Paper

The Non-Didactic Aspects of e-Learning Quality

Ewa Stemposz, Andrzej Jodłowski, and Alina Stasiecka

Abstract— The paper presents a research on the quality of e-learning from the non-didactic point of view. It illustrates a discussion about measures developed on the basis of statistical analysis of data gathered from e-learners who evaluated the quality of e-learning applications and systems. The main contribution of the paper is the proposal for the quality metrics with the features concerning e-learning platforms in the technological and human aspects.

Keywords— e-learning, metrics, quality.

1. Introduction – the Quality of e-Learning

E-learning is currently a very dynamically developing form of distance learning, carried out with the use of up-to-date communication and information technologies. One of its learning forms is learning through Internet/Intranet that utilizes the access of teachers and students to a global/local computer network.

That kind of education can gain advantage over traditional teaching methods mainly on the grounds of freedom of access to information (knowledge) – unlimited time and unlimited place of learning and also for the reason that e-learning enables learners to assimilate new information at a pace and in the way adjusted to one's needs and abilities. Despite unquestionable merits of e-learning, there appear many problems related to its propagation.

1. Technological possibilities of educational environment – lack of Internet connection and/or insufficient technical parameters of those connections.

2. Resources – the HTML (hypertext markup language) file format is the basic content format of distance training and courses that are available through the Internet and Intranets. E-trainings seldom take other forms, e.g., a teleconference or a videoconference. E-resources are usually custom-made, so they do not support any common e-learning standard. For example, online course materials used in higher education are created in colleges and at universities by the teaching staff responsible for the course. Therefore, schools do not in fact order materials from other producers.

3. Direct participants of that process, i.e., teachers and learners – research shows resistance to the introduction of new technologies. It also confirms that there is a strong need for interaction among course participants, which is often missing in that form of learning.

We think problems that are related to e-resources, as well as those related to e-teachers/e-learners require direct attention. Those issues involve to make an attempt to solve them through ensuring adequate quality level of e-learning processes. In our opinion, quality is undeniably one of the vital issues concerning education process by e-learning techniques.

There exist many different definitions of learning quality that are dependent on needs and expectations of participants of that process. However, it is difficult to call those definitions as precise. For example, the definition of quality by Praxiom[1] is as follows:

"A quality is a characteristic that a product or service must have. For example, products must be reliable, useable, and repairable; similarly, service should be courteous, efficient, and effective. These are some of the characteristics that a good quality product/service must have. In short, a quality is a desirable characteristic. However, not all qualities are equal. Some are more important than others. The most important qualities are the ones that customers want. So providing quality products and services is all about meeting customer requirements. It's all about meeting the needs and expectations of customers. So a quality product or service is one that meets the needs and expectations of customers."

There arises a fundamental problem from such a general definition. How to identify the minimal possible set of the most important quality criteria which could encompass the needs and expectations of all interested parties? Which way to discipline the e-learning processes so as not to limit creativity, flexibility, and abilities of e-learning participants?

Basing on the division of those problems into three groups, we propose to consider the quality of e-learning education in three general aspects.

1. **In technological aspect**, related to computing environment, where education processes and e-learning platforms are embedded, concerning, i.e.:

   – the expectations regarding the scope of design, implementation and development quality for e-learning systems, including the development of associated standards also;

   – the activities encompassing adaptation and integration of computer technologies with existing e-learning systems and associated standards;

[1] Praxiom Research Group Limited: http://www.praxiom.org/iso-definitions.htm

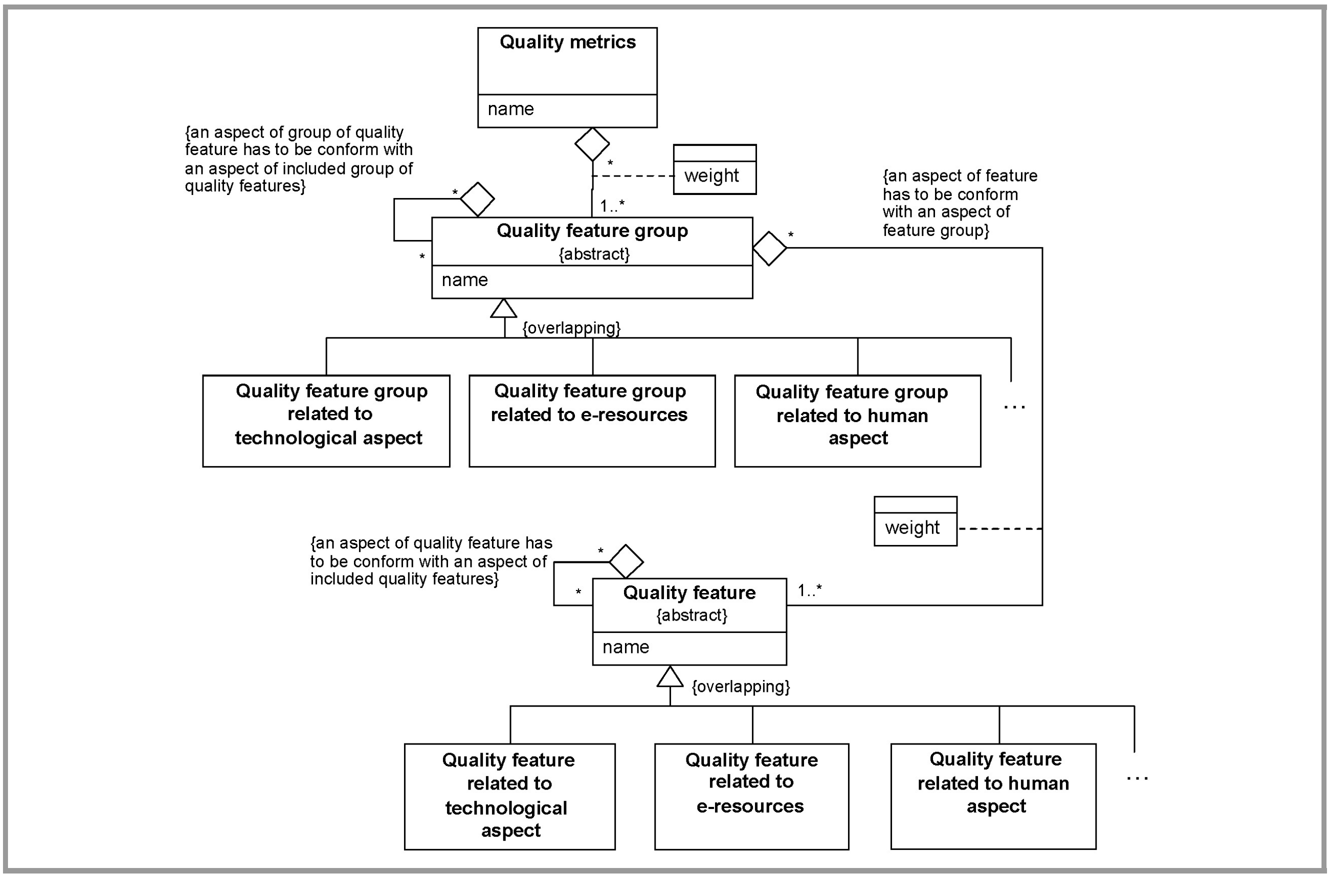

Fig. 1. The idea of quality metrics.

- user expectations related to working platforms (e-learning systems) including, e.g., support for personalization and customization, ensuring proper security level, data protection, complying with the needs of learners related to unlimited access to materials, ensuring data recovery after failure, support for interoperability with other platforms, ease of use, work speed.

2. **In e-resources aspect** related to requirement descriptions and estimation of quality of e-learning materials, both in didactic aspect, e.g., conformance to teaching model(s) [1], [2], as well as in non-didactic aspect considering, e.g., amount and quality of multimedia used, or quality of process of e-resource development.

3. **In human aspect** – we classify e-learning process participants into two general groups as follows:

   - direct participants: suppliers and designers of e-learning systems, teachers, methodology specialists, trainers, students;

   - and indirect participants: authorities, accreditation, standardization, law establishing, and law regulating institutions, etc.

Realization processes ensuring the quality of e-learning should involve all participants. Quality is influenced both by qualifications of a team designing a course and teachers who realize it. One cannot also forget the degree of involvement of teachers and students in the learning processes.

Various e-learning quality elements can be shown using a graphical diagram (in UML (unified modeling language) notation), see Fig. 1. *Quality feature* denotes an element which influences the quality of e-learning. To ensure the clarity of the diagram, most of class attributes are omitted except for *name* attributes within classes: *Quality metrics, Quality features group, Quality feature*.

2. The Quality of e-Learning in Technological and Human Aspects

Our prior research was focused on the quality of e-learning from a didactic point of view [3]–[6]. The next stage of our considerations included the analysis of e-resources quality in the non-didactic aspect and the research on the quality of platforms (applications and e-learning systems).

In this paper, we make an attempt to identify measures of quality features from a technological point of view and from a human point of view. Both analyses were performed on the basis of studies of the quality of e-learning applications. The first step was to create a questionnaire concerning technological and human aspects of e-learning. The questionnaire ought to have provided data with reference to the quality of existing e-learning applications and with reference to expectations of potential users to such applications [7]. The questionnaire consisted of 26 questions concerning issues about graphical interfaces and e-learning. The respondents were mostly students of computer engineering (32 persons).

The questions are classified into three groups.

A. The questions concerning respondents; they focused attention on the effectiveness of e-learning.

B. The questions characterizing features that are desired for platforms and e-resources; they could be used to build a quality metrics.

C. The questions concerning processes of interface design for e-learning platforms.

Further research used the data gathered from the questionnaire that were related to desirable features of platforms and e-resources (the B group) only. The questions included in the A group and C group were passed over.

The questions from the B group concerned both the actual state (they should show what platforms and e-resources were used) – the B1 subgroup, as well as user expectations (what platforms and e-resources should look like) – the B2 subgroup. Further works were based on those question belonging to the B, and B2 subgroups.

In order to perform statistical analysis of data gathered from the questionnaire, we constructed a set of measures that characterized e-learning platforms. Successive measures corresponded with features characterized by questions from questionnaire, where features were denoted by labels: "name-and-number-of-group.question-number-within-group", e.g., b1.1, b2.4 – see Table 1.

The data gathered from the questionnaire concerning the set of features from Table 1 were subjected to the statistical analysis using the gradational data analysis of the GradeStat program [8].

We considered two groups of features:

– features related to the technological aspect;

– features concerning the e-resource aspect.

Because the questionnaire, in fact, omits the human aspect (only one feature) – we did not examine separately the group of features related to that aspect. The analysis was performed with regard to the classification of features into the B1 ("present state") and B2 ("expectations") subgroups, where the B2 group included features both from technological and e-resources aspects (because the latter comprised one feature only).

For those groups mentioned above we computed overrepresentation maps with the use of the GradeStat program. Further analysis led us to specify sets of characteristics which differentiated and undifferentiated the elements of the population.

2.1. Analysis of Overrepresentation Maps – Features Related to the Technological Aspect

Figure 2 presents the overrepresentation map for features related to questions from the B1 group.

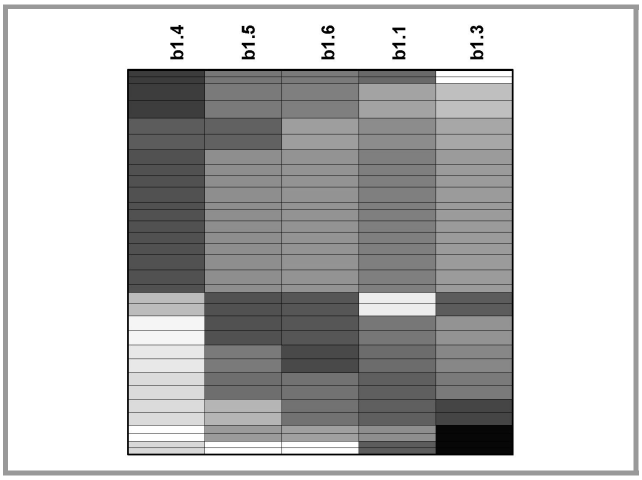

Fig. 2. The overrepresentation map for features from the B1 group – technological aspect.

On the basis of the overrepresentation maps, the cluster analysis was performed. Figure 3 illustrates the dependence of Rho* values[2] on a cluster count that was evaluated for columns. Basing on that diagram it was assumed that the cluster count for columns should be equal 3.

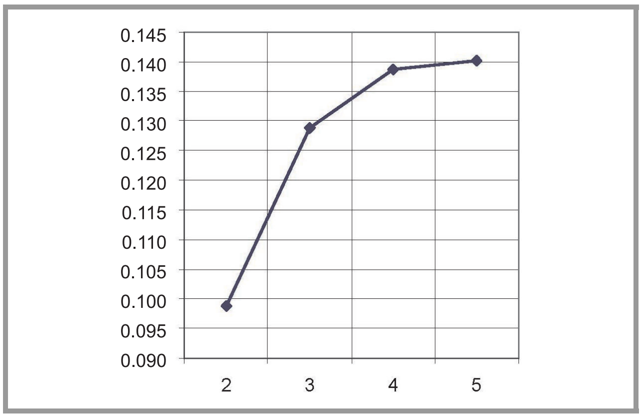

Fig. 3. The dependence of Rho* on the cluster count for columns – technological aspect, the B1 group.

The overrepresentation map containing 3 feature clusters is presented in Fig. 4.

[2] Rho* – spearman's rank correlation coefficient.

Table 1
Set of quality measures

Questionnaire question	Feature characterizing a platform/an e-resource	Domain
TECHNOLOGICAL ASPECT		
How do you estimate interfaces of platforms that you used to work?	**b1.1 platform interface**	{**1** = slow, illogical design, uncomfortable, not easy to use **2** = not very well designed, allowing the use of platform **3** = I have not learnt that way **4** = well designed, required some improvements for the quality work **5** = very well designed}
How fast do pages, graphics, audio, video, and other materials load? How do you estimate the general work speed?	**b1.3 work speed**	{**1** = definitely slow **2** = rather to slow **3** = don't know **4** = sufficient fast **5** = definitely fast}
How do you estimate an audiovisual attractiveness of e-learning applications that you used?	**b1.4 audiovisual attractiveness**	{**1** = definitely low **2** = rather low **3** = no opinion **4** = rather high **5** = definitely high}
Have applications well-designed navigation (with a readable menu, site map, etc.) and well-organized courses (with clear structure; how lessons and are materials subdivided into chapters, exercises, etc.)?	**b1.5 navigation**	{**1** = poor design **2** = not very well designed **3** = don't know **4** = mostly well designed **5** = definitely well designed}
For application you used, was interface consistent in such aspects as navigation, background colors, font colors, or within header, content, text, link, material and label elements?	**b1.6 interface consistency**	{**1** = inconsistent **2** = partially consistent **3** = don't know **4** = mostly consistent **5** = fully consistent}
In your opinion, what features have the biggest influence on the reliability of an Internet application?	Influence on application reliability **b2.1a objectivity and extensiveness of content** **b2.1b reputation of author(s)** **b2.1c professional graphic design** **b2.1d links to other sites** **b2.1e lack of advertising banners** **b2.1f visit count**	{**1** = inessential **2** = little importance **3** = important **4** = vital}
What features best characterize the usability of Internet application? (according to ISO 9241, the usability is defined as a measure of performance, efficiency and user satisfaction, i.e., in shorthand as a measure of service ergonomics)	Importance of features characterizing a platform usability **b2.2a good navigation design** **b2.2b content essentiality** **b2.2c work performance** **b2.2d platform-independent layout** **b2.2e professional graphic design** **b2.2f simplicity of use**	{**1** = inessential **2** = little importance **3** = important **4** = vital}

Continuation of Table 1

Questionnaire question	Feature characterizing a platform/an e-resource	Domain
In your opinion, how important is graphical user interface (GUI) for everyday work when using the same application?	**b2.4 significance of graphical interface**	{**1** = lack of influence, a form of use does not matter **2** = little importance **3** = no opinion **4** = important **5** = crucial}
Choose maximum 5 features that are the most important, in your opinion, for the user interface. If there is any not quite clear description, trust your intuition and your first impressions.	**b2.5a clarity/simplicity/ cleanliness** **b2.5b forseeability/acquitance/ compatibility with other systems** **b2.5c easy-to-use/comfortableness** **b2.5d configurability/flexibility** **b2.5e visual attractiveness of graphical design** **b2.5f consistency** **b2.5g communication directness/ awareness and control** **b2.5h performance/speed** **b2.5i error tolerance/reversibility**	{**1** = inessential **2** = important}
Would you like that an e-learning platform could be able to facilitate relationships among learners and teachers in a similar way as on community portals, e.g., grono.net, nasza-klasa, facebook?	**b2.7 possibility to build community relationships**	{**1** = no **2** = no, no opinion **3** = yes}
ASPECT RELATED TO E-RESOURCE		
How do you estimate the quality and the design of e-learning resources?	**b1.2 e-resource**	{**1** = mediocre **2** = sufficient **3** = don't know **4** = well **5** = very well}
In your opinion, what features have the biggest influence on reliability of an Internet application?	**b2.1a objectivity and extensiveness of content essentiality**	{**1** = inessential **2** = little importance **3** = important **4** = vital}
What features best characterize the usability of Internet application? (according to ISO 9241, the usability is defined as a measure of performance, efficiency and user satisfaction, i.e., in shorthand as a measure of service ergonomics)	**b2.2b content essentiality**	{**1** = inessential **2** = little importance **3** = important **4** = vital}
In your opinion, what kind of elements should usually supplement textual content of courses?	**b2.3a graphics** **b2.3b audio** **b2.3c video** **b2.3d animation** **b2.3e interludes/interactive games** **b2.3f only text**	{**1** = never **2** = rarely **3** = often **4** = always}
HUMAN ASPECT		
In your opinion, what features have the biggest influence on reliability of an Internet application?	**b2.1b reputation of author(s)**	{**1** = inessential **2** = little importance **3** = important **4** = vital}

Analyzing the overrepresentation maps shown in Fig. 4 we chose the most external columns corresponding to the most differentiated features: b1.4 and b1.3. On the basis of those features, one can find that persons who estimated high the attractiveness of platforms regarding a visual aspect (overrepresentation of the b1.4 feature) at the same time estimated low the loading speed (underrepresentation of the b1.3 feature).

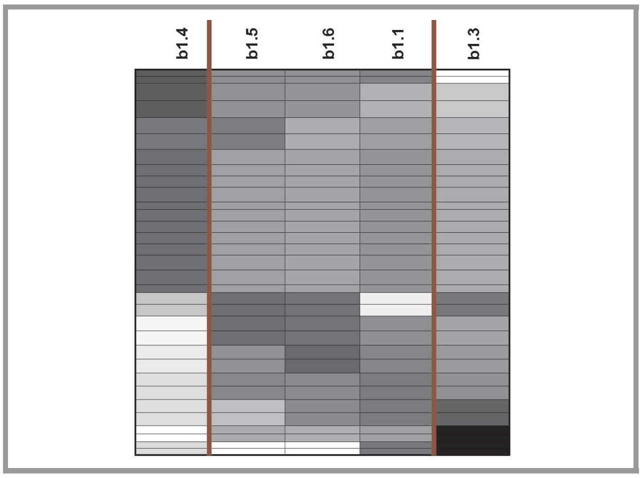

Fig. 4. The overrepresentation map with marked 3 clusters – technological aspect, the B1 group.

As non-differentiated features we chose columns in the middle of the overrepresentation map (b1.1, b1.5, and b1.6). On those grounds one can find that the majority of respondents estimated as important (non-differentiated) the following features: the quality of the interface of the e-learning platform (b1.1), the well-designed navigation of an e-learning application (b1.5), and the interface consistency (b1.6). It is interesting that the attractiveness of e-learning applications in the audiovisual aspect and with respect of the working speed (i.e., loading speed of pages, graphics, audio, video, etc.) were definitely important for the minority of respondents (b1.3, b1.4).

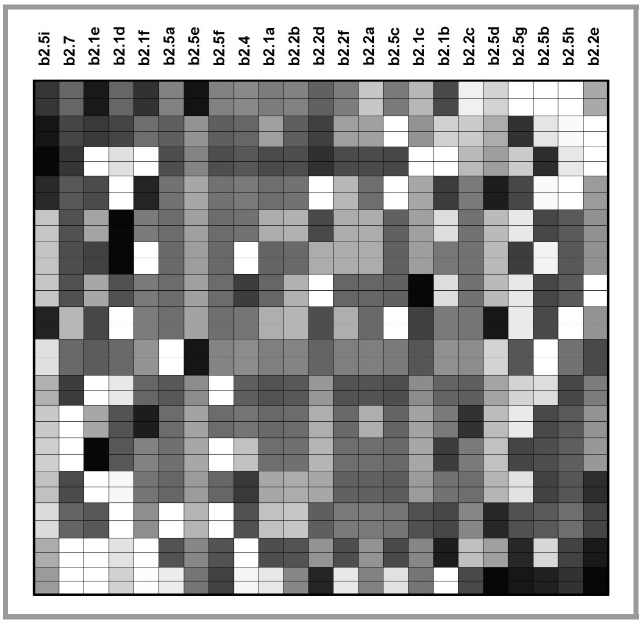

Fig. 5. The overrepresentation map for the B2 feature group.

Next, the B2 feature group was analyzed analogically. The overrepresentation map for them is presented in Fig. 5.

As previously, we performed the cluster analysis in order to find two subset of features: non-differentiating and differentiating for the features of the B2 group. Figure 6 illustrates the dependency of Rho* values (for the columns).

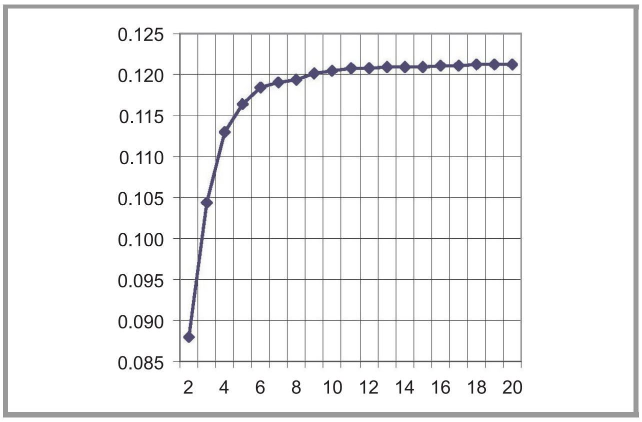

Fig. 6. The Rho* for the different values of the number of clusters – technological aspect, the B2 group.

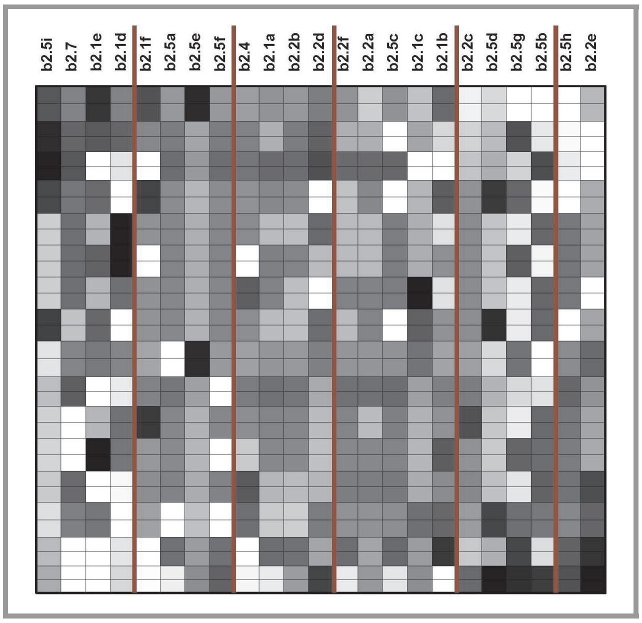

Fig. 7. The overrepresentation map with the chosen numer of clusters – technological aspect, the B2 group.

On the basis of that diagram, 6 clusters for the columns were chosen. The overrepresentation map with the determined number of clusters is shown in Fig. 7.

Analyzing the map presented in Fig. 7 we can distinguish two separate groups of features:

– differentiating: two left-most and two right-most clusters;

– non-differentiating: two clusters in the middle of the map.

On the basis of the differentiating features, we can notice that for a small group of respondents the following features are important:

- within the group of features that are most important for good interface: b2.5a – clarity/simplicity, cleanliness, b2.5e – visual attractiveness of graphical design, b2.5f – consistency, and b2.5i – error tolerance/reversibility;
- within the group concerning the reliability of an internet application: b2.1e – lack of advertising banners, b2.1d – links to other sites, and b2.1f – visit count;
- also b2.7 – a possibility to build community relationships.

On the other hand, the respondents don't pay attention to the following differentiating features:

- b2.2c – work performance, b2.2e – professional graphic design;
- features characterizing the interface: b2.5b – forseeability/familiarity/compatibility with other systems, b2.5d – configurability/flexibility, b2.5g – communication directness/awareness and control, and b2.5h – performance/speed.

To estimate the quality of e-learning platforms from the technological point of view, the non-differentiating features should be taken into consideration:

- the group of features with the greatest importance for the application reliability, i.e., b2.1a – objectivity and extensiveness of content essentiality, b2.1b – reputation of author(s), b2.1c – professional graphic design;
- the group of features characterizing the internet applications with the best usability, i.e., b2.2a – good navigation design, b2.2b – content essentiality, b2.2f – simplicity of use;
- the group of features, the most important for good interface, i.e., b2.5c – easy-to-use/comfort/ convenience, and b2.4 – significance of graphical interface.

2.2. Analysis of Overrepresentation Maps – the e-Resource Aspect

In Fig. 8, we present the results of the analysis performed using the GradeStat overrepresentation map for the features concerning the e-resource aspect (the B2 group).

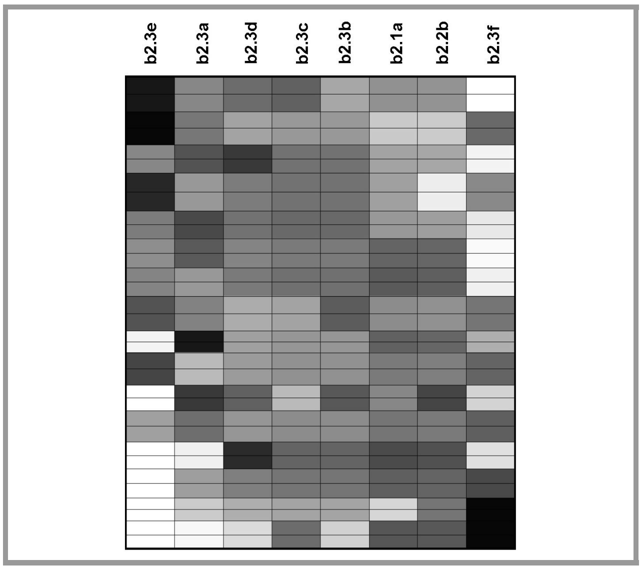

Fig. 8. The overrepresentation map for the B2 features group (e-resource aspect).

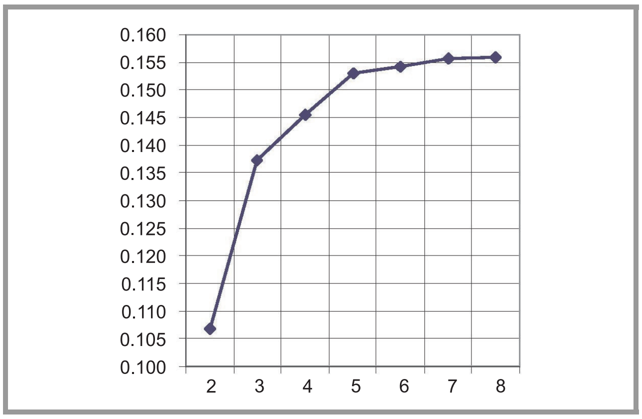

Fig. 9. The Rho* for the different values of the number of clusters – e-resource aspect, the B2 group.

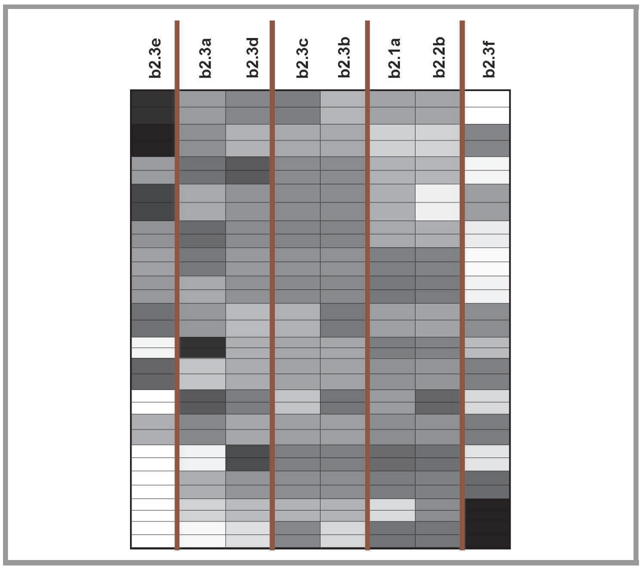

Fig. 10. The overrepresentation map with the chosen number of clusters – e-resource aspect, the B2 group.

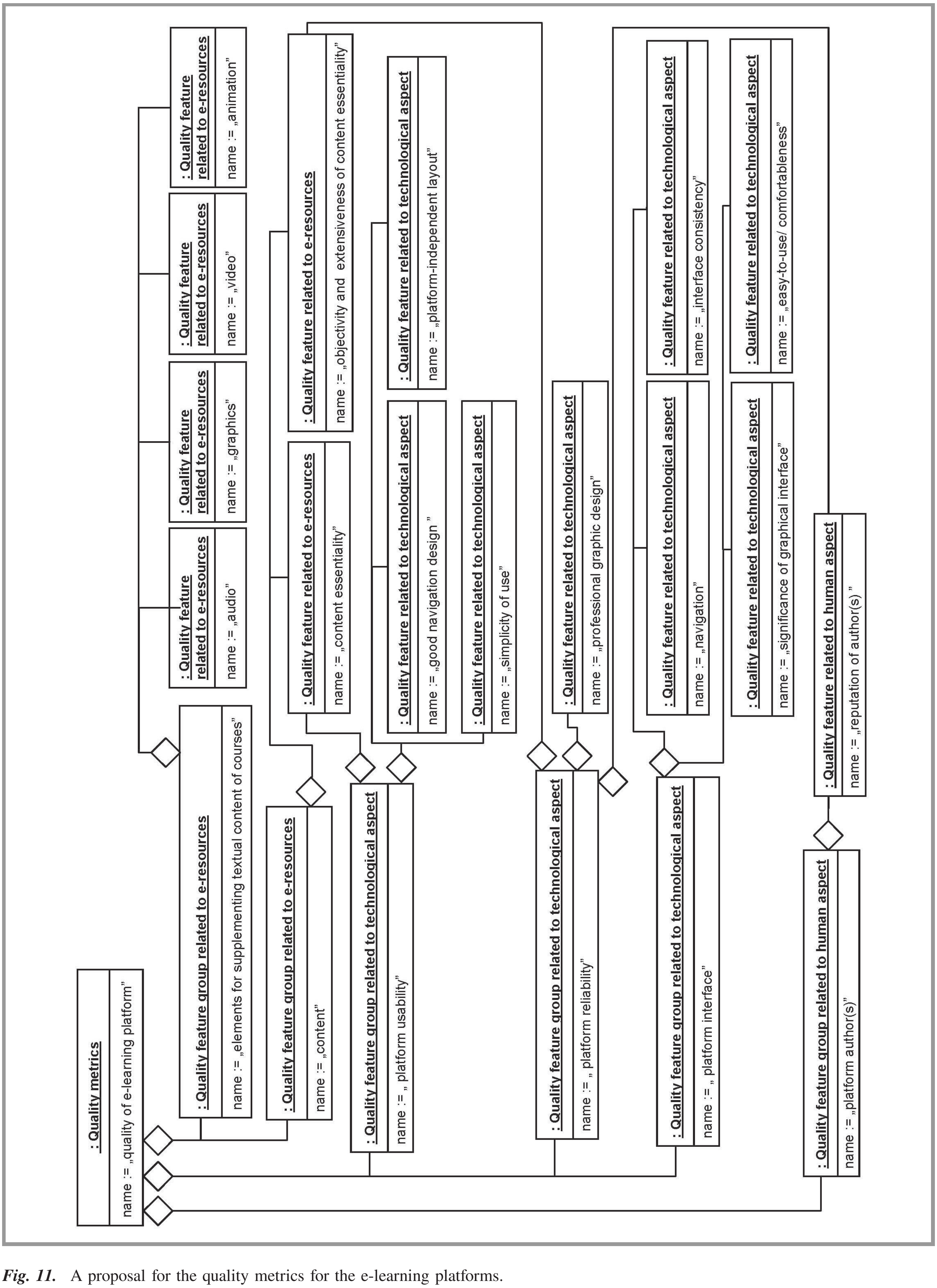

Fig. 11. A proposal for the quality metrics for the e-learning platforms.

The cluster analysis helps us to determine two groups of features: the features which do not differentiate the examined population (the middle columns of the map) and those which differentiate the population (the left-most and the right-most columns). After the analysis of Rho* variations (see Fig. 9) we chose 5 clusters for the columns within the overrepresentation map (see Fig. 10).

Finally, we can specify two following groups of features:

– differentiating features: b2.3e – interludes/interactive games, and b2.3f – only text;

– non-differentiating features: b2.3a – graphics, b2.3b – audio, b2.3c – video, b2.3d – animation, and also b2.1a – objectivity and extensiveness of content essentiality, b2.1b – reputation of author(s).

2.3. The Quality Metrics for the e-Learning Platforms

As a result of our studies, we propose the quality metrics for the e-learning platforms (Fig. 11), conformant to the idea of quality metrics (Fig. 1).

In Fig. 11 the attribute *weight* was omitted. At the moment the weights are equal 1 for all quality features. Of course, in the future we should find weights for the particular features, testing the metrics on the existing e-learning platforms.

3. Conclusions and Further Research

In our previous publications concerning the quality of e-learning we focused on the research on e-learning resources. This paper discusses two other quality aspects, i.e., the technological aspect and the, so-called, human aspect, which in our opinion, are vital to the quality of e-learning.

After the analysis of the data gathered from the questionnaire with regard to non-didactic features, for both aspects we specified the most important features, those having the biggest influence on the quality of e-learning. That constitutes the quality metrics in the non-didactic aspect.

To the most important features related to the technological aspect were ranked, i.e., the quality of the interface of the e-learning platform, in particularly, the well-designed navigation and the interface consistency. Regarding the human aspect, the following features are identified as distinctive, i.e., content essentiality, the reputation of author(s), multimedia form/s of e-materials, or clarity, simplicity, and attractiveness of graphical interface.

Further work will be necessary to establish the weights of measures and to the augmented quality metrics for e-resources and e-learning platforms with regard to non-didactic features.

References

[1] E. Stemposz and A. Stasiecka, "Determining a set of measures for quality estimation of e-resources conformant to the model/models defined in traditional education", in *Proc. 6th WSEAS Int. Conf. E-ACTIVITIES'07*, Puerto de la Cruz, Spain, 2007.

[2] B. Joyce, E. Calhoun, and D. Hopkins, *Przykłady modeli uczenia się i nauczania* (Models of learning – tools for teaching). Warsaw: WSiP, 1999 (transl. – in Polish).

[3] A. Stasiecka, E. Stemposz, and W. Dąbrowski, "Didactic aspects influence on quality of e-learning resources", in *Proc. WSEAS Int. Conf. Circ. Syst. Commun. Comput.*, Athens, Greece, 2005 (*WSEAS Trans. Inform. Sci. Appl.*, iss. 7, vol. 2, pp. 1002–1008, 2005).

[4] A. Stasiecka, J. Plodzien, and E. Stemposz, "Measures for estimating the quality of e-learning materials in the didactic aspect", in *Proc. Conf. Web Inform. Syst. Technol. WEBIST 2006*, Lisbon, Portugal, 2006, pp. 204–212.

[5] E. Stemposz, A. Stasiecka, and A. Jodłowski, "The proposal of metadata for defining the quality of e-learning", in *Proc. Conf. ENMA 2007 Eng. Math.*, Bilbao, Spain, 2007.

[6] A. Stasiecka, E. Stemposz, and A. Jodłowski, "E-resources versus traditional teaching models", *J. Telecommun. Inform. Technol.*, no. 3, pp. 74–81, 2008.

[7] M. Maliszewski, "Metodyka projektowania interfejsu użytkownika w e-learningowych aplikacjach WWW". M.Sc. thesis. Warsaw, Polish-Japanese Institute of Information Technology, Dec. 2008 (in Polish).

[8] "Program for grade data analysis", GradeStat, 2007, http://gradestat.ipipan.waw.pl/

Ewa Stemposz was born in Wasilków/Białystok, Poland. She graduated master degree at the Faculty of Electronics, Technical University of Warsaw. She has been employed at the Institute of Computer Science of the Polish Academy of Sciences, Warsaw (from 1988) and the Polish-Japanese Institute of Information Technology, Warsaw (from 1994), where she has been engaged in computer graphics, computer vision, data basis, software engineering, object analysis, project management, and e-learning.

e-mail: ewag@pjwstk.edu.pl
Polish-Japanese Institute of Information Technology
Koszykowa st 86
02-208 Warsaw, Poland

e-mail: ewag@ipipan.waw.pl
Institute of Computer Science
Polish Academy of Sciences
J. K. Ordona st 21
01-237 Warsaw, Poland

Andrzej Jodłowski received his M.Sc. degree from the Warsaw University of Technology, Poland, in 1995, in the area of applied computer sciences. He received his Ph.D. from the Institute of Computer Science of the Polish Academy of Sciences, Warsaw, in 2003, in the area of object-oriented database technologies. Currently he is a Lecturer at the Warsaw University of Life Sciences. His research interests concern object-oriented databases, software engineering, and e-learning.

e-mail: Andrzej_Jodlowski@sggw.pl
Warsaw University of Life Sciences
Nowoursynowska st 166
02-787 Warsaw, Poland

Alina Stasiecka was born in Warsaw, Poland. She finished the Electronics and Information Technology Faculty of the Warsaw University of Technology. She was working in the Institute of Computer Science of the Polish Academy of Sciences, Warsaw (years 1986–2001). Since 2001 she has been employed at the Polish-Japanese Institute of Information Technology, Warsaw, where she has been engaged in software engineering and e-learning.

e-mail: alas@pjwstk.edu.pl
Polish-Japanese Institute of Information Technology
Koszykowa st 86
02-008 Warsaw, Poland