IEEE Access
Multidisciplinary ⋮ Rapid Review ⋮ Open Access Journal

Received February 7, 2020, accepted February 27, 2020, date of publication March 9, 2020, date of current version April 7, 2020.

Digital Object Identifier 10.1109/ACCESS.2020.2979277

Intelligent System for Evaluating the Level of Formation of Professional Competencies of Students

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ABSTRACT This paper proposes the creation of an intelligent system for assessing the levels of professional competencies of students in e-learning. Mathematical models and methods for assessing the formation of professional competencies of students at the level of disciplines, modules and the entire educational program are built. Algorithms for calculating the assessment of levels of competency in the discipline, module, and educational program are developed. These estimates can be used in the formation of inference rules for making decisions on changing the structure and content of disciplines, modules and educational programs.

INDEX TERMS Artificial intelligence, decision support systems, intelligent systems, knowledge based systems, expert systems, distance learning, electronic learning.

I. INTRODUCTION

It is known that the result of training is an indicator of what the student should know, understand and/or be able to perform. Learning outcomes are defined in terms of the level of competency acquired by the learner. Competence is defined as a dynamic combination of knowledge, understanding, skills, and abilities. Competencies are formed within the framework of various units of the program and are evaluated at different stages of learning.

The competency-based approach raises the problem of determining the types of competencies and assessing their levels. Today, many universities independently decide what the methodology for the formation and the use of funds of assessment tools should be for the assessment of the level of formation of their students' competencies. This gave rise to various methodologies and evaluation tools which complicated the mobility of teachers and students. Thus, there was a need to develop a unified technology for assessing the level of formation of students' professional competencies at the level of the structure of disciplines, modules and the educational program, which can be automated in e-learning [1]–[3].

The associate editor coordinating the review of this manuscript and approving it for publication was Shadi Aljawarneh.

To organize and manage the educational process in e-learning, we suggest using the ‘‘smart-university'' intelligent system as described in [4]–[8].

For e-learning and the assessment of knowledge on specific (compulsory and elective) disciplines [9], [10] in a given educational program; for example, they will be carried out by using intelligent textbooks [11]–[18], and generated by the generator of electronic educational publications [18]–[25].

II. FORMALIZATION OF THE PRESENTATION AND ASSESSMENT OF KNOWLEDGE IN THE EDUCATIONAL PROGRAM

Currently, methods for presenting and processing a knowledge base in a given subject area through the use of ontology are rapidly developing. Ontology is understood as a formalized representation of knowledge about the subject area by using conceptual schemes consisting of concepts (concepts, classes), functions (interpretations), relations (properties, connections) and axioms (facts). A specific ontology represents a knowledge base for a specific subject area. Formally, an ontology is represented by a set of three components [21]:

$$O =< C, R, F >, \quad (1)$$

where:

$C-$ set of concepts;

$R-$ set of relationships between concepts;

$F-$ set of functions.

As you know, the educational program has three levels:

1 - level of disciplines that may have several sections and topics;

2 - level of modules, each of which is formed from several disciplines;

3 - educational program level which consists of several modules.

Therefore, any competency assessment needs to be carried out at these three levels.

We can consider each unit at these levels as a separate subject area and will build their ontological models and obtain knowledge bases of the following corresponding levels: D_i^l – at the disciplinary level, M_k^l – at the module level, and E – at the level of the educational program.

$$M_k^l = \cup_{k_i=1} D_{k_i}^l \tag{2}$$
$$E = \cup_{l=1} \cup_{k=1} M_k^l, \tag{3}$$

There l – semester number; k – module number, k_i – discipline number in the module k.

Competency for a particular module can be obtained as the average value obtained from the competency values of the disciplines included in this module, and competencies at the level of the educational program can also be obtained from the average values of the modules. Similarly, it is possible to calculate certain competencies for different learning paths within the educational program, which is formed from the study of various elective disciplines. Therefore, it is very important to build methods for determining competency at the level of the disciplines [24], [25].

Let $P-$ be a finite and nonempty set representing the knowledge base of a given discipline; $Q-$ a finite and nonempty set representing a base of test questions in a given discipline; $T-$ a finite and non-empty set representing a base of standard answers to test questions in a given discipline;

$$f : Q \to T, \quad f(q) = t, \; q \in Q, \; t \in T \tag{4}$$

a function to generate answers to asked questions; S – a finite set representing the knowledge base of student answers to test questions in the given discipline. Then you can define the following rules to make a decision:

If the set of student responses is the empty set, i.e. $S = \emptyset$, then it is believed that he does not have a single answer to the test questions;

If the student's set of answers to the test questions is not an empty set, but is not contained in the knowledge base of a given discipline, i.e.

$$S \neq \emptyset \& S \not\subset P, \tag{5}$$

then it is believed that he does not know the material for a given discipline.

If the student's set of answers to the test questions is not an empty set, but completely coincides with the set of standard answers, i.e.

$$S \neq \emptyset \& S = T, \tag{6}$$

then it is believed that he fully knows the material provided for in the standard answers.

If the ontology generated by the student's answers to the test questions is not an empty set, but is strictly contained in the set of standard answers, i.e.

$$S \neq \emptyset \& S \subset T, \tag{7}$$

then it is believed that he partially knows the material provided for in the standard answers.

If the student's set of answers to the test questions is not an empty set and is not contained in the set of standard answers, but is contained in a given discipline, i.e.

$$S \neq \emptyset \& S \not\subset T \& S \subseteq P, \tag{8}$$

then it is believed that he knows the material on a given discipline and that his answers can replenish the base of standard answers and that the corresponding test questions can be generated.

Comment: in the case of

$$S \neq \emptyset \& S \not\subset T \& S \subseteq P \tag{9}$$

the knowledge base of the standard answers can be replenished with student answers, which means that it is self-learning.

In order to compare

$$S \subseteq T \tag{10}$$

we will use the Bron-Kerbosch algorithm. It is a branch-and-bound principle to search all cliques (as well as maximum ones for involving independent sets of vertices) of a nonoriented graph. It was developed by Dutch mathematicians Bron and Kerbosch in 1973 and is currently still one of the most effective algorithms for searching subsets of vertices, every two of which are connected to the graph's edge. In other words, it is a full sub graph of the primary graph. The algorithm uses the fact that every clique within the graph appears as its maximum involving the complete sub graph. Starting from the single vertex (forming the complete sub graph), the algorithm for each of its steps attempts to expand the already built complete sub graph by adding vertices from the candidate's set into it. The high rate is provided by cutting out at iterating over options which certainly will not lead to the clique build-up because the additional set for which it is used encompasses vertices that have already been used for the complete sub graph expansion.

The algorithm is operated by three vertex sets of the graph: compsub set – is a set, containing on each step the full subgraph for the mentioned step. It is built recursively. candidates set – is a set of vertices which may increase the compsub. not set – is a set of vertices which had been already used to expand the compsub at the algorithm's previous steps.

The algorithm is a recursive procedure which is applicable for these three sets.

Procedure Extend (Compsub, Candidates, Not)

WHILE candidates NOT null AND not NOT contains vertex, CONNECTED WITH ALL vertex from candidates, DO:
1 Choose vertex v in candidates ∪ not (from candidates and add it to compsub)
2 CREATE new_candidates, new_not (Form new_candidates and new_not, by deleting it from candidates and not vertex, not CONNECTED with v)
3 IF new_candidates AND new_not = null
4 THEN compsub ∪ {v}, candidates ∩ new_candidates (v), not ∩ new_candidates (v)) (compsub – clique)
5 ELSE candidates: = candidates \ {v} (recursively call extend (new_candidates, new_not)
6 not : = not ∪ {v} (Delete v from compsub and candidates, and put it in not)

Now, by taking the above specific rules for making decisions into account you can determine the assessment of student responses to test questions in the form of the following fuzzy binary relation:

$$S \subseteq T = \left\{ s \in S, t \in T, \mu_{S \subseteq T} \left(< s, t >\right) \right\}, \qquad (11)$$

'Mark' ⇌ where

$$\mu_{S \subseteq T} : S \times T \rightarrow]0, 1[\qquad (12)$$

fuzzy relation function.

To calculate the elements of a fuzzy relationship (10) set elements S and T must be specified, which represent the many individuals of the class, the many properties of the class, and the many semantic arcs incidental to the class.

Now for a method of assessing the level of knowledge, as proposed in [24].

Let be

$$Q = \{q_1, q_2, \ldots, q_n\} \qquad (13)$$

many open (no answer options) test questions,

$$S = \{s_1, s_2, \ldots, s_n\} \qquad (14)$$

many student answers to test questions,

$$T = \{t_1, t_2, \ldots, t_n\} \qquad (15)$$

many standard answers generated by only one answer to each test question from the set Q.

Then the fuzzy binary relation (10) can be represented using table 2, in which the elements of the set serve as row names S, and the column names as set elements T. At the intersection of a line s_k and column t_l an item is placed:

$$\mu_{S \subseteq T} \left(< s, t >\right), \quad k = 1, \bar{\bar{n}}; \; l = 1, \bar{\bar{n}}. \qquad (16)$$

The total score corresponding to table 2 is calculated by the formula:

$$\mu_{S \subseteq T} \left(< s, t >\right) = \frac{\sum_k^n \sum_l^n \mu_{S \subseteq T} \left(< s_k, t_l >\right)}{n * n}, \qquad (17)$$

TABLE 1. Definition of a fuzzy binary relation $S \subseteq T$.

	t_1	t_2	…	t_n
s_1	$\mu_{S \subseteq T} = (< s_1, t_1 >)$	$\mu_{S \subseteq T} = (< s_1, t_2 >)$	…	$\mu_{S \subseteq T} = (< s_1, t_n >)$
s_2	$\mu_{S \subseteq T} = (< s_2, t_1 >)$	$\mu_{S \subseteq T} = (< s_2, t_2 >)$	…	$\mu_{S \subseteq T} = (< s_2, t_n >)$
…	…	…	…	…
s_n	$\mu_{S \subseteq T} = (< s_n, t_1 >)$	$\mu_{S \subseteq T} = (< s_n, t_2 >)$	…	$\mu_{S \subseteq T} = (< s_n, t_n >)$

If for each test question from the set Q several reference answers to the i-th test question are generated (i.e.

$$T = \{t_{1m_1}, t_{2m_2}, \ldots, t_{nm_n}, \} \qquad (18)$$

m_i – number of reference answers), then table 2 will be multidimensional, in which the elements can again be tables and can have several levels of hierarchy. For each table, regardless of its hierarchy level, the overall score will be calculated using a formula similar to formula (17). In this case, the overall score of the low-level table is the value of the table element of the nearest upper level.

Thus, we have developed a method for assessing knowledge in a given subject area on the basis of a fuzzy relationship between the student's sets of answers to test questions and the sets of standard answers generated by test questions.

Now we will translate the calculated grade into a familiar grade for everyone by using the GPA grade value:

$$Mark = \begin{cases} 0, & \text{if } 0 \leq \mu_{S \subseteq T} \left(< s, t >\right) \\ \leq 0.240.5, & \text{if } 0.25 \leq \mu_{S \subseteq T} \left(< s, t >\right) \\ \leq 0.491, & \text{if } 0.5 \leq \mu_{S \subseteq T} \left(< s, t >\right) \\ \leq 0.541.33, & \text{if } 0.55 \leq \mu_{S \subseteq T} \left(< s, t >\right) \\ \leq 0.591.67, & \text{if } 0.6 \leq \mu_{S \subseteq T} \left(< s, t >\right) \\ \leq 0.642, & \text{if } 0.65 \leq \mu_{S \subseteq T} \left(< s, t >\right) \\ \leq 0.692.33, & \text{if } 0.7 \leq \mu_{S \subseteq T} \left(< s, t >\right) \\ \leq 0.742.67, & \text{if } 0.75 \leq \mu_{S \subseteq T} \left(< s, t >\right) \\ \leq 0.793, & \text{if } 0.8 \leq \mu_{S \subseteq T} \left(< s, t >\right) \\ \leq 0.843.33, & \text{if } 0.85 \leq \mu_{S \subseteq T} \left(< s, t >\right) \\ \leq 0.893.67, & \text{if } 0.9 \leq \mu_{S \subseteq T} \left(< s, t >\right) \\ \leq 0.944, & \text{if } 0.95 \leq \mu_{S \subseteq T} \left(< s, t >\right) \leq 0.100 \end{cases} \qquad (19)$$

Types of marks and their designation: lecture assessment - Lec; Practical assessment - Pra; Laboratory Assessment - Laboratory - Lab; Evaluation Studio - ES; Student's independent work - SIW; Student Independent work with the teacher - SIWT; Master's Independent work - MIW; Master's Independent work with the teacher - MIWT; Doctoral student's independent work - DIW; Doctoral student's Independent work with the teacher - DIWT.

Types of grades Translation of lecture grades into lecture input. Types of evaluations Practical assessment, Laboratory

TABLE 2. Translation estimates in percentages, GPA and letters.

Evaluation of the traditional system	Evaluation of the credit system		
	Numerical equivalent assessment	Literal equivalent assessment	Percentage
Excellent	4,0	A	95-100
	3,67	A-	90-94
Good	3,33	B+	85-89
	3,0	B	80-84
	2,67	B-	75-79
	2,33	C+	70-74
Satisfactorily	2,0	C	65-69
	1,67	C-	60-64
	1,33	D+	55-59
	1,0	D	50-54
Unsatisfactorily	0,5	FX	25-49
	0	F	0-24

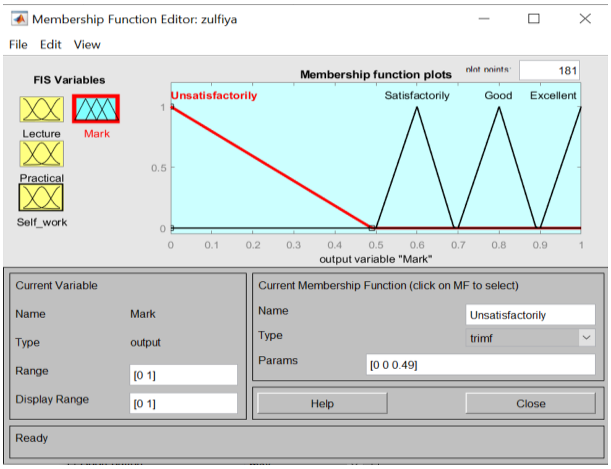

FIGURE 1. Membership function Lecture of fuzzy machine.

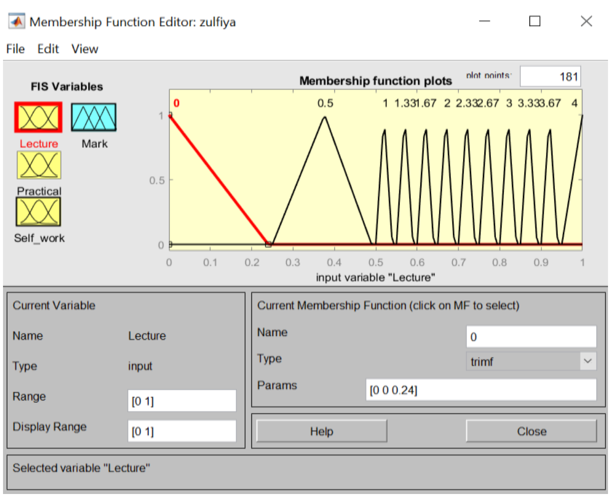

FIGURE 2. Membership function Practical of fuzzy machine.

assessment, Studio assessment, Seminar assessment are combined into Practical. The rest is transferred to Self_work.

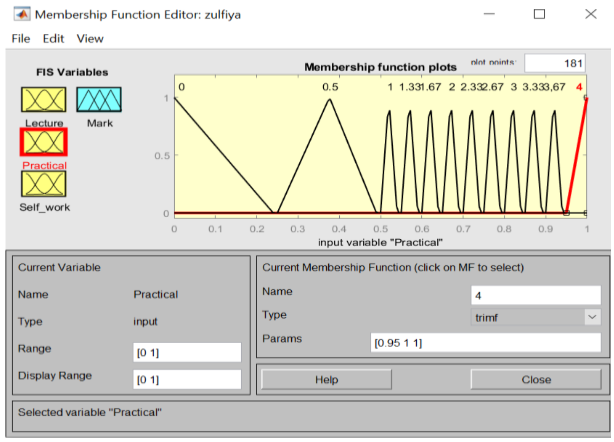

FIGURE 3. Membership function Self_work of fuzzy machine.

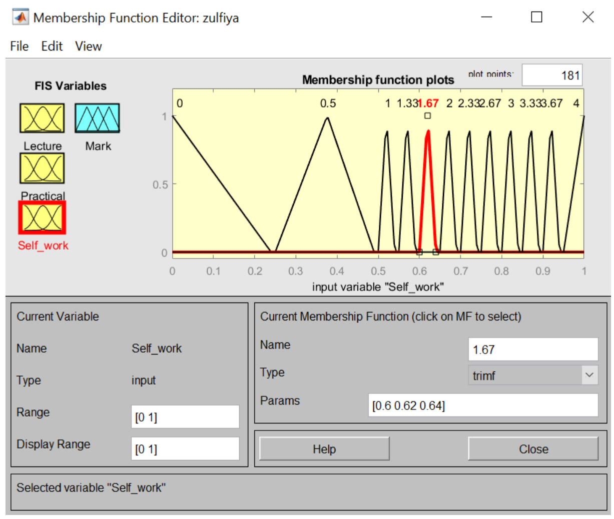

FIGURE 4. Rules of fuzzy machine.

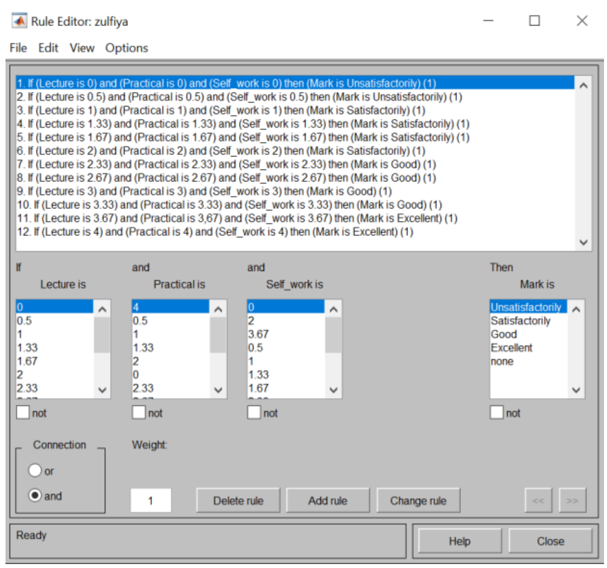

FIGURE 5. Output variable Mark of fuzzy machine.

We used the Mamdani method implemented in Matlab to build fuzzy calculations. The corresponding fuzzy calculations are shown in Figures 1-7.

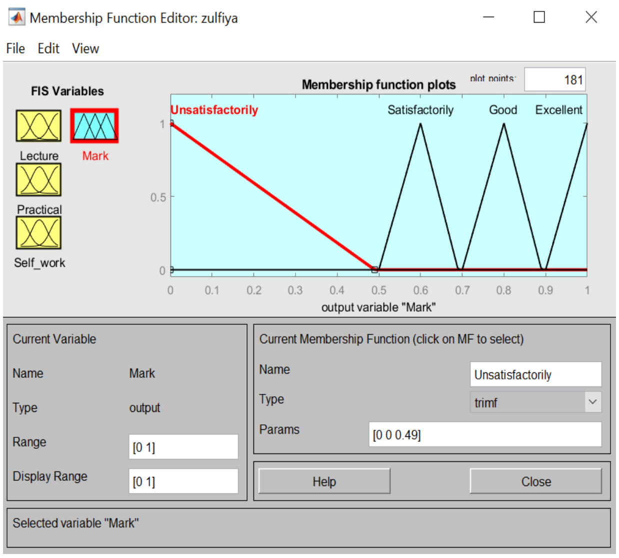

FIGURE 6. Output variable Mark of fuzzy machine.

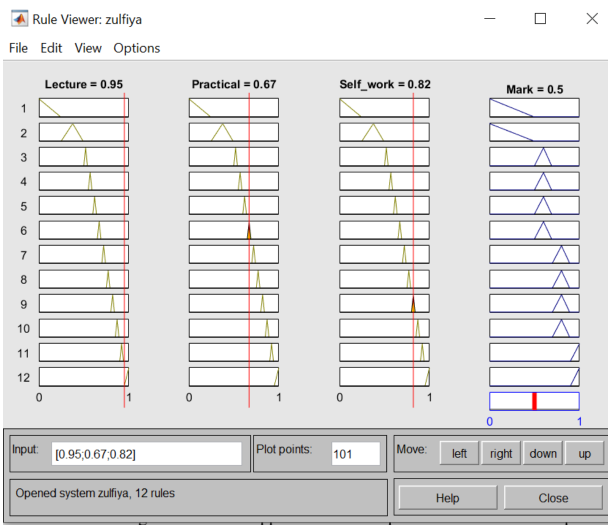

FIGURE 7. Result of fuzzy machine.

Description of fuzzy calculations in pictures 2-7.

Usually an examination ticket consists of three questions: 1 - a question on lecture materials; 2 - a question on practical exercises; 3 - the question on independent work. We build an ontology from the standard answer of the teacher to each question. Then we build the ontology from the student's answer to the same question. Using the method described above, we compare two ontologies and get the result of the similarity of the two answers in a percentage ratio in a metric from 0 to 100. Having received the answers to three questions from the exam ticket, we transfer them to a fuzzy machine. As a result, we showed that the assessment of student performance by using fuzzy calculations is more acceptable. In addition, fuzzy calculations are an internationally recognized powerful mathematical tool and should be used everywhere.

III. CONCLUSION AND FURTHER WORKS

In this paper competency (knowledge) assessments were carried out at three levels of the educational program. To assess knowledge, we used fuzzy binary relations between the standard answers from the knowledge base and student answers, which are presented in table 1. Equivalent values of knowledge assessments in numerical and literal equivalent assessments and percentages are given in table 2. Fuzzy calculations were carried out on data obtained by the comparison algorithm. In this work, we used the Mamdani method implemented in Matlab for constructing fuzzy calculations.

The proposed method for assessing the competencies of disciplines is based on the establishment of fuzzy binary relations between students' answers to test questions and standard answers synthesized from the knowledge base on these test questions. We calculated the assessment of competencies for all modules based on the grades obtained on the disciplines included in the given modules. As a result, the assessment of competencies for the entire educational program (EP) is calculated as the average value of all types of competencies for the EP. This approach to the calculation of competencies allows us to change the content of not only certain types of competencies, but also of the entire EP, that is, you can determine the vulnerabilities of each discipline, each module, each competency and the EP as a whole. Then, by changing the structure and content of individual disciplines and the module, without changing competencies, it is possible to change the structure and content of individual competencies without changing the EP. This allowed us to create a technology for the formation and assessment of competencies, which can be used to form a competency assessment of any EP. When developing the technology for assessing competencies, the following points were taken into account: disciplines are the main links in educational activity, and it is precisely the levels of students' mastery of the disciplines that are assessed. It is obvious that by assessing the level of knowledge within the disciplines that it is ultimately possible to correctly establish the level of competencies. In such conditions, it is more convenient to adapt the already gained experience and to use adapted diagnostic methods within the framework of the competency-based approach. Within the framework of the methodological aspects of the automated assessment of competencies, a knowledge base of test questions of various types and different levels of complexity will be developed. In addition, within the technical aspects, researchers will continue to develop software that implements all stages of the semantic analysis of texts based on ontological technology and natural language processing. The results of the study can be used in the creation of intelligent distance learning systems and in the assessment of competencies in a natural language.

REFERENCES

[1] I. N. Eliseev, "Mathematical models and software complexes for automated assessment of learning outcomes using latent variables," (in Russian), M.S. thesis, JuRGTU, Novocherkassk, Russia, 2013, p. 371.

[2] I. V. Sibikina, "Models and algorithms for the formation and assessment of competencies of graduation," (in Russian), M.S. thesis, Astrahan, Russia, 2012, p. 200.

[3] O. E. Permyakov and S. V. Menkova, "Diagnostics of the formation of professional competencies," (in Russian), FIRO, Moscow, Russia, Tech. Rep., 2010, p. 114.
[4] A. B. Barlybayev, A. A. Sharipbayev, and A. S. Omarbekova, "Semantic model of an intellectual E-University for the environmental education," in *Proc. 1st Global Conf. Environ. Stud., AWERProcedia Adv. Appl. Sci.*, Antalya, Turkey, vol. 2013, pp. 602–608.
[5] A. Barlybayev, D. Kabenov, and A. Sharipbay, "The virtual assistant for applicant in choosing of the specialty," *Life Sci. J.*, vol. 10, no. 3, pp. 2120–2125, 2013.
[6] A. Sharipbay and A. Barlybayev, "Formal models of the intelligent electronic University," *Int. J. Inf. Technol. Comput. Sci.*, vol. 21, no. 1, pp. 35–40, Aug. 2015.
[7] K. Zulfiya, B. Gulmira, and S. Altynbek, "Ontological model for student's knowledge assessment," in *Proc. 5th Int. Conf. Eng. MIS (ICEMIS)*, Nur-Sultan, Kazakhstan, 2019, Art. no. 18, doi: 10.1145/3330431.3330449.
[8] A. Sharipbay, A. Barlybayev, T. Sabyrov, and E. Akimbekova, "Software for automation of activity of the personnel in the smart-university," in *Proc. EDULEARN Conf.*, Barcelona, Spain, 2016, pp. 3731–3735.
[9] A. Sharipbay, A. Barlybayev, and T. Sabyrov, "Measure the usability of graphical user interface," *Advances in Intelligent Systems and Computing*, vol. 444. Cham, Switzerland: Springer, 2016, pp. 1037–1045.
[10] A. Sharipbay, A. Omarbekova, A. Seifullina, and A. Zakirova, "Creating intelligent electronic textbooks based on knowledge management," in *Proc. World Congr. Eng. (WCE)*, vol. 1, 2014, pp. 224–227.
[11] A. Sharipbay, A. Omarbekova, and G. Nurgazinova, "Creating intelligent electronic textbooks in Kazakhstan," in *Proc. 6th Int. Conf. Educ. New Learn. Technol.*, Barcelona, Spain, 2014 pp. 2926–2933.
[12] G. Nurgazinova, V. Golenkov, A. Sharipbay, A. Omarbekova, and A. Barlybayev, "Designing of intelligent reference system for algebra based on the knowledge database," in *Proc. Int. Conf. Control, Automat. Artif. Intell.*, Lancaster, PA, USA, 2015, pp. 230–235.
[13] G. Nurgazinova, V. Golenkov, A. Sharipbay, A. Omarbekova, and A. Barlybayev, "On creation of the intelligent help system," *J. Theor. Appl. Inf. Technol.*, vol. 86, no. 1, pp. 26–33, 2016.
[14] G. Nurgazinova, V. Golenkov, A. Sharipbay, A. Omarbekova, and A. Barlybayev, "Designing of intelligent reference system for algebra based on the knowledge database," in *Proc. Int. Conf. Control, Automat. Artif. Intell. (CAAI)*, Phuket, Thailand, 2015, p. 7.
[15] A. Barlybayev, A. Sharipbay, and T. Sabyrov, "Student's performance evaluation by fuzzy logic," *Procedia Comput. Sci.*, vol. 102, pp. 98–105, Jan. 2016.
[16] A. Sharipbay, A. Omarbekova, and A. Seifullina, "Creating intelligent eletronic textbooks based on knowledge," in *Proc. Manage. World Congr. Eng.*, London, U.K., Jul. 2013, pp. 224–227.
[17] A. Sharipbay, A. Omarbekova, and A. Seifullina, "The creation intelligent e-learning system by higher education in Kazakhstan," in *Proc. 14th Int. Symp. Adv. Intell. Syst. (ISIS)*, Daejeon, South Korea, 2013.
[18] A. Sharipbay and A. Omarbekova, "Generator of electronic educational publications," in *Proc. 4th Int. Acad. Res. Conf. Bus., Educ., Nature Technol.*, Seattle, WA, USA, Nov. 2013.
[19] A. Omarbekova, A. Sharipbay, A. Zakirova, and A. Barlybayev, "Generation of intelligent e-learning editions on the basis of ontologic model," *J. Int. Sci. Publications, Educ. Alternatives*, vol. 11, pp. 47–53, 2013.
[20] A. Sharipbay, A. Omarbekova, and A. Zakirova, "Frame concept for generator of electronic educational publications," in *Soft Computing in Machine Learning* (Advances in Intelligent Systems and Computing), vol. 273. 2014, pp. 11–20.
[21] D. Fensel, "Ontology-based knowledge management," *Computer*, vol. 35, no. 11, p. 59, 2002.
[22] A. S. Omarbekova, G. S. Nurgazinova, A. A. Sharipbay, A. Barlybayev, and G. T. Bekmanova, "Automatic formation of questions and answers on the basis of the knowledge base," in *Proc. Int. Conf. Eng. Technol. (ICET)*, 2017, pp. 1–3.
[23] A. S. Abdygalievich, A. Barlybayev, and K. B. Amanzholovich, "Quality evaluation fuzzy method of automated control systems on the LMS example," *IEEE Access*, vol. 7, pp. 138000–138010, 2019.
[24] A. Sharipbay, "Modeling the assessment of the subject's knowledge," in *Proc. Int. Sci. Conf. 'Inform. Appl. Math.'*, Almaty, Kazakhstan, 2016, pp. 356–361.
[25] A. Sharipbay, "Intelligent technology of knowledge processing and assessment in Kazakh for a given subject area," in *Actual Problems of Applied Mathematics and Information Technologies*. Tashkent, Uzbekistan, 2019, pp. 275–279.

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