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This volume represents the proceedings of the 13th International Conference on ICT in Education, Research, and Industrial Applications, held in Kyiv, Ukraine, in May 2017. It comprises 62 contributed papers that were carefully peer-reviewed and selected from 132 main conference and workshop submissions. The volume opens with the abstracts of the two keynote talks. The rest of the collection is organized in 2 parts. Part I contains the contributions to the main ICTERI conference tracks, structured in four topical sections: (1) Advances in ICT Research; (2) Information Systems: Technology and Applications; (3) Academia/Industry ICT Cooperation; and (4) ICT in Education. Part II comprises the contributions of the three workshops co-located with ICTERI 2017, namely: 3d International Workshop on Theory of Reliability and Markov Modeling for Information Technologies (TheRMIT 2017); 1st International Workshop on Rigorous Methods in Software Engineering (RMSE 2017); 2nd International Workshop on Professional Retraining and Life-Long Learning using ICT: Person-oriented Approach (3L-Person).

Preface

It is our pleasure to present you the proceedings of ICTERI 2017, the thirteenth edition of the International Conference on Information and Communication Technologies in Education, Research, and Industrial Applications: Integration, Harmonization, and Knowledge Transfer, held in Kyiv (Ukraine) on May 15-18, 2017. This year's edition focused on research advances, information systems technologies and applications, business/academic applications of Information and Communication Technologies. Emphasis was also placed on the role of ICT in Education. These aspects of ICT research, development, technology transfer, and use in real world cases are vibrant for both the academic and industrial communities.

The ICTERI 2017 Call for Papers as well as the main conference were structured into four tracks reflecting these research fields.

The conference program was complemented by two invited keynote talks, a PhD Symposium, poster and demo track, Ph.D. mentors panel, industrial IT Talks subevent, and the contributions to three co-located workshops:

- The 3nd International Workshop on Theory of Reliability and Markov Modeling (TheRMIT 2016) addressing long-standing research and development aspects of reliability**,** security and safety modeling and assessment for modern IT systems
- The 1st International Workshop on Rigorous Methods in Software Engineering (RMSE 2017) focused on the aspects of formal techniques for specification and analysis of distributed software and cyber-physical systems, computer simulation
- The 2nd International Workshop on Professional Retraining and Life-Long Learning using ICT: Person-oriented Approach (3L-Person 2016) presenting new uses of information technology for life-long learning

The first keynote talk given by Dr. Aliaksandr Birukou from Springer Verlag GmbH presented the linked open data project using Springer Nature paper collections to make them openly available through the LOD portal. The second keynote talk was given by Prof. Yannis Dimitriadis from the University of Valladolid. This talk was about Technology Enhanced Learning. In particular, Prof. Dimitriadis focused on the ways to overcome the barriers of an effective and efficient classroom orchestration of innovative pedagogies.

The rationale behind the Ph.D. Symposium sub-event is to offer an expert environment for the presentation of the tractable ideas and early results of PhD projects or other research aiming at receiving a PhD. Young researchers joined the Symposium to take part in discussions and/or present their papers. They were offered a rare opportunity to exchange and discuss their research ideas with their peers, supervisors, and

senior scientists working in the fields within the scope of ICTERI 2017. The PhD Mentors Panel provided the opportunity for Ph.D. candidates to listen to and discuss the visionary ideas and promising topics for Ph.D. research offered by several renowned experts.

Poster and Demo track at ICTERI 2017 called for software demonstrations, interactive models, real-time visualizations, novel technology applications. The two selected demonstrations were presented as live action in a way to enable interaction with the audience.

Overall ICTERI 2017 attracted a substantial number of submissions – a total of 155 comprising the main conference, PhD symposium, posters and demos, and workshops. Out of the 56 paper submissions to the main conference we have accepted 24 high quality and most interesting papers to be presented at the main conference and published in our proceedings. The acceptance rate was therefore 43 percent. Our three workshops received overall 76 submissions, of which 38 were accepted by their organizers and, also, included in this volume. Thus, the acceptance rate for ICTERI 2017 workshops was on average 50 percent.

The conference would not have been possible without the support of many people. First of all, we would like to thank all the authors who submitted papers to ICTERI 2017 and thus demonstrated their interest in the research problems within our scope. We are very grateful to the members of our Program Committee for providing timely and thorough reviews and, also, for being cooperative in doing additional review work. We would like to thank the local organizers of the conference whose devotion and efficiency made this instance of ICTERI a very interesting and effective scientific forum.

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Workshop 3L-Person

Development of e-Learning Quality Assessment Model in Pedagogical University

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Abstract. The paper is concerned with the practice of implementation of lifelong learning in Volodymyr Hnatiuk Ternopil National Pedagogical University (Ukraine), analyzed various models of e-learning quality assessment are analyzed. Based on many years of experience, a model of e-learning assessment in Volodymyr Hnatiuk Ternopil National Pedagogical University (Ukraine) was developed. It includes criteria and indicators for assessment of the e-learning system quality. In order to implement and adapt the model into practical learning process an experimental research was conducted. The article presents the contents of the study, the range of respondents and analyzed results.

Keywords: Lifelong learning, e-learning, pedagogical university, e-learning quality, model.

Key Terms. Methodology, TeachingProcess, InformationCommunicationTechnology.

1 Introduction

1.1 The Problem Statement

Lifelong learning is becoming very important field of education in the world and especially in the developed countries. Today there are three main forms of lifelong learning [9]:

– formal education – primary, general secondary education, secondary vocational education, higher education, education after graduation (postgraduate and doctoral

studies), training and retraining of specialists and managers with higher and secondary vocational education in institutes, on faculties and training courses and professional retraining;
- non-formal education – professionally aimed and general cultural training courses in adult education centers, on TV, on various courses of intensive training;
- informal learning – is a general term for education outside a standard educational environment – individual cognitive activity that accompanies everyday life, implemented by individuals' own activity in their cultural and educational surroundings; communication, reading, visiting cultural institutions, travel, media and more. Herewith, man turns the educational potential of society into an effective factor for his own development.

The European Commission brought together various educational and training initiatives into a unified Lifelong Learning Programme. One of the priorities of lifelong learning is the development and implementation of e-learning into both formal higher education and non-formal education, and informal learning. With increasing growth in popularity of electronic learning (e-learning) with the aim to obtain education and training, the assessment of e-learning quality is a relevant issue [5].

1.2 The State of the Art

Various aspects of the problem highlighted in many scientific works of domestic (V. Yu. Bykov, Yu. M. Bohachkov, R. S. Hurevych, M. I. Zhaldak, Yu. O. Zhuk, T. I. Koval, A. Yu. Kravtsova, V. M. Kukharenko, N. V. Morze, Yu. S. Ramskyi, S. A. Rakov, O.V. Spivakovskyi, O.M. Spirin, Yu. V. Tryus) and foreign scientists (M. Allen, C. McLoughlin, D. Morrison, E. Allen, D. Lederman, AL Fritschler, K. Khan, K. Thompson, E. Smyrnova-Trybulska). Many publications are devoted to a detailed examination of the problem [11; 13; 14; 15]. Thus, M. Allen [1] singled specific technology and educational techniques that affect the improvement of the quality of e-learning; B. Khan [12] offered hexagonal model of e-learning in higher education to improve its quality; N. Morze [16] created a model for assessing the quality of e-learning courses in the practice of Ukrainian universities and identified relevant criteria.

Ukrainian researchers M. Shyshkina, O. Spirin, Yu. Nosenko indicate that the quality of educational resources needs to take into account the requirements of maintenance management, interface design, ergonomics, hygiene and other [21]. They offer to assess the quality of e-learning according to the following criteria: adaptability, interactivity, integration and security. E-learning quality assessment requires appropriate training of qualified scientists on information and communication technologies in education [22]. A distinctive feature of professional competences of these professionals is their commitment to lifelong learning and self-development [4].

Group of Iranian scientists conducted a study [10] during which the criteria for a successful e-learning were analyzed. As a result, a model of assessment with five groups of criteria was created: 1) infrastructure and technology; 2) human resources 3) plans, policies, strategies adopted by institutions in order to develop distance learn-

ing 4) development; 5) cooperation with other organizations and interested individuals.

American scientist B. Chaney [8] proposed a different model for assessing the quality of e-learning in higher education, which includes the following criteria:

- student-teacher interaction;
- active learning techniques;
- prompt feedback;
- respect diverse ways of learning;
- student support services;
- faculty support services;
- program evaluation and assessment;
- strong rationale for distance that correlates to the mission of the institution;
- clear analysis of audience;
- appropriate tools and media;
- documented technology plan to ensure quality;
- reliability of technology;
- institutional support and institutional resources;
- implementation of guidelines for course development and review of instructional materials;
- course structure guidelines.

The following models of quality assessment and certification of e-learning are also used in international educational practice:

- ISO, IMS standards;
- UNIQUE, DETC institutional systems;
- software systems (ASIIN, CEL, eXcellence);
- technological standards (IMS, ADL) [25].

Models and tools to ensure the quality of e-learning are currently defined [19; 20; 26], so there is only a need to decide on their set and the use. Given the above, we note that every international model for e-learning quality assessment requires adaptation to the realities of Ukrainian pedagogical universities. The problem of e-learning quality assessment in higher education needs to be solved, including the definition of criteria and indicators of assessment related to the educational process in pedagogical university.

1.3 The Purpose of the Article

Object of the article is to develop model of e-learning quality assessment and its experimental testing in Volodymyr Hnatiuk TNPU.

2 The Presentation of Main Material

Department of Computer science and Teaching Techniques of Volodymyr Hnatiuk Ternopil National Pedagogical University has a considerable experience in the field of lifelong learning, both formal and informal. It prepares students, undergraduates, graduate students (education after graduation), holds retraining of specialists on training courses and professional training in the center of postgraduate education. An international training center "Educational Innovation" and STEM-center "Digital erudites" operate on the Department and they can be attributed to the formal institutions of further education. As part of these centers staff conducts numerous workshops, master classes, seminars, tours for students, teachers, school leaders, education coordinators, auditors of the employment center.

In the context of lifelong learning, one of the urgent problems of the university is a system of quality assurance. It is primarily about internal quality assurance. Now the trend is to coordinate and unify standards of educational materials developed by different standard organizations such as IEEE, IMS, ISO / IEC JTC1 SC36 and others, as well as to tie together the national standards with international ones [21].

In its day-to-day activities, to ensure quality of education in general, and quality of e-learning, in particular, our university adheres to the following basic principles: mobility (rapid response to customer requirements of educational services and the labor market, strategic and tactical changes in the system of training and innovations in education); complexity (optimal implementation of all activities (educational, organizational, technical, scientific, educational, etc.), publicity and openness (discussing the achievements and results of the university and its departments on different directions on university councils and other meetings, in cyberspace of the institution and on media, collective and personal responsibility of teaching staff, support staff and students for the organization, progress and results of the educational process).

E-learning system has been implemented in Volodymyr Hnatiuk TNPU since 2007. The implementation of e-learning in the university is guided by the following documents: Law of Ukraine "On Education", Resolution "On Higher Education" by the Cabinet of Ministers of Ukraine as of 23 September 2003 Number 1494 "On approval of the development of distance learning for 2004-2006"; Provision on distance education, approved by the MES of Ukraine as of January 21, 2004; Resolution by the Cabinet of Ministers of Ukraine as of December 7, 2005 № 1153 about State Program "Information and communication technologies in education and science for 2006-2010"; "Provision of electronic educational methodological complex discipline in Volodymyr Hnatiuk TNPU" as of 26.06.2007, the "Regulations on distance education in Volodymyr Hnatiuk Ternopil National Pedagogical University" as of 28.10.2014.

E-learning system is based on the following principles: adaptability, flexibility, modularity, portability, accessibility, universality and individuality. The main software components of the system are: the domain system preserving user accounts, learning management system, service Fizmat-Wikipedia, institutional repository, virtual private network, private and public (G Suite, Microsoft Office 365) university clouds. Technically, the system provides eLearning servers, storage, LAN, Internet,

computer labs, Wi-Fi and more. All these services are integrated both with the use of a single account of a student or a teacher, and at the level of content [17; 18].

In the process of creating a model of e-learning, cloud technologies have been widely used. E-learning quality assessment system model was introduced in Volodymyr Hnatiuk TNPU taking into account the components of the overall model of cloud based university environment formation, including its objectives and functions, methods, approaches and principles, service models and eligibility criteria [6]. We were guided by the following principles of cloud based university environment formation: the principles of open education (mobility of students and teachers, equal access to educational systems, structure formation and implementation of educational services) and specific principles (adaptability, personalization, unification of management, full-scale interactive ICT tools) [7].

2.1 E-learning quality assessment model

The model of quality education in Volodymyr Hnatiuk TNPU was formed in 2008 and is based on the standard ISO 9001: 2000 (ISO 9001: 2008). A task was set to formulate a list of criteria to assess the quality of e-learning, adapted to the peculiarities of Ukrainian education and e-learning in pedagogical university. Research on the development of e-learning quality assessment model and its experimental testing is the continuation of research on the topic "Implementation of technologies of e-learning in higher and secondary educational institutions" (state registration number 0111U004875, 2011-2016) [2; 3].

Among the variety of options when creating and selecting the set of criteria for education quality assessment indicators and their structural features a working party that works on the elaboration of criteria selected an approach, that is traditional for most European systems of e-learning quality assessment. The choice of areas of assessment and criteria was based on guarantees of a sufficient quality of education.

Analysis of different e-learning quality assessment models enabled to identify those components that are the core of e-learning system for any educational institution. These include:

- strategic management;
- technical support;
- development of curricula and courses;
- work with teachers and students.

The model of e-learning quality assessment in TNPU is dynamic one. The proposed model is a reference and can vary considerably depending on the specific institution and how the process of e-learning will be developed. Based on the components, which is the core of e-learning, we offer to highlight such groups of e-learning quality assessment criteria: technological, educational, organizational and communication criteria.

Technological criteria imply assessment of such indicators as:

- compliance with generally accepted standards and technologies;

– services internal integration;
– safety;
– reliability and system integrity.

Educational criteria imply assessment of such indicators as:

– compliance of e-learning educational resources with training content;
– pedagogical design;
– possibility of individual learning course implementation;
– variety of evaluation system.

Organizational criteria imply assessment of such indicators as:

– practicability of using e-learning during different modes of study;
– opportunity to monitor the actions of teachers and students;
– availability of technical support.

Communication criteria imply assessment of such indicators as:

– existence of systematic feedback teachers and students;
– providing with synchronous and asynchronous communication using modern services;
– providing with collaborative learning.

2.2 Organization, Conduct and Results of Experimental Work

The survey was conducted among teachers, postgraduates and students of Volodymyr Hnatiuk Ternopil National Pedagogical University and among auditors of postgraduate center who use e-courses available in the portal elr.tnpu.edu.ua during the learning process. The survey asked 859 respondents participated, of which 515 – students, 266 – teachers and postgraduate students, 78 – auditors of postgraduate center (see Table 1).

Table 1. Distribution of respondents by age

Age category	Amount
18-22	515
23-40	218
41-60	126

Among the 23-40 age category 158 teachers and postgraduate students, 60 auditors of postgraduate center were surveyed; among the 41-60 age category 108 teachers and 18 auditors of postgraduate center were surveyed.

Expert teachers carried out the external assessment, based on groups of criteria that determine the quality of the whole system, namely technological, pedagogical, organizational, and communication criteria. Experts estimated indicators for the following parameters: 0 points – the indicator is not observed, 1 point – the indicator is more not observed than observed, 2 points – the indicator is more observed than not observed,

3 points – the indicator is fully observed. The indicator was considered positive if the arithmetic mean value of its parameters was at least 1,5 [24; 23].

Results of the survey of experts represented in Table 2:

Table 2. Results of expert assessment of e-learning

Criteria / Experts	Total points			
	Technological	**Educational**	**Organizational**	**Communication**
1	3	2	1	2
2	3	1	2	2
3	3	2	2	2
4	3	2	1	2
5	3	2	1	2
6	3	2	2	3
7	2	2	2	2
8	3	1	2	2
9	3	2	2	3
10	2	2	1	2
11	3	2	2	3
12	2	2	2	3
Arithmetic mean value	2,75	1,83	1,67	2,33

We used Kendall's coefficient of concordance to assess the consistency of ex-pert opinion. Taking into account that the experts assessed different criteria with the same points, and the ratio

$$W = \frac{12\sum_{j=1}^{m} Rij - \frac{\sum_{ji} R_{ij}}{n}}{m^2(n^3 - n) - m\sum_{k=1}^{z}(B_k^3 - B_k)} \quad (1)$$

where Rij – point of i assessment criterion, by j expert, B – number of related (similar) points of k expert, n – number of groups of criteria, m – number of experts, we got a Kendall's coefficient of concordance W = 0,589.

It indicates the existence of average degree of consistency of expert opinion. However, this coefficient W is not objective, as it could be obtained due to random assessing of particular criteria groups. To determine the degree of expert assessment coordination, we calculated Pearson correlation coefficient $\chi 2$=21,138. Comparing it with tabulated for n-1=3 degrees of freedom and α=0,05 for level of significance, we get $\chi 2$=21,138> 7,814. So we can conclude that the value of W=0,589 is not accidental and there is a consistency between the experts' conclusions.

The above given criteria and quality indicators are more concerned with the process and the result of training activities. Since foreign educational systems engage

students as experts, we also carried out e-learning quality assessment based on a survey of students of Volodymyr Hnatiuk Ternopil National Pedagogical University. Students of 1–4 courses of the university with mixed form of education using e-learning courses were selected as the group of respondents.

The proposed questionnaire included questions aimed at studying criteria such as ease of use of electronic course; utility; interaction; individualization and contentment (Table 3). For each criterion of the questionnaire, students answered on a 4-point scale: "Disagree", "Almost agree", "Agree", "Absolutely agree". Table 3 shows the basic criteria groups.

Table 3. Summary of criteria groups of students questioning

Criterion	Indicator
Ease of use	Learning with the system was easy for me
	I find the system easy to use
	The system quickly gives me what I need
Utility	Using the system I improved productivity of studying learning material
	Taking online courses I improved studying of learning material
	I spend less time learning with the help of the system
Interaction	I can share information effectively
	I can get support from cooperative learning and group work with other students
	I can easily get advice and support from the teacher
Individualization	I can choose time and pace for learning on my own
	Existence of personalized learning support
	There are multilevel theoretical and practical tasks within the system
Contentment	Overall, I feel content with this learning model
	I am pleased that e-learning meets my demands
	I would constantly use these tools during my learning process

These criteria correlate with the e-learning assessment criteria assessed by expert teachers (Table 4).

Table 4. Correspondence of e-learning assessment criteria (teacher / student)

Criteria for e-learning quality assessment (teachers)	Criteria for e-learning quality assessment (students)
Technological	Ease of use
Educational	Utility

Organizational Communication	Individualization Interaction, contentment

The survey results are presented in Table 5.

Table 5. Results of a students' survey

	Ease of use	**Utility**	**Interaction**	**Individualization**	**Contentment**
Disagree	39	41	57	42	24
Almost agree	104	78	146	96	98
Agree	234	269	222	267	288
Absolutely agree	138	127	90	110	105

Analyzing the results of a students' survey, we have to note that a large percentage of objections falls on such system assessment criteria as interaction and individualization (Fig. 1). For example, there are only 17.5% of fully pleased with system interaction opportunities students and there are 11% of fully displeased students. Along with this, we can say that a significant percentage of students acquire competency without difficulty while working with e-learning system services of the university.

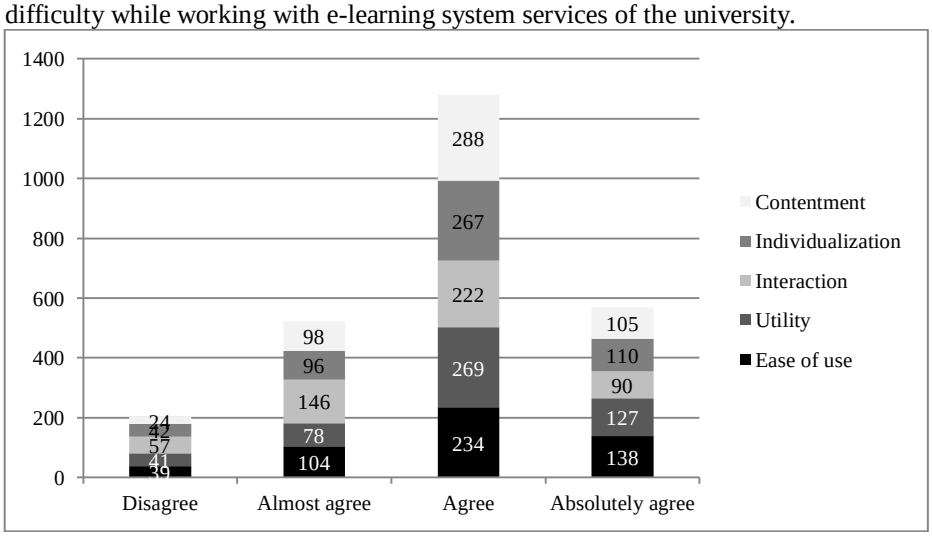

Fig. 1. Students' assessment of e-learning system

E-learning quality in this case is guaranteed by the availability of effective educational process and outcomes that please the student, resulting in a positive assessment of their knowledge.

3 Conclusions

As a part of the study we have created a model of e-learning quality assessment adapted to teaching not only students, but also people of older age categories. There are good reasons to include criteria related to the processes and results of learning activities, including: organizational, technological, educational, and communication criteria in order to assess e-learning.

Statistical processing of study data allows making scientifically substantiated conclusions on the correct choice of criteria and indicators of e-learning quality in pedagogical university, sufficient educational quality from the use of electronic courses, as well as the likelihood of the results.

E-learning quality assessment model of Volodymyr Hnatiuk Ternopil National Pedagogical University enables to: develop e-learning program for students, who study lifelong; improve the quality of e-learning, identifying weaknesses and elements for their improvement; use best existing e-learning practices.

Further research will determine the additional criteria and indicators of e-learning quality assessment. A prospect for further research is to develop methods of specialist training in the field of e-learning.

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