Adaptation of Educational Content when Learning Mathematics in Bilingual Condition*

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Abstract. Adaptive learning is an advanced technology providing personalization of educational process in e-learning environment. It is deemed currently important to develop and use e-learning courses that include mechanisms of adapting educational content to language peculiarities when teaching students originating from Russian indigenous minority peoples. The article represents an approach to adapting educational content when teaching mathematics in Russian-Tuvan bilingual conditions. The authors have chosen LMS Moodle as a software environment for implementing e-learning courses. It has the functional of educational content mechanism implementation via the accessibility settings of the e-learning course. The authors have developed an adaptive e-learning course (AELC) in discrete mathematics which supports automated course content navigation and is aimed at developing Russian language competence along with mathematical competence. Adaptation mechanisms have been put into action in the AELC by designing the rule base of educational content choosing and their binding to corresponding elements of the AELC, the access of students to which executes their activation by established conditions. Module "Sets and Relations" of the adaptive e-learning course "Discreet Mathematics" has been piloted and showed its effectiveness in training future mathematics and computer science teachers at the Faculty of Physics and Mathematics of Tuvan State University (training program 44.03.01 – Pedagogical Education). Over the longer term it is planned to optimize adaptation mechanisms of the AELC by means of including the conditions of student e-learning environment activity accounting into the rule base of educational content choosing.

Keywords: Adaptive learning, Personalization adaptive learning, E-learning, Teaching mathematics, Bilingualism.

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1 Introduction

Nowadays digitalization of education is characterized by the orientation of educational programs on intensive use of innovative e-learning technologies providing personalization of educational process in e-learning environment. Many researchers consider adaptive learning to be an advanced technology providing personalization [1, 2]. Its main purpose is to organize educational content in the e-learning environment providing the variability of educational content with regard to student personal characteristics [3]. Many Russian higher educational establishments take efforts in this direction. For example, the Institute of Information and Space Technology of Siberian Federal University develops adaptive e-learning courses (AELC) where the adaptation of educational content is put into practice depending on learning content acquisition and student individual style [4-7]. Introducing the AELCs into the educational process for IT-majoring students shows their high performance on the part of educational content acquisition quality improvement [8].

However, the range of individual characteristics is very wide including cognitive and personal features of students. For example, when teaching students originating from Russian indigenous minority peoples, it is necessary to use mechanisms of adapting educational content to language peculiarities. It is particularly true for junior years when teaching basic disciplines including mathematics.

2 Adaptive learning in Russian-Tuvan bilingual conditions

Let us consider the Republic of Tuva, which is located in isolation from the rest of Russia and represents a specific cultural world [9]. By and large, the republic has a bigger percentage of population to speak the Tuvan language natively than in other national regions of Russia. It leads to the fact that many applicants do not have a sufficient command of Russian or only speak everyday Russian. It causes a specific educational process organization problem that resides in the necessity to develop Russian language competence alongside with subject competences because Russian is the instruction language at the university [10, 11].

The authors suggest using adaptive e-learning courses to organize mathematics training in Russian-Tuvan bilingual conditions. When creating the courses, it is important to take into account the level of Russian comprehension of students and make provision for combined development of both mathematical and Russian language competences. Herewith, one of the educational objectives is to acquire learning materials and get the course credit completely in Russian. The authors have chosen LMS Moodle as a software environment for implementing e-learning courses. It has the functional of educational content mechanism implementation via the accessibility settings of the e-learning course.

The authors have used the microteaching strategy when designing the adaptive e-learning course in discrete mathematics. Educational content model represents a collection of micro-chunks for learning material represented in several ways with the

difference in the extent of Russian use. The learning material variant designed for a student with a low command of Russian is formed simultaneously in Tuvan and Russian. It enables students to adapt to new learning conditions. The next variant of the material is designed for the students who have a medium command of Russian, i.e. those who can speak everyday Russian. This variant contains Russian formulations of statements and definitions and is accompanied by Tuvan translation, also including a mathematical term glossary. The number of fragments in Russian in each micro-chunk increases from version to version and finally reaches an entirely Russian variant.

When structuring the knowledge domain of the discreet mathematics course with the workload of 180 academic hours, 28 micro-chunks of educational content were formed in three different versions, and 62 terms were included into the subject field glossary.

Let us consider the representation of the educational content of the micro-chunk "Relations". This is how the definition of relations is represented in the Russian version:

ОТНОШЕНИЕ – это способ задания взаимосвязей между элементами.

Strict definition:

N-АРНОЕ ОТНОШЕНИЕ НА МНОЖЕСТВЕ А называется любое подмножество упорядоченных n элементов этого множества.

The definition is given in Tuvan for the students who do not have a sufficient command of Russian:

ХАРЫЛЗАА – дээрге кезектернин бот-боттарынын аразында онаарынын аргазы.

Strict definition:

А БӨЛУГДЕ N-АРНЫГ ХАРЫЛЗАА дээрге ол-ла бөлугнун подмножествонун чурумчудуткан n- кезектери.

For the students with the low command of Russian, the material contains Russian formulations of statements and definitions but it is accompanied by the Russian-Tuvan glossary of mathematical terms, a fragment of which is shown in Table 1.

When preparing educational content of the e-learning course the methodical technique "Language communication technique variability" has been used. It is aimed at the simultaneous use of two languages – Russian and Tuvan to create better learning conditions in the realm of intelligibility and perception of the material learnt.

The AELC provides for automated navigation between the material versions depending not only on the command of Russian but also on the level of acquiring learning material. Students are offered a version of learning material to study. Then the acquisition of new material is checked automatically and, depending on the results obtained, these stages follow:

- if there is a problem acquiring language-related learning material, the course automatically offers the learning material version with more material in Tuvan corresponding to the current Russian level of the student;
- if the problem lies in the lack of comprehension of the course material, the student gets assistance in the form of automated heuristic prompts and explaining examples embodied as a training test.

Table 1. A Fragment of Russian-Tuvan glossary of AELC.

Concept in Russian	Concept in Tuvan language
Отношение ρ, заданное на множестве A, называется *рефлексивным*, если $\forall x \in A : (x,x) \in \rho$. *Например*, отношение жить в одном городе на множестве людей.	Бир эвес $\forall x \in A : (x,x) \in \rho$ харылзаа кылдынып турар болза, A деп бөлүгде онап каан ρ деп харылзааны *рефлексивный* дээр . *Чижээлээрге*, чангыс хоорайга болуг кижилернин чурттаар харылзаазы
Отношение ρ, заданное на множестве A, называется *антирефлексивным*, если $\forall x \in A : (x,x) \notin \rho$. *Например*, быть сыном.	Бир эвес $\forall x \in A : (x,x) \notin \rho$ харылзаа кылдынып турар болза, A деп бөлүгде онап каан ρ деп харылзааны антирефлексивный дээр. *Чижээлээрге*, оглу болуру.
Отношение ρ, заданное на множестве A, называется *симметричным*, если $\forall x, y$ **из того** *что* $(x,y) \in \rho$ *следует, что* $(y,x) \in \rho$ *Например*, быть соседом.	Бир эвес $\forall x, y$ *–ке (x, y)ϵ p болгаш оон уламчызы (y, x)ϵ p* деп харылзаа кылдынып турар болза, A деп бөлүгде онап каан ρ деп харылзааны симметричный дээр *Чижээлээрге*, кожазы болуру.
Отношение ρ, заданное на множестве A, называется *антисимметричным*, если $\forall x, y$ **из того** *что* $(x,y) \in \rho$ *и* $(y,x) \in \rho$ *следует, что* $x = y$ *Например*, быть потомком	Бир эвес $\forall x, y$ *–ке* мындыг харылзаа кылдынып турар болза *(x, y)ϵ p биле (y, x)ϵ p,* болгаш оон уламчызы $x = y$ болза, A бөлүгде онап каан ρ деп харылзааны антисимметричный дээр. *Чижээлээрге*, салгакчы болуру.
Отношение ρ, заданное на множестве A, называется *транзитивным*, если $\forall x, y$ **из того** *что* $(x,y) \in \rho$ *и* $(y,z) \in \rho$ *следует, что* $(x,z) \in \rho$ *Например*, быть старше.	Бир эвес $\forall x, y$ *–ке* мындыг харылзаа кылдынып турар болза *(x, y)ϵ p биле (y, z)ϵ p,* болгаш оон уламчызы *(x, z)ϵ p* болза, A бөлүгде онап каан ρ деп харылзааны транзитивный дээр. *Чижээлээрге*, улуг болуру азы

Adaptation mechanisms have been put into action in the AELC by designing the rule base of educational content choosing and their binding to corresponding elements of the AELC, the access of students to which executes their activation by established

conditions. For example, the rule of automatic presentation of other version of the educational content to the student who has not acquired learning material and shown medium command of Russian is set as follows:

IF

[Parameter «Command of Russian» : = «*Средний*»

AND

Parameter «Term i acquisition level» : = «*Insufficient*» (from 0 % to 50%)]

ELSE

[Parameter «Term i intelligibility » := TRUE

AND

Parameter «Version» := «Version *B*»

AND

Parameter «Detalization» := « Maximum»].

At the moment the authors are designing the elements of the adaptive e-learning course that include training tests providing step-by-step solution of multistage problems and peer review individual project assignments.

The proposed approach was tested in the educational process of students of Tuva State University. Before the study, the control and experimental groups of 19 people were formed.

The construction of the educational process in the control group was carried out traditionally, and in the experimental group using the approach proposed in the work using AELC. The positive dynamics of the formation of mathematical and russian-language competence in the control and experimental groups when teaching discrete mathematics, Fig. 1.

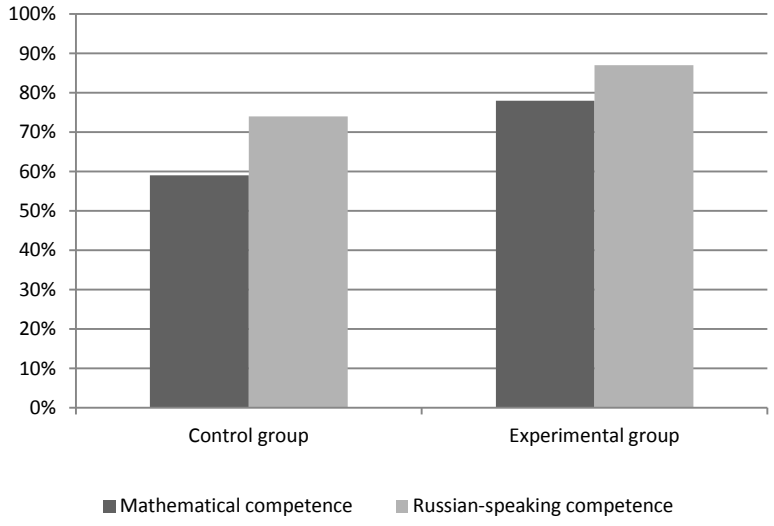

Fig. 1. Dynamics of educational results

Assessment of the level of formation of competencies of each student was carried out on a 100-point scale. The histogram shows the average values of the formation of each competence in the control and experimental groups, converted into percentage components.

3 Conclusion

Module “Sets and Relations” of the adaptive e-learning course “Discreet Mathematics” has been piloted and showed its effectiveness in training future mathematics and computer science teachers at the Faculty of Physics and Mathematics of Tuvan State University (training program 44.03.01 – Pedagogical Education).

The use of adaptive e-learning courses enabling adaptation of educational content when teaching mathematics in Russian-Tuvan bilingual conditions has made it possible to develop Russian language competence along with mathematical competence. Over the longer term it is planned to optimize adaptation mechanisms of the AELC by means of including the conditions of student e-learning environment activity accounting into the rule base of educational content choosing.

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