Intelligent Methods in the Field of e-Learning. Evaluaton of Student Written Works

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ABSTRACT: *The realization of effective control of learners' knowledge and development of software products for evaluation in distance form of learning is becoming increasingly important. This work offers a formalized approach to assessing written works of students through unconventional application of dichotomous Rasch model with the use of fuzzy evaluations of the criteria. The model allows a program realization and can be embedded into platforms for e-learning.*

KEY WORDS: *E-learning in higher education, distance learning, evaluation of written works of students, one-parameter Rasch model, Rasch measurement, formalization of the evaluation process.*

INTRODUCTION

Changes in the higher education system in the Republic of Bulgaria with the aim of improving the quality of teaching imply the use of information and communication technologies in the educational process. As a result of implementation of projects under the scheme BG051PO001-4.3.04 "Development of electronic forms of distance learning in higher education system" by the operational programme "Human Resources Development", co-financed by the European Social Fund of the European Union, universities began to massively introduce electronic and distance forms of learning.

Many publications represent the acquired positive experience and "best practices" for teachers in the use of electronic forms of distance learning for bachelor's and master's degrees and post-graduate qualification in various professional fields.[7], [8].

Analysis of available sources shows that the efforts of the academic staff are focused on creating technical and informational infrastructure, effective management, development of educational content and procedures for the realisation of distance learning.

Introduction of various distance learning technologies helps to create adequate educational environment, and at the same time is accompanied by many problems, some of which have still not found a suitable solution. Such problems are those associated with the activation and the intensification of students' independent work, monitoring the progress of the learning process, development of motivation system, providing interaction not only with the teacher but also among learners, etc.

The problem of realization of effective control over learners' knowledge and development of software products for evaluation in distance learning is becoming increasingly important. Assessment of distance learning students' knowledge should correspond with the evaluation of learners' knowledge in regular and correspondence courses since education as a combination of knowledge, skills and habits must meet the same requirements, regardless of the form of education. A permanent control over student's knowledge is applied throughout the whole period of distance learning course which should form motivation for learning, knowledge acquiring and individual achievements. In distance learning systems technologies for remote assessment of learning outcomes in different disciplines must be developed and introduced, which guarantee objectivity of the assessment and compensate for the lack of personal contact with the student.

Automation of control procedures implies formalization and adequate modelling of teacher's thinking in the decision-making process of forming assessment. The problem of assessing learners' knowledge is linguistically described, multi-criterial and non-formalized, and therefore difficult to model. The process of interaction between the assessor and the assessed cannot be strictly formalized. At the same time, the development of software for the control of students' knowledge requires, if not total, at least partial formalization of educational subject area, since only objective and formal methods can generate unambiguous and reproducible assessments.

To obtain an objective assessment of learners' knowledge various measuring tools are used: a test, an essay, review, term paper, course project, report for the internship period, solving cases, tasks from the subject area, diploma thesis and others.

Item Response theory (IRT) develops formal models of assessment for test control of student's knowledge some of which have been software realized [9]:

- Winsteps (Dichotomous Rasch Model, Partial Credit Model, Rating Scale Model);
- Bilog, Multilog, Parscale (Birnbaum models and their extensions for polytomic tasks);
- Facets (Many-Facet Rasch Model);
- RUMM (Rasch Unidimensional Measurement Models);
- Conquest (multidimensional models), etc.

Test systems allow rapid and objective assessment of students' knowledge in the given subject area, but also have significant disadvantages, for example, the possibility of random answer selection, the complexity of developing high-quality tests, the lack of specialists in the field of test theory, the impossibility to assess abstract, creative knowledge, and more.

Striving to avoid the drawbacks of test systems increasingly directs the attention of experts to the use of written works as a tool to measure the knowledge or skills that students learn in certain subject areas [1], [4]. Development of essays, term papers, review papers, course projects, etc. develops creative thinking, ability for structuring, generalization and analysis of information, skills to use acquired knowledge in practice and much more.

It is intuitively clear that written works in free form are more informative than formalized tests. Their assessment is an intellectual process; its automation is connected with the realization of high technologies for text analysis. Models use artificial intelligence methods, which allow an adequate modelling of the decision-making process of assessing learners' knowledge. For formalization of knowledge graph models, semantic networks, neural networks, fuzzy sets, fuzzy logic and other formalisms for modelling under conditions of uncertainty are used. Those works still have theoretical and research nature, but will undoubtedly lead to obtaining substantial results and software methods for their realization.

The actuality of the problem is confirmed by the fact that many famous institutions and leading IT companies (CIA, IBM, Google, Yandex, Megaputer Intelligence (http://megaputer.ru/), RCO (http://www.rco.ru/) and many others) actively develop technologies and efficient algorithms for formalized analysis of textual content. In [9] some experience in development of hybrid expert system for knowledge assessment in distance education is shared. An innovative development of Modern Humanitarian Academy, Moscow, Russia (http://www.muh.ru/), uses semantic networks and realizes a multicriteria approach for measuring the quality of written works of students and (according to the authors), provides the necessary objectivity and operability of the process through robotization of the system [5]. The result is a formalized document - a review of the work that serves as a basis for forming of assessment.

OBJECTIVES, METHODOLOGY AND RESEARCH DESIGN

Research objective

The student works, such as essays, papers, term papers, reviews, course projects, course works, and others are presentations in free form which are assessed by a lecturer. Here we exclude the assessment of diploma works and computer programs, which have different models.

The problem of estimating is non-formalized and is solved under conditions of uncertainty of various types determined by criteria and linguistic rules for decision making.

The aim of this work is to propose and give reasons for a formalized approach to assessing of students' written works by means of unconventional application of the one-

parameter Rasch model. The model allows software realization and can be used in all forms of education, but is especially useful in distance learning, where there is no direct contact between the assessor and assessed.

Applicability of the Rasch model

The possibility of use of unidimensional Rash model [2], [3] to formalize the evaluation of written works of students follows from the following considerations, which are not inconsistent with actual practice, and the nature of the thinking process of the lecturer:

• Learners' knowledge and difficulty of written work are evaluation parameters, which allow an objective assessment, regardless of the assessor and used measuring tool. The rejection of that view leads to questioning of the possibility of objective assessment of learning outcomes at all.

• Written work is a tool to measure students' knowledge in a particular subject area.

• Subject to assessment is the latent variable <quality of student's written work> that does not allow direct measurement, but can be measured objectively.

• The lecturer is able to assess objectively the quality of work; moreover, higher quality work will be rated higher.

• The probability for qualitative development of written work depends on its complexity: the more complex in theoretical and practical terms a particular work, the lower the probability for its quality accomplishment regardless of who develops it.

• It's intuitively clear that the trained student will develop a higher quality work compared to the unprepared one, regardless of work complexity and the assessor.

• Scores of different, equally competent lecturers, on one and the same work can differ from one another insignificantly because of unavoidable measurement errors, but not due to the differences in competencies.

• Thorough analysis of lecturer's thinking in the decision-making process for evaluation formation shows that lecturers have a subjective inclination to encourage knowledgeable students and negative expectations of unknowing ones which affects the assessment. Likewise, because of nonlinearity, the Rasch model favours knowledgeable students and is unfriendly towards unknowing ones.

Formalization of the problem of the evaluation of written works

The latent variable <quality of the written work of the student> does not allow a direct measurement, but can be decomposed into indicator variables (or criteria) that can more easily be evaluated.

We introduce the following notations:

$S = \{s_1, s_2, \dots s_m)$) is a finite, discrete set of written works, which are subject to evaluation;

D – a finite, discrete set of diagnoses;

$C = \{c_1, c_2, \dots c_n\}$ – a finite, discrete set of given criteria (indicator variables);

$A = ||a_{ij}||$, i=1,2,…m, j=1,2,…n – a matrix containing the results of the evaluation; $a_{ij} \in L$ is the rating of the work s_i on the c_j criterion;

L – a discrete scale of assessments' values.

Using the linguistic model of decision making for evaluation of written works, the greatest semantic proximity can be achieved, if it is regarded as a task for a diagnosis of a type (1):

$$<S, C, L, A, D>, \quad (1)$$

with the following formulation: For any written work $s_i \in S$ determine the diagnosis $d \in D$ on the basis of results A from the estimations based on criteria C given in the scale L.

Formally, this means to find an injective image (2):

$$\Omega: S \rightarrow A \rightarrow D \quad (2)$$

of quantitatively measured opinion of quality of the written works A in the set of diagnoses D. The image $S \rightarrow A$ is obtained as a result of evaluation of works $s_i \in S$ on the

basis of given criteria $c_j \in C$ by the lecturer. In order to obtain $A \rightarrow D$ we apply the Rasch model for dichotomous data [1], [3].

Unidimensional Rasch model

The Rasch model is designed to assess results of testing. It establishes a correspondence between observed results of the test solving and two sets of latent variables associated with the difficulty of the test and the proficiency of learners [2], [3].

Paraphrasing the Rasch model, we can assume that the probability P for a student with proficiency S to develop a work of high-quality with difficulty T is defined by the following formula:

$$P(S,T) = \frac{S}{S+T}$$

The function P(S, T) is called a function of success, and the variables S and T - latent variables. If we introduce the following notations:

$$A = LN(S), S = EXP(A)$$

$$B = LN(T), T = EXP(B)$$

for P we get:

$$P(S,T) = \frac{EXP(A)}{EXP(A)+EXP(B)} = \frac{1}{1+EXP(B-A)}$$

The resulting ratio is called the basic logistic model of Rasch. From the last formula it is seen that the probability of success depends only on the difference B-A, which is why the Rasch model is one-parameter. The model parameters A and B characterize the proficiency of the student and the difficulty of the written work and are measured in logit. If A = B = 1 logit, then P = 0.5, what semantically means that the probability for a standard student to prepare a standard work is 0.5. If the proficiency of the student is much greater than the difficulty of the work (B - A $\rightarrow$ - ∞) then the probability to develop a written work of high quality P $\rightarrow$ 1. In case of much less proficiency than the degree of difficulty of the work (B - A $\rightarrow \infty$), the probability of a quality development is P $\rightarrow$ 0.

Selection of a scale

Selection of a scale is an expert one and depends on the nature of the solved problem and the competence of the expert. Continuous scales can be used for a formalized program evaluation but the accuracy is limited. In practice, there are numeric or linguistic discreet scales L, satisfying the requirements for finiteness and completeness:

$$L = \{l_1, l_2, \dots l_k\}, l_i \neq l_j \text{ if } i \neq j \text{ и } l_i < l_j \text{ if } i < j$$

The number of terms is selected from 2 to 9 in such a way that specialists can effectively allocate 2-9 states.

The Rasch model used in dichotomical scale {yes, no} ≡ {0, 1}, which is a little informative. Select the scale L = {bad, good, excellent} ≡ {1, 0.5, 1}. It is applicable with minor modification to the Rasch model. This scale is convenient for teachers, and gives greater opportunity for the formation of unambiguous assessment compared to the scales in which the number of terms k > 3.

Assessment criteria of written work

The choice of criteria for assessing the quality of the project has significant relevance to the objectivity of the evaluation.

Criteria described linguistically, their interpretation may arise ambiguities, inaccuracies, related to their subjective interpretation of teachers.

The convolution of multi-criteria assessment in scalar is a result of the establishment of preferences in sets with high dimensionality, in which objects are represented by a large number of traits that are determined on linguistic scales.

The lecturer follows the non-formalized rules that lead to ambiguous assessment due to the subjectivity of experts and linguistic uncertainty of the terms used. Evaluation is formed as a result of operations that are difficult to formalize, for example:

<the work is not very well structured> and <goal not clear> and <poor knowledge of scientific terminology> and <detailed analysis is made>), etc.

The analysis shows the following:

<the work is not well structured> - linguistic variable <structure> is used with the term set {badly ,well, excellent}. Each term is fuzzy set.

{very well-structured} – the operation concentration on fuzzy set {well};

{not very well structured} – operation negation on fuzzy set {very well-structured};

<the goal is not clear> is a linguistic variable <purpose> with the term set {not clear, clear}

<the work is not very well structured> and <goal not clear> - the operation intersections of fuzzy sets, etc.

The evaluation of various student works as intended (essay, review, term paper, ets.) requires a different set of criteria that must comply with the specifics of the work. Some criteria are universal: layout as required, completeness, proper citation of sources and others. For scientific papers must be included criteria such as originality, knowledge and use of scientific methods, scientific value of the results, etc.

In Bulgarian universities to test the student knowledge and skills in a discipline "referats" are often used.

Referat (Bulgarian: Реферат, German: Referat, Latin: Refere - report) - a written statement on a topic, which summarizes information from several sources. It includes basic factual information and conclusions, without further interpretation or critical remarks by the author. It enables the assessment of the author's knowledge in the subject area, the skills for selection, processing, systematization and structuring of scientific literature, using and understanding the terminology, layout according to the requirements, proper citation of sources etc.

The translation of the word "реферат" in English is associated with inaccuracy, apparently caused by the lack of similar format of written assignments in foreign universities. Close in their meaning are report, abstract, student paper, review, review paper, student review paper, scientific review paper, etc. We will use „scientific review paper".

For the purpose of the experiment were selected 11 criteria for assessing the quality of the scientific review papers. They were selected on the basis of the analysis of Internet sources and consultations with lecturers.

Criteria:

1. Compliance with the requirements of the work layout.
2. Clearly defined purpose.
3. The content according to the purpose of the work.
4. A review of world achievements on the topic
5. Relevance of the review to the topic.
6. Adequate use of scientific terminology.
7. Logically organized text.
8. Completeness of the topic.
9. The deep analysis of the problem
10. The credibility of conclusions.
11. Independence of the work

The last criterion cannot be assessed objectively by the lecturer. For this purpose, an anti- plagiarism system is used (Advego Plagiatus, http://advego.ru/plagiatus/), which checks the text on the uniqueness and gives the result in percent. In the presence of borrowings greater than a preselected threshold of acceptability (for example, 40%), the work is disqualified and a bad grade is given.

Research design

The assessment is performed in the following sequence:

1. The teacher evaluates the work on pre-selected criteria in the scale L. As a result of expert evaluation, we obtain A matrix m x n, where m is the number of checked works, n is the number of criteria.

2. Calculate the primary score b_i, i = 1, 2, ...m of students as the sum of the ratings on the lines:

$$b_i = \sum_{j=1}^{n} a_{ij}$$

3. Calculate the parameters p_i , i=1, 2, ...m by the formula:

$$p_i = \frac{b_i}{n}$$

Ignore the extremal scores as follows: if b_i = 0, make p_i = ε; if b_i is equal to the maximum score, make p_i = 1 - ε where ε is quite a small number, for example, ε = 0,001.

4. The initial approximation of the evaluation of the i-s work is calculated by the formula:

$$A_i = LN\left(\frac{p_i}{1-p_i}\right), i = 1,2,...m$$

5 Calculate the primary score c_j, j = 1, 2, ... m of criteria, obtained by summing the ratings on the columns.

$$c_j = \sum_{i=1}^{m} a_{ij}$$

6. Calculate the parameters p_j , j=1, 2, ...n by the formula:

$$p_j = \frac{c_j}{m}$$

Similarly to (3) if c_j = 0, make p_j = ε; if c_j is equal to the maximum score, make p_j = 1 – ε.

7. Calculate initial values of the criteria difficulty by the formula:

$$B_j = LN\left(\frac{1-p_j}{p_j}\right), j = 1,2,...n$$

8. The final assessment of written work is obtained by linear transformation Ai $\in$ [min(A_i), max(A_i)], i = 1, 2, ... n] of the scale {2,3,4,5,6} ≡ {bad, fair, good, very good, excellent}.

DISCUSSION OF THE RESEARCH OUTCOMES

To test the possibility of using the described method an experiment was carried out. The developed review papers of students from Shumen University, studying the discipline "Programming for office systems" were assessed by the lecturer and with the use of the Rasch model. Part of the results is shown in table 1.

Table 1. Experimental results of evaluation of review papers of students

Criteria / Student	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11. (%)	11. {0; 1}	Primary ball bi	p_i	Ai=Ln(p_i/(1-p_i)) in logits	Evaluation	Teacher assessment
Student 1	excellent	excellent	bad	excellent	excellent	excellent	excellent	excellent	excellent	excellent	16	1,00	10,00	0,909	2,303	**6**	6
Student 2	good	excellent	good	excellent	excellent	excellent	excellent	excellent	excellent	excellent	22	1,00	10,50	0,955	3,045	**6**	6
Student 3	excellent	excellent	bad	excellent	bad	excellent	bad	excellent	excellent	bad	30	1,00	6,00	0,545	0,182	**4**	6
Student 4	bad	good	bad	bad	good	bad	excellent	bad	excellent	bad	27	1,00	4,50	0,409	-0,368	**4**	4
Student 5	bad	bad	bad	excellent	bad	excellent	bad	bad	bad	excellent	36	1,00	4,00	0,364	-0,560	**3**	4
Student 6	bad	bad	bad	bad	bad	bad	excellent	bad	excellent	bad	74	0,00	2,00	0,182	-1,504	**2**	3
Student 7	bad	bad	good	bad	bad	bad	excellent	good	excellent	excellent	53	0,50	4,50	0,409	-0,368	**4**	3
Student 8	excellent	bad	bad	bad	excellent	bad	bad	bad	bad	excellent	35	1,00	4,00	0,364	-0,560	**3**	4
Student 9	excellent	excellent	good	bad	bad	good	bad	excellent	bad	bad	79	0,00	3,00	0,273	-0,981	**3**	4
Student 10	excellent	good	excellent	good	excellent	excellent	excellent	excellent	excellent	excellent	53	0,50	9,50	0,864	1,846	**6**	6
Student 11	bad	excellent	excellent	excellent	bad	excellent	bad	bad	excellent	bad	20	1,00	6,00	0,545	0,182	**4**	6
Student 12	excellent	excellent	good	bad	excellent	good	excellent	bad	excellent	bad	36	1,00	7,00	0,636	0,560	**5**	5
Student 13	excellent	bad	bad	bad	good	excellent	bad	bad	bad	good	47	0,50	3,00	0,273	-0,981	**3**	3
Student 14	excellent	good	bad	excellent	bad	excellent	bad	good	bad	excellent	24	1,00	5,00	0,455	-0,182	**4**	5
Student 15	bad	bad	good	bad	bad	good	bad	bad	bad	bad	98	0,00	1,00	0,091	-2,303	**2**	2
Student 16	bad	bad	bad	excellent	excellent	bad	good	bad	bad	good	62	0,00	4,00	0,364	-0,560	**3**	3
Student 17	good	excellent	excellent	good	excellent	bad	excellent	excellent	excellent	excellent	41	0,50	9,00	0,818	1,504	**6**	6
Student 18	excellent	good	bad	excellent	bad	good	bad	bad	bad	bad	67	0,00	2,00	0,182	-1,504	**2**	3
Student 19	excellent	bad	good	good	bad	good	bad	bad	good	bad	37	1,00	3,00	0,273	-0,981	**3**	4
Student 20	good	excellent	bad	excellent	good	bad	excellent	excellent	bad	excellent	38	1,00	7,00	0,636	0,560	**5**	5
Student 21	bad	bad	good	good	good	excellent	bad	bad	good	excellent	11	1,00	5,50	0,500	0,000	**4**	4
Student 22	excellent	good	bad	bad	bad	excellent	good	bad	bad	bad	45	0,50	2,50	0,227	-1,224	**3**	3
Student 23	bad	bad	good	bad	bad	excellent	bad	bad	excellent	good	31	1,00	4,00	0,364	-0,560	**3**	4
Student 24	excellent	good	bad	excellent	bad	bad	excellent	excellent	good	bad	49	0,50	4,50	0,409	-0,368	**4**	4
Student 25	good	bad	excellent	bad	excellent	good	bad	bad	bad	bad	49	0,50	4,00	0,364	-0,560	**3**	4
Student 26	bad	bad	good	bad	bad	excellent	excellent	bad	good	excellent	27	1,00	5,00	0,455	-0,182	**4**	4
Student 27	excellent	good	bad	excellent	bad	bad	bad	good	bad	bad	36	1,00	3,00	0,273	-0,981	**3**	4
Student 28	bad	excellent	bad	bad	bad	excellent	good	bad	bad	good	55	0,50	3,50	0,318	-0,762	**3**	3
Student 29	excellent	good	bad	excellent	bad	bad	bad	excellent	good	bad	46	0,50	3,50	0,318	-0,762	**3**	3
Student 30	excellent	good	excellent	excellent	excellent	excellent	excellent	excellent	excellent	good	47	0,50	9,50	0,864	1,846	**6**	5
Primary ball c_j	11,00	13,50	9,50	15,00	11,00	17,00	13,50	11,50	14,50	13,50							
p_j	0,367	0,450	0,317	0,500	0,367	0,567	0,450	0,383	0,483	0,450							
Bj=Ln((1-p_j)/p_j) in logits	0,547	0,201	0,769	0,000	0,547	-0,268	0,201	0,475	0,067	0,201							

Analysing the results, we can draw the following conclusions:

- The proposed model realizes a multi-criteria approach for measuring the quality of written works of students.
- Convolution of linguistically defined vector score in scalar using the Rasch model helps the lecturers in their work.
- The criteria should allow an objective assessment. Therefore they must be accurate, clear, unambiguous, without use of logical connections (and, or, not).
- The difference in the estimates by the Rasch model and those by a lecturer (the last columns in the table) is due to the subjectivity of the lecturer. Some of the assessments given to students who have regularly attended classes (and known by the lecturer!), are higher. In actual examinations the lecturer should evaluate written works "in the dark".
- The criteria are of unequal weight. Artificial determining of weights (for example, when processing an expert opinion), can distort the information on the proficiency of the students.
- In repeated real experiments, statistical data can be used to "fit" ("Within population item-fit") the input parameters (criteria) to the requirements of the model. The simple criteria (which are met by all) and the complex ones (which none of the works meets) criteria can be excluded.
- Plagiarism compromises the assessment. All written works must be checked for uniqueness by means of anti-plagiarism system. Non-unique works (for example, plagiarism > 40%), get a poor mark. If the percentage of plagiarism is low or missing, it is impossible to formally determine the authorship of the texts. Authorship of the student work can only be ascertained in a direct contact between the assessor and assessed.

CONCLUSIONS AND FUTURE WORK

A software realization of the proposed method is forthcoming as a part of developed "Intelligent system for evaluation of students' knowledge".

The Work is in the following areas:

- Development of a formalized method for determining the criteria.

- Development of methods for the evaluation of written works of students. In addition to the Rasch model, a fuzzy model based on the theory of fuzzy sets is being developed.
- Selection of appropriate scales and methods for correct conversion of the assessments from one scale to another.

REFERENCES

[1] Black A. Tools for Education Assessment. Retrieved 21.06.2015 from http://www.ehow.com/info_7896270_tools-education-assessment.html

[2] Bond T.G, James Cook Applying the Rasch Model. Fundamental Measurement in the Human Sciences, 2007. Retrieved 21.06.2015 from https://mmm1406.sanjose14-verio.com/rascho/books.htm

[3] Maslak, A. A., Measurement of Latent Variables in Social and Economic Systems: Theory and Practice. Slavyansk-na-Kubani: Publishing Center SGPI, 2007

[4] Methodology of Educational Measurement and Assessment. Series Editors: Veldkamp B., von Davier, M. Springer, Retrieved 21.06.2015 from http://www.springer.com/series/13206

[5] Киселева Л.А., В.Г. Ерыкова, Роботизированное оценивание творческих работ как инструмент повышения качества подготовки выпускников. Retrieved 21.06.2015 from http://www.muh.ru/content/doc/2012/120924_kiseleva.pdf

[6] Лобанева А. Р. Разработка программного продукта для оценки качества тестирования в рамках модели Раша. Журнал Вестник Кемеровского государственного университета , Выпуск № 4 (56), том 2, 2013

[7] Пета национална конференция по електронно обучение във висшите училища. Русе, 2014. Retrieved 21.06.2015 from http://www.elearning-conf.eu/nkeo2014/

[8] Сподели своя опит, предай нататък. Уеб-базирана платформа за сътрудничество чрез обмен на творчески практики и успешен образователен опит. Retrieved 21.06.2015 from https://teachfolio.wordpress.com/

[9] Томашева Л. Ю. Система оценки качества знаний студентов дистанционного обучения. Retrieved 21.06.2015 from http://elib.altstu.ru/elib/books/Files/pa2010_2/pdf/196tomasheva.pdf

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The paper has been reviewed.