Determining a set of measures for quality estimation of e-resources conformant to the model/models defined in traditional education

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Abstract: – In the paper, we discuss our research devoted to defining a set of measures sufficient for the e-resources quality estimation – from the didactic point of view. In the very beginning, we worked with one of the traditional teaching models – the model of effective learning. Successively, we took an attempt to generalize the results on any teaching model through construction of a metamodel of teaching. Basing on the metamodel, we defined a set of measures useful for estimation of e-resources quality. Then, we carried out a multidimensional statistical data analysis among 56 e-resources' population. As a final result, we assumed a subset of the initial set of the considered measures as a set of measures sufficient for the e-resources quality estimation.

Key-Words: – e-learning, e-resource, quality of e-resources, learning model

1 Introduction

In recent years, we can observe a great dynamic growth in the development of new kind of teaching – e-learning. E-learning, interpreted as teaching exploiting new information technologies (e.g.: computer nets: intranet, Internet) differs from traditional ways of education. The traditional teaching paradigms, which are rather no longer suited to the work within virtual work space, make educators and researchers to consider the new approaches to the didactic processes. Additionally, new valuable capabilities of virtual environment should be taken into account to support e-learner during his/her self-learning process – which is more important in e-learning then in traditional classroom teaching.

A lot of e-resources created nowadays conform to some of existing standards (IMS, SCORM 2004, LOM, etc. [1], [2], [3]). Unfortunately up-to-date, these standards impose only e-resource structure; they practically don't pay attention to the quality estimation (in didactical, content-related, technical aspects, etc.).

In the paper, we have presented our research devoted to defining a sufficient set of measures for the e-resources quality estimation – from the didactic point of view.

At the introductory stage of our research, we have proposed the quality measures' set basing on e-resource structure conformant to the model of effective learning [4], [5], [6].

Then, with this set of measures, we have carried out a multidimensional statistical data analysis among 56 e-resources' population – using GradeStat program's tools (like overrepresentation map), developed in Institute of Computer Science, Polish Academy of Sciences [7],[8],[9]. Because of the too large size of the set, we have decided to constrain it. As a result, a sufficient subset of measures, which could be useful for introductory e-resource quality estimation (called further *sufficient measures' set*), was determined [10], [11], [12].

Because of the fact, that our considerations were conducted for the one of traditional teaching models, at the next step we have taken an attempt to generalize the conclusions on any teaching model. We have proposed a metamodel of teaching and a new set of measures – conformant to this metamodel, basing on the analysis of the most popular models exploited in traditional education [14].

The paper is organized as follows. Section 2 briefly presents our previous research concerned defining a sufficient set of measures for the model of effective learning. In section 3 we have presented results of examination a new sufficient measures' set

– for the metamodel of teaching. Section 4 concludes the paper and outlines our future research.

2 Sufficient set of measures – for the model of effective learning

The research, which we have carried out to define a sufficient set of measures, were conducted in the following steps:

1. Defining the measures' set for estimating an e-resource quality – based on the model of effective learning.
2. Constructing a questionnaire, to help to estimate the quality of the available e-resources – in the didactic aspect and carrying out a statistical analysis of the gathered data.
3. Basing on the analysis results, defining a sufficient subset of measures for the introductory estimating the quality of e-resource.

The above mentioned research was discussed in details in our previous publications [6], [10], [13].

Ad.1 To remind, the model of effective learning requires: (1) hierarchical structure of an e-resource (two levels of hierarchy), (2) for both of the hierarchy levels, the correct order of partial elements, (3) the preservation of mutual proportions of the 1st level elements. The measures' set for an e-resource, constructed according to above requirements, was defined as following:

(1) F_{mefl} = {0.t, 0.1.p, 0.1.q, …, 0.4.p, 0.4.q, 0.1.1.p, 0.1.1.q, …, 0.1.4.p, 0.1.4.q, 0.2.1.p, 0.2.1.q, …, 0.4.3.p, 0.4.3.q },

where:

for the measures, we propose the following syntax:

position_in_resource. suffix:

- *position_in_resource* – defines the path of nesting for the partial element; "0" stands for a resource as a whole (the root of hierarchy). For example, *„0.2"* determines the 2nd element of the 1st level of hierarchy.
- *suffix* states the kind of measure, as following:
  - *p* – means the presence of the element in e-resource. The measure takes an integer value from the interval [0, 1]; 1– if the considered element is present in the resource, while 0 – means its lack.
  - *q* – determines the quality of the element, assessed by a respondent. The measure takes an integer value from the interval [0, 5].
  - *t* – states the preservation degree of the mutual proportions of the elements nested in a given element (required by the model); for example *„0.t"* means the preservation degree for the 1st level elements. The measure *t* takes a real value from the interval [0, 1]. The values of measures are connected with the GradeStat' concentration indexes. The concentration index = 0 means that the proportions of the nested elements are totally preserved.

Ad.2 It is easily seen, that the statistical analysis done among the 56 e-resources' population proved that e-resources with structures conformant to the model of effective learning have got better marks from the respondents [6], [13]. As we have additionally observed, it was possible to define two subsets for the F_{mefl} set: 1st – a subset of differentiating measures – it allows to choose the best e-resource among the given population; 2nd – a subset of non-differentiating measures which allows to estimate a quality of the single e-resource.

Because of the F_{mefl} set cardinality (29 elements), connected with the potential difficulties of the e-resource quality estimation, determining a sufficient subset of measures was needed and practically necessary.

Ad.3 Basing on the analysis of the GradeStat' overrepresentation maps and clustering analysis, we have obtained the following sufficient subset of measures (see Table 1).

	Non-differentiating measures' set
0.1.q	Introduction
0.1.1.q	Abstract and indication of key elements
0.1.3.q	Motivating the learner to start using the resource
0.2.p	Main content
0.2.q	Main content
0.2.1.p	Base knowledge
0.2.3.q	Examples of applying new knowledge in practice
0.3.p	Summary
0.3.1.p	Recapitulation
0.4.p	Evaluation
0.4.1.p	Self-evaluation
0.4.1.q	Self-evaluation

Table 1

It is easy to observe, the initial set of measures was significantly limited; the new set contains 12 measures instead of 29.

We have also noticed, that except the quality measures, the subset contains also the measures connected with the presence of the elements (e.g. 0.2.p). It means that the presence of some elements required by the model has an influence on the resource quality.

At the next step, we have an attempt to generalize the results on any traditional teaching model. To achieve this goal we have analysed the most popular

models defined by the educators for the needs of the traditional teaching. In the end, we have proposed: (1) the metamodel based on the generalized features of the traditional models [15]; (2) the new set of measures. Then we have carried out the renew examinations to define the new sufficient set of measures.

3 Sufficient set of measures – for any traditional teaching model

The analysis we have done for the most popular teaching models elaborated by traditional educators [15] allowed us to formulate the following observations:

1. In publications, connected with the didactics, discussions of about several dozen didactic models, like for example the process-recognition, behavioural, social and personal development models, can be found. The model of effective learning, discussed in section 2, is a member of the first group. It seams to be impossible to exploit all of these models in the e-learning: sometimes because of their necessity for cooperative work (e.g. playing roles during classes – social models) or the need of permanent control and support provided by the teacher. We have skipped these kinds of models in further considerations.
2. Despite the differences between particular models it is possible to extract their common features. Basing on them, it is possible to define a teaching metamodel, which could be useful for constructing e-resources with the structure conformant to the models known in traditional education.
3. The models exploited in traditional teaching have a processing character – they are described by the sequence of particular stages, which have to be carried out in the required sequence. Then at the beginning it is necessary to adapt them to the e-learning needs.

In the first step, we have chosen the groups of the traditional teaching models, which potentially could be used in the teaching with exploiting the newest information technologies.

Like for the model of effective learning, for each of the chosen models, we have taken an attempt to convert the process into an ordered structure. To the every distinguish model stage, an appropriate metamodel partial element (called learning unit) was assigned. The metamodel defined in above way constituted the base for the further considerations (see details in [14]). According to it, the new set of measures was determined as below:

(2) F_n = {0.t, 0.o, 0.1.p, 0.1.o, …, 0.4.p, 0.4.o, …, 0.1.1.p, …, 0.1.4.p, 0.2.1.p, …, 0.4.3.p, …},

where:
for the measures, the following syntax was chosen:
position_in_resource. suffix:

- *position_in_resource* – (see section 2).
- *suffix* states the kind of measure, where:
  p – (see section 2).
  t – (see section 2).
  o – defines the degree in which the elements nested in a given e-resource element preserve their mutual order. The measure *o* takes the value from the interval [0, 100], in per cent. 100% means that the order required by the model is totally preserved. If *o* value is ≠ 100%, it means element with the more or less disordered structure. For example, *„0.2.o"* determines the preservation degree for the elements nested in the 2nd partial element on the 1st level of hierarchy. Exemplary method for the preservation degree calculation was presented in [14].

The following considerations will be conducted on the basis of the model of effective learning. For this model, we have defined the set of measures as below:

(3) F_{n_mefl} = {0.t, 0.o, 0.1.p, 0.1.o, …, 0.4.p, 0.4.o, …, 0.1.1.p, .., 0.1.4.p, 0.2.1.p, …, 0.4.3.p}

Like in section 2, the new set of measures is too large to effectively use it in estimation of e-resources quality – there are 24 measures.

Therefore, the further examinations were concentrated on the attempts to: (1) constrain the size of F_{n_mefl} set, (2) determine a sufficient subset of measures which could be useful for introductory e-resource quality estimation in practice.

Like previously, the same population of 56 e-resources (section 2) was examined through the statistical analysis with the GradeStat tools. Because of the fact, that only 37 e-resources have determined the values for the t-measure, the further consideration was based on this subset of the population. Additionally, in F_{n_mefl} set we have omitted the measures without the values determining by the respondents, like following: 0.1.o, 0.2.o, 0.3.o, 0.4.o. These were the measures connected with the order of nested elements.

In the Fig. 1, we present the results of the statistical date analysis conducted among the same

population as before. We have used the GradeStat overrepresentation map.

To remained:

The rows of the map represent e-resources while the columns – the measures. To describe them, we have used the following convention: (1) the rows – by the marks of e-resources (got from the respondents), (2) the columns – by the names of the measures defined for F_{n_mefl} set. The order of the map's rows and columns is determined by GradeStat program. The left-most and the right-most columns represent the measures which differentiate the population in the highest degree. Additionally, the overrepresentation map's fields have various shades of grey. The shading degree depends on comparison the real value of the particular measure for the given e-resource to expected value of this measure.

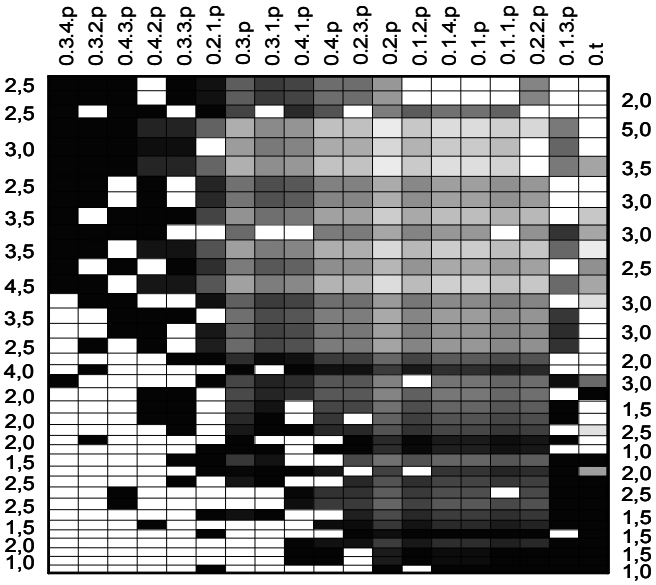

Fig.1 Overrepresentation map for the population of 37 e-resources

Analyzing the map presented in Fig.1 we can distinguish two subsets of measures: the measures which non-differentiate the given population (the middle columns of the map) and those which differentiate the population (the most-left and the most-right columns). The provide this it is necessary to do: (1) the analysis of Rho* variations; (2) the cluster analysis for the rows and columns of the overrepresentation map.

Ad (1) Rho* stands for the total diversity index for the set of rows/columns; to calculate Rho*, the concentration indexes are used. The Rho* value strongly depends on the order of the rows/columns.

Ad (2) The cluster analysis basis on the aggregation of some columns into one column (similarly it is done for the rows). The optimal number of clusters are obtained when the changes of the subsequent Rho* values are negligible.

Detailed description of the above notions you can find in [7], [9].

In Fig.2 two charts of the Rho* values in function of the number of clusters for the F_{n_mefl} set are presented (separately for the rows/columns).

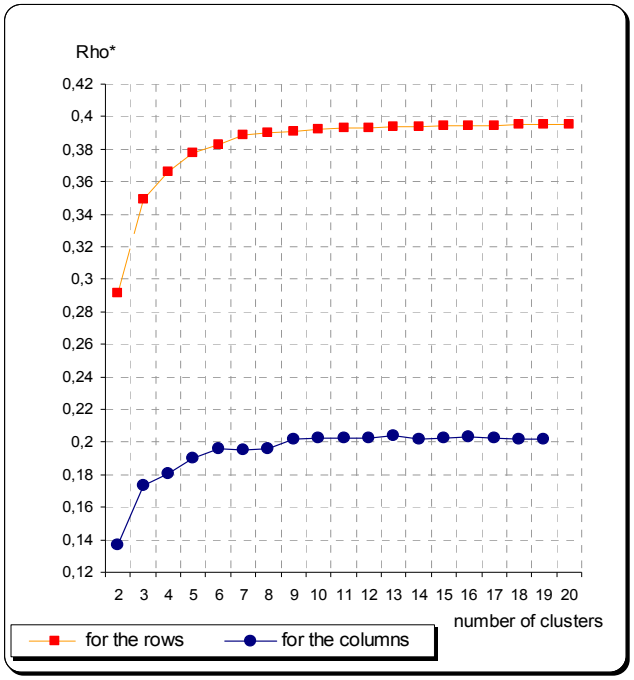

Fig.2. The Rho* for the different values of the number of clusters – for the F_{n_mefl} set.

The changes of subsequent Rho* values are presented in Fig.3.

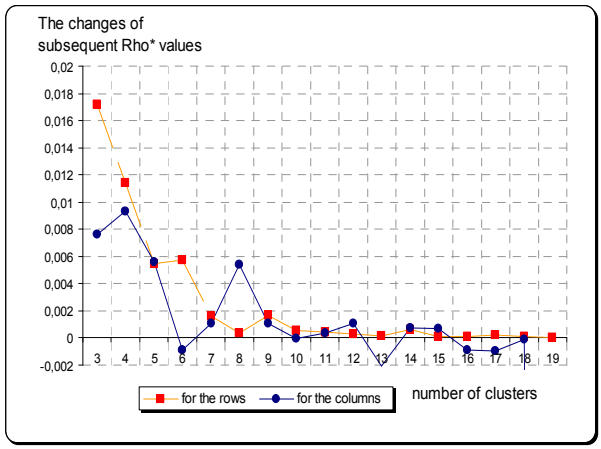

Fig.3 The changes of the subsequent Rho* values in the function on numbers of clusters – for the F_{n_mefl} set.

After the analysis of the two above charts, the following numbers of clusters for the F_{n_mefl} were chosen: 7 for the rows and 9 for the columns.

The overrepresentation map, with the chosen number of clusters is presented in Fig.4.

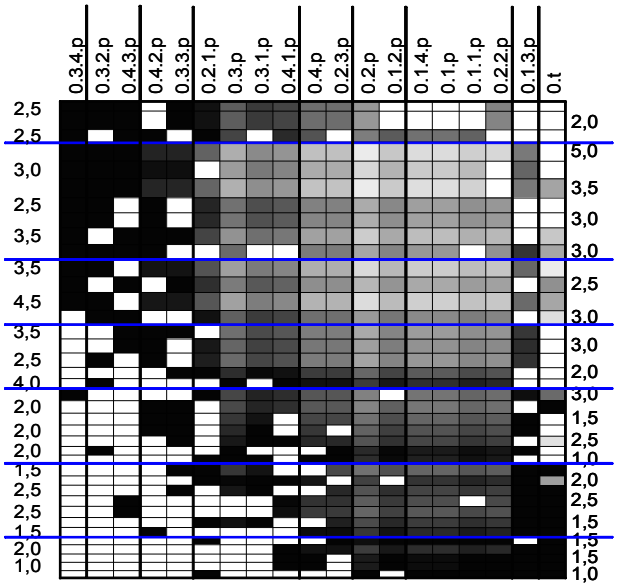

Fig.4 The overrepresentation map with the chosen number of clusters.

In the next step, to find the non-differentiating measures' set, the calculation of the average overrepresentation index for every cluster has to be done.

For each cluster, the average value of the overrepresentation indexes is presented in Fig.5. For the map, we have taken the following description: (1) the every row is labelled by both the cluster number and the average marks for the connected e-resources; (2) the every column – by cluster number and the names of the connected measures.

	1 0.3.4.p	2 0.3.2.p 0.4.3.p	3 0.4.2.p 0.3.3.p	4 0.2.1.p 0.3.1.p 0.4.1.p	5 0.4.p 0.2.3.p	6 0.2.p 0.1.2.p	7 0.1.4.p 0.1.1.p 0.2.2.p	8 0.1.3.p	9 0.t
2,33 1	0.6042	1	1	0.9166	0.5	0.3333	0	0	0
3,57 2	0.5006	1	1	0.9166	0.6666	0.5416	0.25	0.0833	0
3,38 3	0.5232	0.9166	1	0.9166	0.9166	0.5416	0.4166	0.1666	0.1666
3,0 4	0.2487	1	1	1	1	0.85	0.5	0.3	0
2,0 5	0.2794	1	1	1	1	0.9642	0.6428	0.5714	0.7142
2,0 6	0.3939	0.6666	1	1	0.9166	0.7916	0.8333	0.8333	1
1,4 7	0.0041	0.5	0	0.5	1	1	0.5	1	1

Fig.5 The overrepresentation map with the average values of the overrepresentation indexes for the clusters.

To decide which measures are common among the analysed population, the columns for which the most significant changes of values can be observed should be found. According to these rules, the clusters 5 and 6, and respectively the measures contained in them were chosen.

The set of non-differentiating measures is presented in Table 2.

	Non-differentiating measures' set
0.2.1.p	Base knowledge
0.2.3.p	Examples of applying new knowledge in practice
0.3.p	Summary
0.3.1.p	Recapitulation
0.4.p	Evaluation
0.4.1.p	Self-evaluation

Table 2

It is easy to seen, that the initial set of measures was significantly limited; the new set contains 6 measures instead of 19.

It is worth to compare this set with the sufficient measures' set described in section 2. The new set is practically included in the previous one. There is only one exception – element *0.2.3 Examples of applying new knowledge in practice*, for which the previous set includes *0.2.3.q* measure; the new set – *0.2.3.p* measure.

5 Conclusion

In the paper, we discussed our attempt to generalize the results in determining a set of measures sufficient to e-resource quality estimation on any model used in the traditional education. Basing on the set of measures, resulting from the metamodel defined by us to describe the structure of a teaching material, we established a proposition of such a sufficient set of measures.

Further works will be focused on the consideration in non-didactic features and their influence on the quality of e-learning materials. We plan to construct the new metrics, and basing on them, to carry out a statistical analysis to define a new sufficient subset of quality measures.

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