

# E-resources versus traditional teaching models

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**Abstract**—The paper presents the discussion about the e-resource structure and its influence on the resources' quality. The thesis we are taking into consideration is as follows: the conformance of e-resource structure with structures suggested by traditional teaching model/models has a strong influence on the quality of this e-resource. To achieve this, the most popular teaching models are analyzed and a proposal of the metamodel useful for e-resources construction is introduced.

**Keywords**— *e-learning, e-resource, learning model.*

## 1. Introduction

In publications dedicated to e-learning, various aspects concerning this form of education are considered. The quality of an e-resource is one of the key issues. According to researchers, it could make a significant impact on the effectiveness of e-teaching process as a whole. The main reason is the limited contact between a student and a teacher in this kind of teaching. Thus, the structure and the content of an e-resource should be well-thought-out to give more support to student during his/her self-study with the resource. Existing standards, like SCORM, IMS [1–3], define some requirements for the structure supporting e-resource construction. Unfortunately, they do not practically pay attention to the assessment of an e-resource quality in didactic and content-related aspects. According to the educators, *the quality of teaching process is strongly influenced by the degree of its conformance to the requirements defined among models existing in traditional teaching.* In the article, we present an approach to prove that the similar thesis is true also for e-teaching. We focus our attention on the quality of the resource from the didactic point of view, while its content-related aspect was left behind.

For introductory considerations, we chose the model of effective learning, discussed in details in our previous publications [8–13]. The model of effective learning, as the other ones used in traditional teaching, has a process nature. It is described by a sequence of particular stages which need to be applied in the appropriate order. Thus, the first step is an adaptation to e-learning needs. It requires the transformation of the teaching process into e-resource structure where the structure' elements preserve both the order of process stages and stages' time proportions. To generalize the results, further examinations were carried out on others traditional teaching models.

The paper is organized as follows: Section 2 describes the already achieved results. Section 3 presents the charac-

teristics of the most popular groups of traditional didactic models. Section 4 introduces the proposal of a teaching metamodel that constitutes the basis for e-resources construction. Section 5 concerns the discussion on the correspondence between e-resource structure and the structure defined by the metamodel, and the dependency between e-resource structure and its quality. Section 6 contains the conclusions and plans for future works.

## 2. E-resource quality versus the model of effective learning

In this section we recall our previous research concerning the following thesis: *the quality of e-resource is conformant to the correspondence between its structure and the ones suggested by the existing traditional teaching models.* The research was done on the basis of the model of effective learning [5, 8, 13, 15].

According to the model, a teaching resource should be constructed hierarchically with two levels of hierarchy. The first level includes four elements, such as:

1. Introduction,
2. Main content,
3. Summary,
4. Evaluation.

The second level should contain the elements which are nested in the appropriate element of the higher level (see Fig. 1).

Additionally, the structure should support some limitations put on it by the model. For the first level of hierarchy: all elements should be present in the resource, they should be kept in the right order, and they should be kept in the appropriate proportions (10%, 65%, 15%, 10% of the whole resource). For the second level: as previously, the presence of all the elements and their order are still required, whereas there are no limitations on the elements proportions. We assumed that a resource would be conformant to the model of effective learning if its structure is organized according to the requirements mentioned above.

To prove the thesis, the examination of 56 virtual e-resources was conducted. E-resources were acquired by the instructors and the students of Warsaw technical universities. The space of features (measures) was created on the basis of the resource structure conformance to the structure defined by the model.

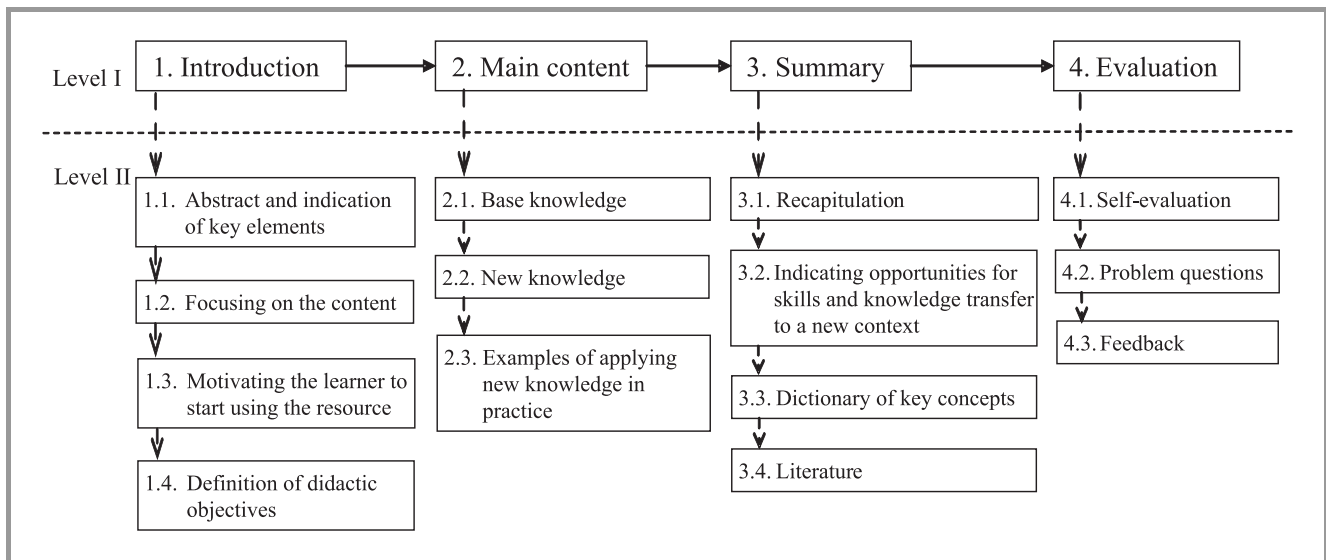


Fig. 1. The structure of a resource conformant to the model of effective learning.

For each measure, we introduced the following notation:

position\_in\_resource. suffix

where:

position\_in\_resource – denotes the nesting path for a partial element connected with considered measure. For example, if position\_in\_resource is 2 it means that the measure describes the second element on the first hierarchy level (2. Main content), while 2.3. marks the third partial element of the second level (2.3. Examples of applying new knowledge in practice).

suffix – defines the kind of measure, as following:

*p* – means the presence of a measure-connected-element in e-resource. The measure takes an integer value from the interval [0,1], where 1 means that the element is present within the resource, while 0 – means its lack. For example, for the element 2.3. Examples of applying new knowledge in practice, the measure 2.3.*p* denotes the presence of this element within the resource.

*q* – means the quality assessment of the considered element given by a respondent; the measure takes an integer value from the interval [0,5]. For example, for the element 2.3. Examples of applying new knowledge in practice, the measure 2.3.*q* denotes its quality.

*t* – defines the ratio (in percentage terms) of the estimated time devoted to work with the considered element to the time devoted to work with the resource as a whole. Traditional educators were estimating the proportions of partial elements through counting the pages of materials. Therefore, it was necessary to adapt the semantics of the measure to the complex virtual environment, where e-resources have a non-linear nature and can contain multimedia elements, etc. The measure takes the value from the interval [0, 100]. For example, if the value 1.*t* is 7 [%], it means that the element 1. Introduction takes 7% of the whole resource.

For a resource conformant to the model of effective learning, the  $F_{mefl}$  and  $F'_{mefl}$  measures' spaces are defined as follows:

$$F_{mefl} = \{1.p, 1.q, 1.t, \dots, 4.p, 4.q, 4.t, 1.1.p, 1.1.q, \dots, 1.4.p, 1.4.q, 2.1.p, 2.1.q, \dots, 4.3.p, 4.3.q\},$$

$$F'_{mefl} = \{1.p, 1.q, \dots, 4.p, 4.q, 1.1.p, 1.1.q, \dots, 1.4.p, 1.4.q, 2.1.p, 2.1.q, \dots, 4.3.p, 4.3.q\},$$

where the  $F'_{mefl}$  is a subset of  $F_{mefl}$  with the *t*-measures excluded.

In the next step, we introduced a virtual ideal e-resource to compare it against the whole examined population. The ideal resource is the one containing all required partial elements, where elements are placed in the correct order and, at the first hierarchy level, their appropriate proportions are kept.

To provide the multidimensional data analysis, we exploited ARs' tables, one of the statistical program GradeStat tools [4].

The concentration index AR allows the evaluation of a distance between a considered e-resource and the ideal one. The smaller AR values correspond to greater similarity with the model. The values of concentration index belong to the interval [0,1].

Figure 2 contains the AR chart constructed on the basis of the  $F'_{mefl}$  set and the 56 e-resources population while Fig. 3 presents the results for  $F_{mefl}$  set and 37 e-resources. In the second case, only those resources are taken into considerations for which the values of *t*-measures were given by the respondents.

On the basis of the presented results, one can notice that e-resources with the structure more conformant to the model of the effective learning, achieved better marks from the respondents than the ones with the lower conformance.

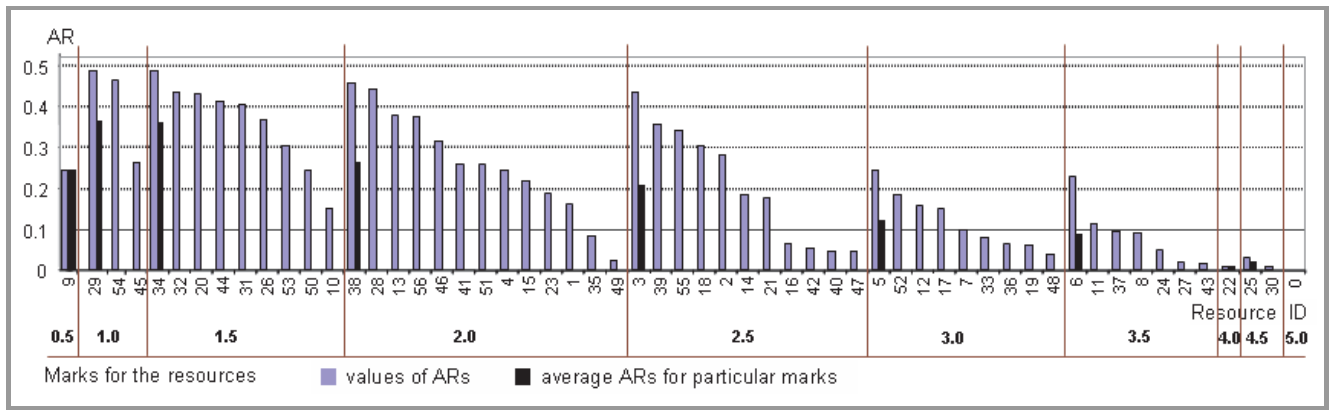


Fig. 2. ARs for  $F'_{mefl}$  and the population of 56 e-resources.

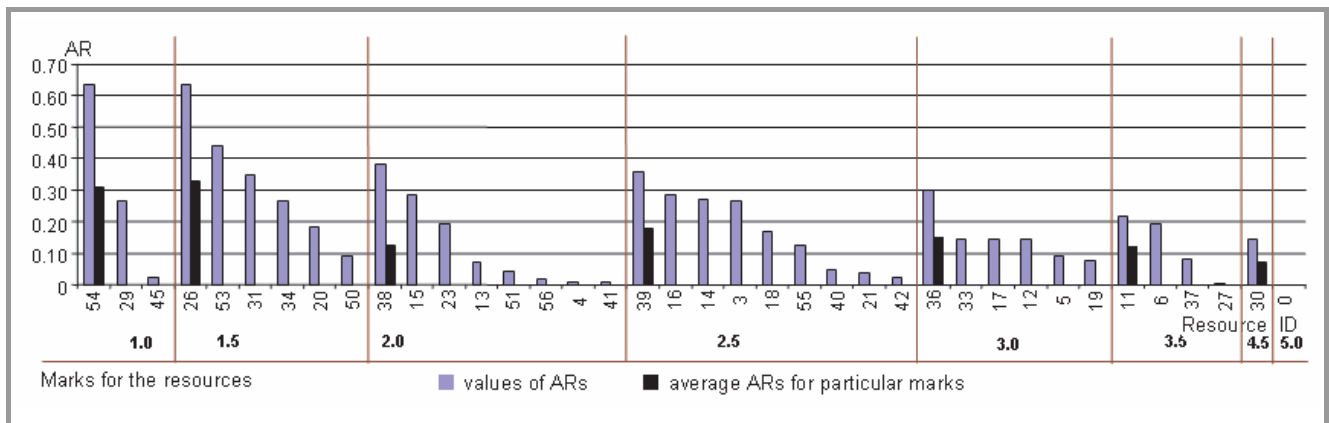


Fig. 3. ARs for  $F_{mefl}$  and the population of 37 e-resources.

To generalize the thesis formulated in Section 2 onto any traditional teaching model, further research was done. We performed an analysis of several other models to identify their common features and on the basis of that, to construct both the metamodel of teaching and the new space of measures useful for the thesis verification.

### 3. Other teaching models used in traditional teaching

A model of teaching/learning (a didactic model also called *a strategy of teaching*) defines: content, methods of learning and learner’s didactic environment [7].

There is a variety of teaching models/group of models which can supplement each other [6], so it is possible (and recommended) to combine different methods and styles into one didactic process. A teacher should choose an appropriate strategy of teaching depending on the goals that he is going to achieve. In this section, we present a more

detailed analysis of some of the models considered by us as the most useful for e-learning:

**Process-recognition models** focus on improving the learner’s mental abilities to support him/her in acquiring information, creating notion and in promoting creative thinking. That group includes: the induction model, notion creation model, synectics model, mnemonic model, model of effective learning (discussed in Section 2).

**Behavioral models** – the ones which base on the behavioral theory, where a person (treated as “a black box”) is considered as a kind of “self- improving communication system” which modifies its behavior in response of reverse information. Among them: the social teaching, program teaching, simulations, and the direct teaching models could be found.

**Social models** support learning of cooperation methods, stimulate activity, facilitate the usage of other students’ work, and examine social relations. That group includes: teaching through joint research, role-playing models, etc. According to us, social models, because of their specific features, are not very useful for e-learning needs.

**Personal development models** pay attention to the learner's internal development, integration of different aspects of learner's personality (emotions, intellect). They are focused on the stimulation of development with the active teacher's support on each step of education. Therefore, they are too difficult to use in case of self-work and as a result not useful for e-learning. The non-directive learning would be a typical representative of this group.

**Induction model** we chose for more detailed discussion. (During the research, the other models suitable for e-learning were analyzed in a similar way.) The didactic goal of the induction model is, apart from gaining new knowledge, acquiring the ability to form notion categories and to use them in the proper context.

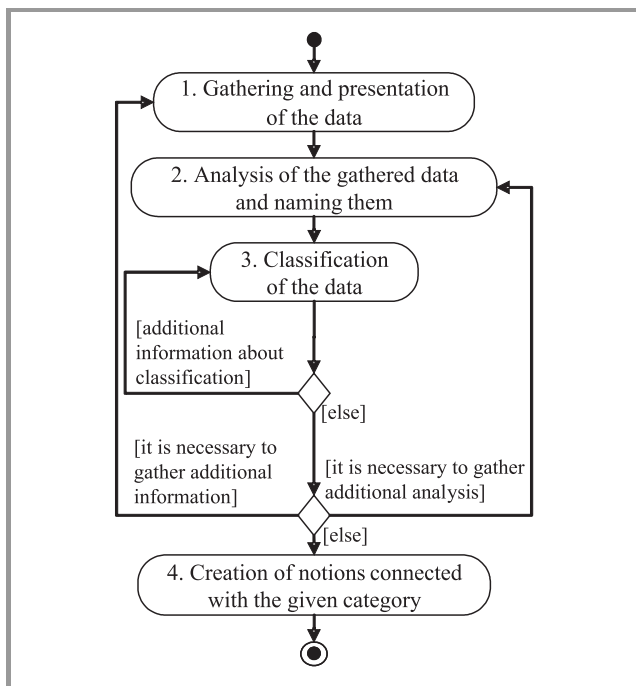


Fig. 4. Induction model.

In the induction model, the following stages can be distinguished (see Fig. 4):

#### 1. Gathering and presentation of the data

The teacher outlines the general area where the data should come from, for example natural medicine. The learners gather the data related to the given topic. It is possible that in the further stages it will be necessary to add/remove the data. When process is coming back to the stage 1, the gathered data are reorganized.

#### 2. Analysis of the gathered data and naming them

The data gathered in stage 1 are mostly incidental and chaotic. Further analysis should be performed in order to: assign the names to them and describe them using characteristic features. As a result, it is possible to define appropriate ordering of data and facilitate making use of them.

#### 3. Classification of the data

Classification of the data is necessary to exploit them in the following steps. The classification stage is performed several times. The first classification is very general. After that, it is possible to make more detailed classification. It happens quite often that there is a need to gather additional information (back to stage 1) or to carry out additional analysis (back to stage 2). Then, the renewed classification of data is executed.

#### 4. Creation of notions connected with the given category

After the data classification the learners are able to recognize the features of notions and to assign notions to the appropriate category. They also acquired the ability to formulate notions which are conformant to the given category.

### 4. Metamodel of learning

As a result of the analysis of the learning models discussed in Section 3, we noticed that some of them are effective only in the case of traditional teaching. It could be difficult to use them in e-learning, especially due to lack of frequent interaction with the teacher, what is characteristic for this type of learning. In the further research we skipped some of them. While considering the other models, it was possible: to extract some common features and to create the metamodel of teaching which could be useful in constructing e-resources with the structure corresponding to the ones used in traditional teaching. The structure of the metamodel is presented in Fig. 5.

To keep the picture clear, we avoided any comments and constraints. They were put below together with explanations concerning the values of attributes, the conditions of their optionality and derivation.

#### The Learning Model class

The derived attribute *catalogue name* is defined as following: the name of the learning models category + the name of a model's basic version (for which the number of version equals 0) + the name of the model's version + the nesting level of the version.

The model is made by the constructor(s) and may be extended by the reconstructor(s) – the person(s) working on the next version(s) of the model.

Interpretation of the attribute's value *constructors\_reconstructors* depends on the version number. If it is the model's basic version, then the values concern the constructors of the model. If it is the subsequent model's version, then the values describe the reconstructors.

The attribute *description of changes* denotes short characteristics of the most important changes made to the model in comparison with the previous version – as a text.

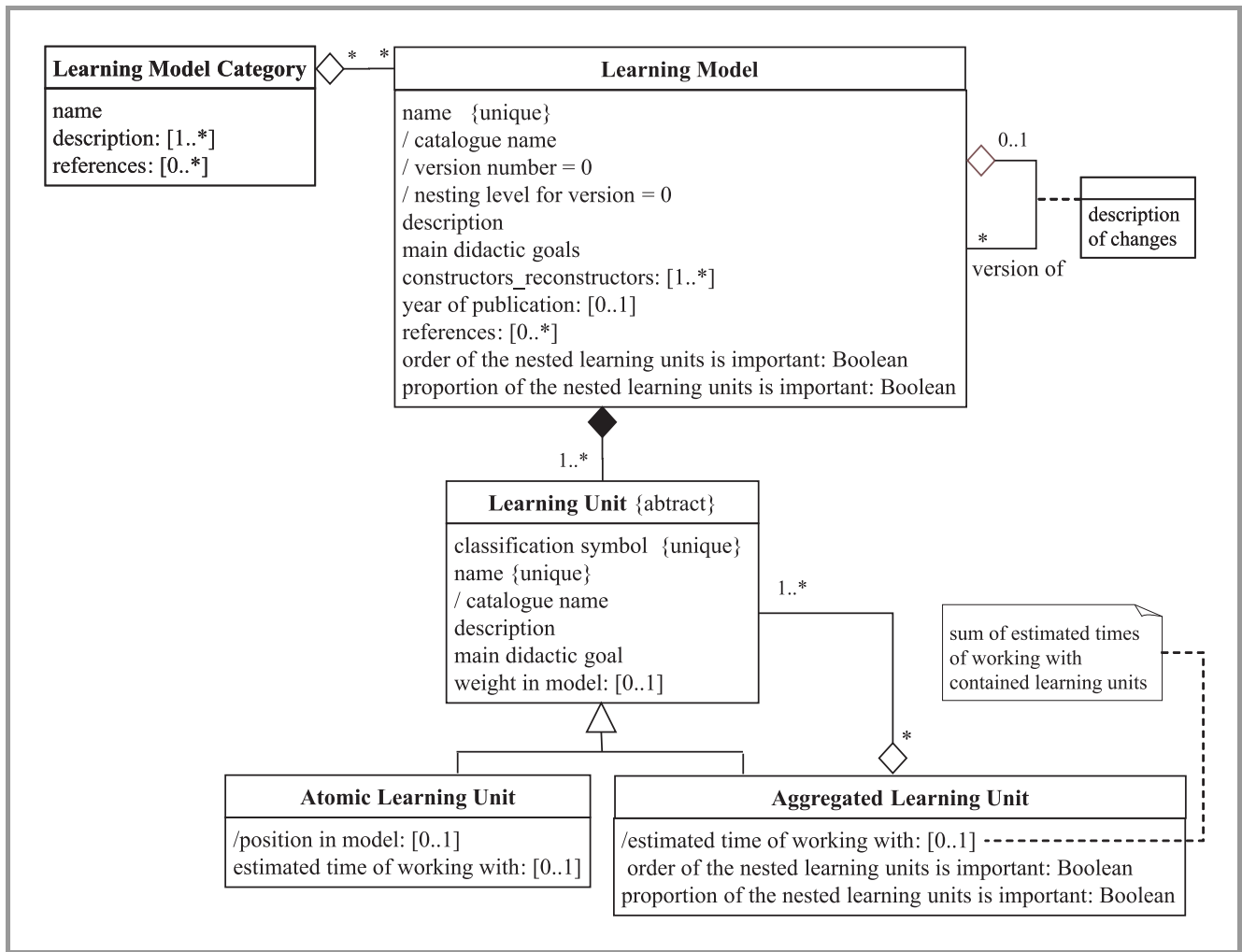


Fig. 5. The structure of a metamodel.

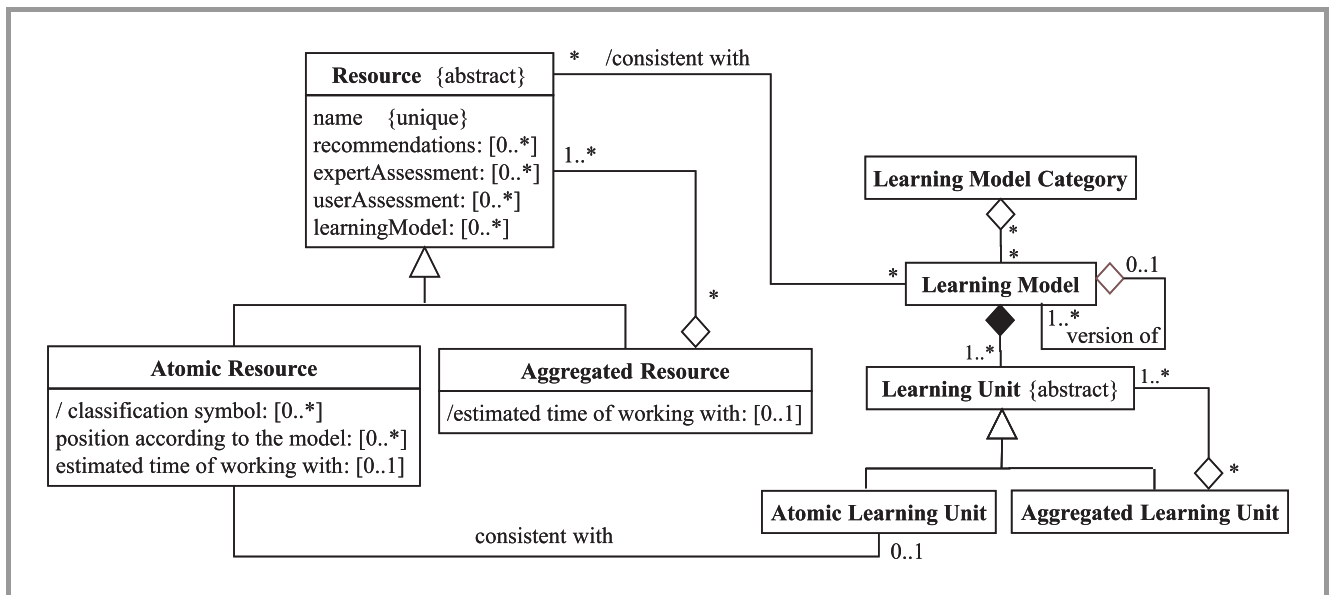


Fig. 6. The structure of a resource.

### The Learning Unit class

The derived attribute *catalogue name* is defined as follows: the name of the model's particular version + the name of the learning unit.

The value of the attribute *classification symbol* means if the mutual order of the nested units is important. If it is, then the attribute's value is stated as the unit position conformant to the relevant unit defined in the model, e.g., "1.1", "1.1.1". In the opposite case, letters are used, e.g., "1.A", "1.1.B".

According to the metamodel definition, we proposed the e-resource structure conformant to the metamodel (see Fig. 6). To keep the picture clear, the Learning Model and Learning Unit classes were presented in the simplified version (without attributes, methods and associations which are not important from this point of view).

## 5. E-resource quality versus traditional teaching models

To generalize the results of the research, which were briefly discussed in Section 2, a few next steps were taken. At the beginning we made an attempt to define the notion of *the conformance of e-resource with any traditional teaching model*. We assumed that a resource is conformant to the chosen model, if: it contains all elements required by the model, and nested elements are both properly ordered and their proportions are kept.

To prove the thesis, we did research on the quality for the same 56-element population of e-resources (see Section 2).

The construction of the new space of measures was based on the metamodel of teaching. The new measures were only related to the resource's structure. In opposition to the model of effective learning, the measure related to the quality assessment was excluded.

As before (see Section 2), each measure is described by the following expression:

position\_in\_resource. suffix

where:

position\_in\_resource – has the same meaning as for the measures' space of the model of effective learning,

suffix – denotes the kind of measure, where:

*p* – has the same meaning as before,

*t* – has the same meaning as before, but this measure may be defined on any nesting level in the model.

To this measures' space, there was introduced a new measure – *o* (order). The measure *o* concerns every aggregated element (having nested elements). It takes the values from the interval [0, 100], which is given in per cent. The measure value = 100% means correct order of the nested elements, each value < 100% points e-resource with incorrect structure.

The level of partial elements' order preservation may be defined as for example: the ratio of *lr* to *mlr*, where *lr* means the number of movements which need to be done for the resource to achieve the required order, and *mlr* defines the maximal number of movements, assuming that the order is a total opposite of the advised one.

There are two typical cases:

1. If an e-resource is an aggregated element (e.g., a complete course), then 100% of conformance to the model/models means that a resource contains all the advised partial elements, which are ordered correctly and kept in the appropriate proportions.
2. If an e-resource is an atomic element, then we assume it is of 100% conformance with the considered model/models.

On the basis of above considerations, the space of measures useful for the quality examination was constructed. In the next, we presented two examples of the measures' space for the complete course resources satisfying requirements defined by two following traditional teaching models:

– model of effective learning:

$$F_{meffl} = \{0.o, 1.p, 1.t, 1.o, 2.p, 2.t, 2.o, \dots, 4.p, 4.t, 4.o, 1.1.p, 1.2.p, \dots, 4.3.p\},$$

– induction model:

$$F_{mit} = \{0.o, 1.p, 2.p, 3.p, 4.p\},$$

where level 0 means the measure connected with the resource treated as a whole.

It is easy to observe that in the case of the induction model there are no measures with suffix *t*, because no suggestions of the appropriate proportions of the elements we found in the literature.

To verify the thesis considered in the paper, the following research of the 56-element population was carried out. The research was done for the new measures' space, constructed for the model of effective learning on the basis of the defined metamodel. As previously (see Section 2), the statistical program GradeStat was used.

Figures 7 and 8 present two AR charts for the new measures' space. Figure 7 concerns the population of 56 e-resources and the measures' space:

$$F_{meffl''} = \{0.o, 1.p, 1.o, 2.p, 2.o, \dots, 4.p, 4.o, 1.1.p, 1.2.p, \dots, 4.3.p\},$$

where *t* measure was excluded.

Figure 8 contains the chart for the population of 37 e-resources and  $F_{meffl''}$  measures' space.

While analyzing the trends in the charts, it is easy to notice that the e-resources highly conformant to the model of effective learning (low AR values) got better marks from respondents than the resources with more differences between their structures and the structure required by the model.

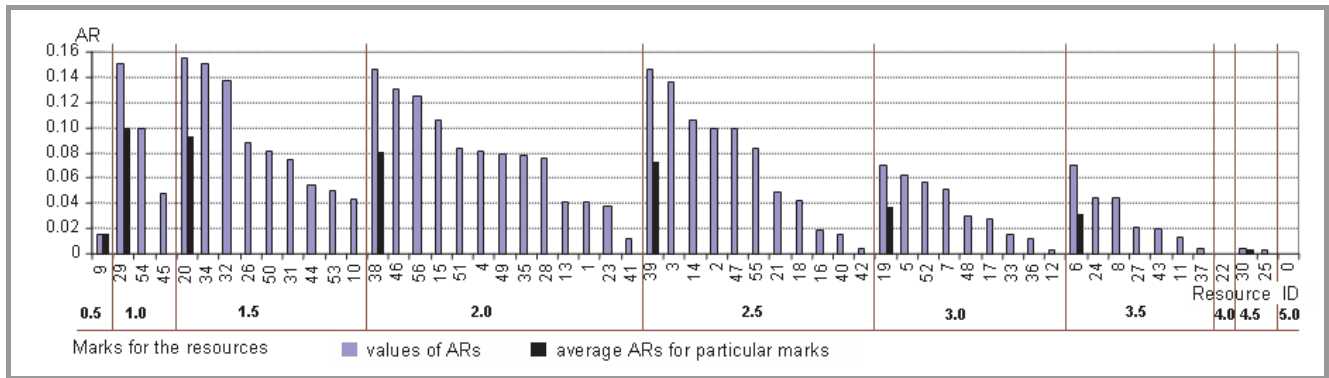


Fig. 7. ARs for  $F_{mefl}$  and the population of 56 e-resources.

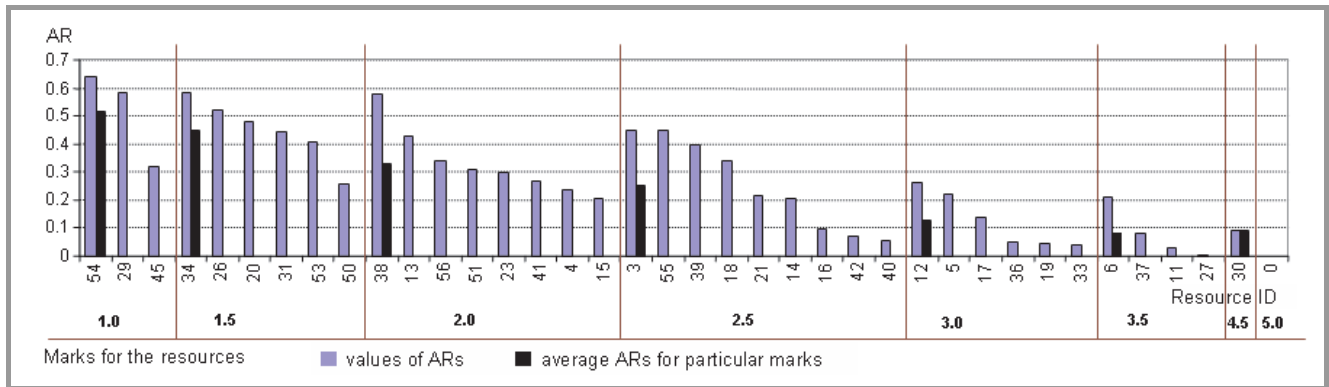


Fig. 8. ARs for  $F_{mefl}$  and the population of 37 e-resources.

Summarizing, the analysis of the data allowed the positive verification of the thesis: *The conformance of an e-resource structure to at least one traditional teaching model has an influence on the quality of the resource.*

## 6. Conclusions and future research

In the paper we presented the research concerning the influence of the e-resource structure conformance with the structures required by traditional teaching models on e-resource quality, from a didactic point of view. As a result, we presented:

- the metamodel for traditional teaching models,
- the e-resource structure which is conformant to the structure defined by the metamodel.

We will continue our research to enhance the metadata currently existing in e-learning standards. This concerns the elements/categories which may have influence on the resource quality, both in didactic and non-didactic aspects (e.g., related to its potential to reuse).

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