's self-study process, however better results can be acquired through multimedia training systems, both separately and within the traditional education form. The innovative course is aimed at acquiring both generally cultural and professional competences, allowing self-learning when necessary.

3.2 A Possibility of Building a Learning Trajectory Based on Culture Specific Features

Based on the processes above, the process of cultural adaptation of multimedia content for each student according to his cultural characteristics appears. It means that, the initially identified student's cultural and cognitive profile will determine the specifics of the learning process, preferred learning tasks, working with educational information, and methods of getting feedback. We suppose that the difficulties caused by the distant form of educational process can be overcome, if subjects of pedagogical process have cross-cultural competency and there is synchronization of activities. In fact, consideration of the student's cultural and cognitive profile specific and, as a consequence, the nature of its educational activities will meet the expectations of students and make the learning process more effective. We also suppose that two main areas must be studied for creation of smart EEE: the selection and design of educational content according to SCCP and selection of interface options, text and illustrations (including information resource pages). [15, 16].

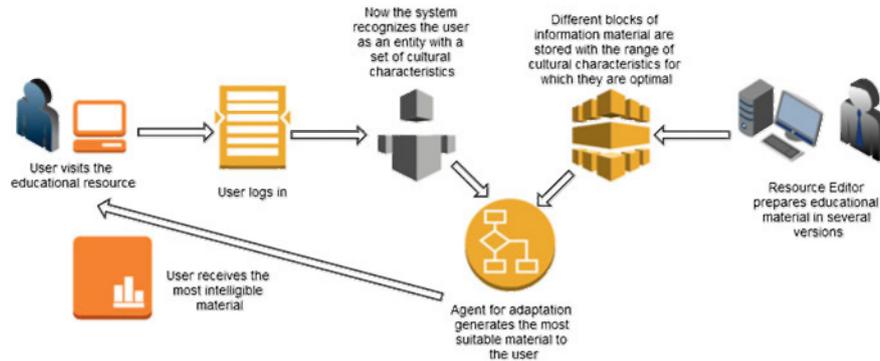


Fig. 4 Scheme of the formation of individual pages for users based on their cultural specificity

Everything, from evaluation of user's cultural parameters to generating personalized pages for him, can be automated. At the initial stage, we can query the user, and then select the most appropriate information for him as follows (Fig. 4).

It is important to say that not only internal but also external courses and educational programs may be assessed this way to provide student with recommendations for development his competence profile by both internal and public external courses. External courses should be selected on the basis of the possibility of certification for already selected learning directions and to improve knowledge in areas, which student is apt for. Regular analysis of SCCP development trends should be used as the basis for such an advisory service.

4 Conclusion

This paper formulates the major principles of constructive learning in an educational environment that contains 3 levels:

- human-to-human level
- human-to-EEE level
- adaptive educational content level

Designing a smart environment is, first of all, based on adapting and filtering the educational environment to fit a student's cultural-cognitive and competence profile. Thus, we can see, that on the 1st level it is essential to develop cultural intellect of the participants of educational communication. The 2nd level involves designing the EEE, with its own cultural intellect and capable of presenting knowledge according to a competence profile. The 3rd level means composing an adaptive - in some cases invariable - educational content (courses' semantic maps, minimal thesauri for disciplines).

We assume, that with this approach a student will mostly use information handling techniques best fitted for his/her own style in the learning process. It is worth noting that both internal (from own faculty or university) and external courses could be graded and presented to a student this way, with system providing student with recommendation on his/her competence profile improvement using all relevant and available sources.

In the end, completion of such personal education course would form up a certain competence profile of a specialist. Undoubtedly, the problem of mapping students' individual study pathways is currently one of the topical issues in modern education, and, in order to choose the most effective models of designing ISP, a thorough research into the global experience in this sphere is essential.

References

1. Beamer, L.: Learning intercultural communication competence. *J. Bus. Commun.* **29**, 285–303 (1992)
2. Berners Lee, T., Lassila, O.: The semantic web. *Sci. Am.* (2001). <http://www.sciam.com/article.cfm?articleID>
3. Blanchard, E., Frasson, C.: Making intelligent tutoring systems culturally aware: the use of Hofstede's cultural dimensions. In: International Conference on Artificial Intelligence, Las Vegas, pp. 644–649 (2005)
4. Gonçalves, V.: Facebook in the learning process: a case study. In: International Conference of Education, Research and Innovation: Abstracts. Madrid <https://bibliotecadigital.ipb.pt/handle/10198/7439> (2010)
5. Hall, E.T.: The silent language in overseas business. *J. Harvard Bus. Rev.*, 87–95 (1960)
6. Hofstede, G.: *Culture's Consequences, International Differences in Work Related Values*. Sage Publications, London (1980)
7. Holodnaya, M.A.: *Cognitive Styles. About Nature of the Individual Mind*, 2nd edn. Peter Publishing house, St. Petersburg (2004)
8. Lewis, R.: *When Cultures Collide: Managing Successfully Across Cultures*. Nicholas Brealey Publishing, London (1999)
9. Nisbett, R.E.: *The Geography of Thought*. Free Press, New York (2003)
10. Osipov, G.S.: *Artificial Intelligence Techniques*. Fizmatlit, Moscow (2011)
11. Osuga, S., Saeki, S., Sudzuki, H. et al.: *Knowledge acquisition: trans. from Jap, Mir, Moscow* (1990)
12. Robert, I.V.: *Theory and Methods of Education Informatization (Psycho-Pedagogical and Technological Aspects)*. IRO RAE, Moscow (2007)
13. Shihnabieva, T.: On the representation of knowledge and control in automated training systems. *J. Inf. Educ.* **10**, 55–59 (2008)
14. Shihnabieva, T., Omarova, N.: Using adaptive semantic models in physics and mathematics education. *J. Sci. Note* **35**, 25–32 (2011)
15. Taratuhina, Y.V.: Choice of appropriate multimedia technology and teaching methods for different culture groups. *Univ. J. Educ. Res.* **2**(2), 200–205 (2014)
16. Taratuhina, Y.V., Aldunin, D.: Specificity of web user interface (WUI) organization in different cultures. *World J. Comput. Appl. Technol.* **1**(3), 59–66 (2014)

17. Taratuhina, Y.V., Avdeeva, Z.K., Mirishli, D.F.: The principles and approach support the mapping of the personal study pathway in electronic educational environments. *J. Procedia Comput. Sci.* **35**, 560–569 (2014)
18. Triandis, H.: *Culture and Social Behavior*. McGraw-Hill, New York (1994)
19. Trompenaars, F., Hampden-Turner, C.: *Managing People Across Cultures (Culture for Business Series)*. Capstone Wiley Publishing Ltd, London (2004)