RIGA TECHNICAL UNIVERSITY
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DEVELOPMENT OF THE REFLECTION STIMULATING ePORTFOLIO SYSTEM TO ENHANCE LEARNERS COMPETENCES

Summary of the Dissertation

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I hereby confirm having written this dissertation which I have submitted for obtaining a doctoral degree in engineering sciences from Riga Technical University. The dissertation has not been submitted to any other university for a degree in engineering.

Aleksandrs Gorbunovs …….(Signature)

Date: ……

The dissertation is written in Latvian, it consists of the introduction, 4 chapters, conclusions, a list of bibliography, 36 appendices, 36 figures, 12 tables, a total of 211 pages. There are 208 titles in the bibliography.

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INTRODUCTION

> „If we want to win the global competition for new jobs and industries, we've got to win the global competition to educate our people. We've got to have the best trained, best skilled workforce in the world."
>
> (Obama, 2011)

Nowadays educational process is not imaginable without use of information systems and technologies. Their implementation in technology enhanced learning programmes becomes more and more demanding and popular all over the world. Especially it applies on already so called traditional e-learning courses, information systems and tools, among them learning and content management systems, which support these e-learning programmes (Miller, 2005). Great potential is seen in a synergy of new information systems and technologies with existing e-learning management systems, and their implementation into learning process (Grundspenkis, 2012). Educational games and simulators are positioned as the important components in achieving of study goals and motivating of learners. Modelling and simulation are successfully used in dealing with topical issues of sophisticated information systems' analysis, optimisation and control (Merkuryev, 2013). Over the past few years the studies and additional potentialities were initiated to find the new solutions in m- and t- learning implementation, as well in the synergy of e-, t- and m- learning (A. Kapenieks, Zuga, B., Kapenieks J., Stale, G., Jirgensons, M., Ozolina, A., Apinis, B., Vitolina, I., Gorbunovs, A., et al., 2013; A. Kapenieks, Zuga, B., Stale, G., Jirgensons, M., 2012a, 2012b, 2012c). Production companies are introducing their knowledge management systems, the latest technology and tools. Telecommunications technologies, combining of e- and m-learning methodologies into an entirety, are embedding into logistics information systems (Ginters, 2005). Abovementioned considerations indicate rather wide and varied adaption of information systems and technologies in modern educational sphere and other sectors. However, due to insufficient or even too low learning outcomes results, educational organisations are still in a search of new information systems, tools, technologies, approaches and methods, which would facilitate learners competence development.

Topicality of the Theme

Investigating scientific articles and research papers in the field of ePortfolio it could be recognized that at the moment fundamentally comprehensive studies in this area do not

exist, irrespective of pretty much of narrow directed publications, findings and opinions regarding adoption of ePortfolio systems in educational organizations. It is found that till now there were not realized evaluations related to efficiency of ePortfolio systems, which field experts recommend to measure based on evidences of system users' activities, marking out for reflection characterizing data (Haig, 2007).

For a few decades world scientists have been investigating education supportive ePortfolio technologies with an aim to harmonize e-learning technical, organisational and educational development. Meanwhile holistic perspective of ePortfolio systems' development is highly fragmented with distinctive tools, functions and implementation levels. Although ePortfolios conceptually could support human resources development in European Union and all over the world, most institutions struggle to define their own concepts, systems and tools.

ePortfolio approach has several advantages – it promotes students activities in new abilities, commitments, knowledge, and skills that enable learners to act effectively, as well it encourages both learners and teachers to engage in study process, critical thinking and reflection, which would be difficult to achieve in traditional e-learning. At the same time it should be noted, that in spite of ePortfolio systems adoption in many organizations, fundamental findings is not made enough. Besides, considering lifelong learning challenges, the research question of further improvement of ePortfolio systems and identity tools, as well searching of new solutions to improve learners' competence levels, is raised. On this score it is very important to find new possible way out by improvement of existing technologies and information systems (Reilly, 2013).

Research Questions

Which ePortfolio solutions are offered to ensure knowledge transfer processes nowadays? How could be improved stimulation of reflection in ePortfolio systems? Which ePortfolio system architectural, engineering and technology solutions might be applied for improvement of reflection parameters?

Research Object and Subject

Research object of the dissertation is data mining, processing and use in ePortfolio system; and research subject – algorithmic and physical development of reflection stimulating ePortfolio system.

Research Goal

The purpose of the dissertation is to develop reflection stimulating ePortfolio system which would merge a scope of technological and educational aspects to facilitate system users' better achievements.

Research Objectives

To reach the goal of the dissertation, the following objectives are set:

- To carry out existing research thoughts, available publications on the ePortfolio and reflection stimulating information systems level;
- To develop ePortfolio system data and algorithmic model;
- To develop ePortfolio system prototype;
- To carry out an approbation of ePortfolio system prototype;
- To carry out acquisition, systematization, generalization and evaluation of ePortfolio system approbation data regarding system users activity and learning outcomes results;
- To evaluate how much experimental information system output parameters are changing against changed input parameters, ensuring achievement of research goals and doctoral theses;
- To provide proposals regarding further improvement of created ePortfolio system;
- To formulate recommendations for implementation of developed ePortfolio system in educational organizations.

Doctoral Theses

The following theses are put forward for the defence of this dissertation:

1) Developed algorithmic model ensures creation and functioning of reflection stimulating ePortfolio system which has direct impact on system users' achievements / learning outcomes.

2) Embedded into ePortfolio system self- and peer-assessment tool facilitates feedback swell which becomes apparent in the main indicator of reflection – in increased number of improved accomplishments.

3) Actions and other activities within ePortfolio system facilitate improvement of users' reflection.

4) Competence levels development is directly dependent on ePortfolio system users' activities in corresponding task work within the system.

Research Methods

Theoretical studies repose on literature survey, systematization and analysis. Appropriate to research subject qualitative and quantitative research methods are used: observation, experiment, interviews, discussions, brainstorming, analysis, expert and user surveys. To evaluate data, statistical data processing methods are used, including correlations, T-tests, Kolmogorov-Smirnov and Mann-Whitney non-parametric tests, graphical analysis, grouping of parameters and creation of overview tables, as well evaluation methods of developed information system with its validation and verification. Practice studies repose on information system modelling, starting with initial considerations by Enterprise Knowledge Development (EKD) method (Bubenko, 2001; Kirikova, 2008; RTU, 2008) which further switch to development of simulative scenarious and achievement of required output parameters (Quinn, 2005), as well implementation of prototype model development method in software engineering process (Dosbergs, 2013a; Vītoliņš, 2006) with an identification of the initial needs and requirements in correspondence with the purpose, their realization in a prototype form, approbation of developed prototype and making necessary improvements in next stages of the model development. Further practice studies ensure the creation of the system in a form of ePortfolio, its prototype and modified version approbation in Living Lab, coming by systematization, aggregating and analysis of operational data, and using of statistical data processing methods by „Excel 2010" and „SPSS 21" tools.

Considering that the measurement of e-learning system efficiency is assumed to be implemented by qualitative and quantitative criteria (Novickis, 2007), created ePortfolio system was also subjected for such measurements by using of Living Lab research method. This choice is based on the reports in scientific publications in which Living Lab is defined as an environment where users validate new information and communication technology solutions (Følstad, 2008), it supports collaborative activities of the users in creation of innovation (Fulgencio, 2012), it is user-oriented research methodology (Eriksson, 2005), innovation ecosystem (Higgins, 2011; M. Pallot, 2009; M. Pallot, 2011; Schumacher, 2007) and real-life approach for planning and development of technologies and services (Ponce de Leon, 2006), it facilitates an adoption of innovative technologies to specific conditions (Marsh, 2013), as well ensures the valuation of users experience (Vicini, 2012). Living Lab research approach includes several research methods and consists of target-group identification, development of scenarious, creation of prototypes, estimation, interviews, groupworking activities, surveys, feedbacks and studies of taget-group activities (Fulgencio, 2012). Recent methodological approaches already reach, but at the same time confine

themselves by analysing of log-data or data files and ethnographic research methods (Følstad, 2008); while self-appraisals and assessments in system groups were not found in a scope of Living Lab research methods. Namely, this dissertation can enrich Living Lab research approach with noted methods.

Scientific novelty of the research

ePortfolio algorithmic model, prototype and use of technology, which were directly aimed to stimulate reflection, were developed.

System users synergistic collaboration, group-working activities, assessment and self-appraisal environment was created. In this way it has shown much better results related to improvement of users' reflection and competence levels, than existing ePortfolio systems.

Living Lab research approach is enriched with system users' assessment and self-assessment methods.

Considerations and new point of view were made regarding self-assessment nature, assessment and self-assessment tools embedding into information system, and an impact of ePortfolio system, equipped with these instruments, on its users achievements.

Efficiency measurement of developed ePortfolio system, which was not conducted before, was made. It displayed an enhancement of its users accomplishements, reflection, and competence development.

New terms, characterizing learning progress within developed information system, were introduced.

On December 16, 2013 the proposal of introducing of the new Latvian equivalent of the term „*scaffolding system*" was submitted to Information Technology, Telecommunications and Electronic Subcommittee (in Latvian – "*Informācijas tehnoloģijas, telekomunikācijas un elektronikas apakškomisija*"; further in the text – ITTEA) of the Terminology Commission, Latvian Academy of Sciences, to include it into Terminology Database „AkadTerm" of the Academy. Proposed Latvian equivalent „*balstsistēma*" had intent to be used to express the meaning of this term more precisely and clearly in the systems's architecture and learning supporting processes. Previously this term in Latvian either was not defined (Jakubaitis, 2006) or just partial solution was offered by translating only the term „*scaffolding*" (in Latvian – "*sastatnes*") – defining it as the scaffolds or "programmes and data, which are intent to support developing and testing of software, but not devised for inclusion into end-product" (LZA, 2007)[1], which, however, does not embody all scope of scaffolding systems' feasible functions. Yet, in this dissertation, taking into account conclusions made in the

[1] ISO 2382 07.11.02, protocol No. 294 (29.06.2007)

newest scientific findings (Bell, 2000; S. Jackson, Krajcik, J., Soloway, E. , 1998; Loh, 1998; Puntambekar, 2005; Quintana, 2004; Reiser, 2004; Tabak, 2004; White, 1998), Latvian term „*balstsistēma*" ("*scaffolding system*") or „*balstsistēmas*" ("*scaffolding systems*") would mean information systems which embodies an aggregate of approaches for sequential acquiring of learning objects and themes, where each next study module scaffolds on previous ones, as well interaction of the learners throughout the course of the entire study. On January, 2014 the ITTEA made the decision to accept Latvian version of the term stated as "*balstīšanas sistēma*". In fact, with this decision the ITTEA fostered the idea and principles of scaffolding systems. However, the Subcommittee did not see the use of the compound "*balstsistēma*" preferable because of other possible congenial derivatives in the terms's pattern.

Theoretical value of the research

New enlarged information system processes operational model is developed. Its main impact factors and expected achievable results are expounded.

New term "competence development spectrum" is introduced and formulated. It characterizes development of competence levels considering learners initial self-assessment. It provides also information regarding the impact of ePortfolio system on its users' competence change dynamics at different stages of the course.

It is gotten straight that learners' reflection in a form of improved homework accomplishments and improvement of their learning outcomes and competence levels direcrly depends on the use of reflection stimulating ePortfolio system. Besides, it was found that even simple logins into ePortfolio system, without any specific activity aims, allow system user obtaining the data of his/her work assessment made by other participants of particular ePortfolio system group, which, in its turn, stimulates reflection and motivates learner to improve his/her initial submission.

Ir is proven that ePortfolio system with its activity, i.e. collaborative and assessment, tools allows its users achieving higher learning outcomes and competence levels apart from intial selfassessment.

Practical value of the research

New ePortfolio system is created. Built on embedded collaborative environment, as well self-assessment and peer-assessment tools, it gives an opportunity for the users to activate their critical thinking and reflection apbilities, and, based on critical thinking notes, made by group members within system's collaborative environment, it enables improvement of users accomplished works more efficient than it would be done without activities in this

system. E-environment ensures self- and group participants' assessments in a form of scores (marks) and textual suggestions.

There was introduced and implemented the new, hitherto unused in ePortfolio systems in this way, tool for users inclusion in specific size groups depending on sequence of homework submissions. Scaffolding systems approach was put into practice to implement of required tasks and activities within ePortfolio system. That ensured more complete exploitation of phased in system.

Created ePortfolio system offers to its users particular learning outcomes improvement instruments which information systems of Riga Technical University and other higher education institutions can not provide.

Offered solution gives the opportunity to the university managing own ePortfolio system independently.

The newly established system ought to be considered as a suitable solution for efficacious applications also in other educational organizations to enhance learners critical thinking, reflection and competence levels.

Built on proposed system's algorithmic model, the developed reflection stimulating ePortfolio system facilitates the growth and progress of its users' reflection parameters, competence levels, as well accomplished tasks outside the system. This new reflection stimulating ePortfolio system was successfully carried into effect and approbated at the Riga Technical University in 2011/12 and 2012/13 academic year, proving by data its effectiveness.

Approbation of the research

Previous evaluation of the outcomes of this work has been carried out in 14 **presentations at the international scientific conferences** (among them 3 – at the Riga Technical University annual conferences) as follows:

- Advances of eBig3 Course Implementation and a Vision on the ePortfolio System Possible Integration // The 7th International Scientific Conference REEP-2014: „Rural Environment. Education. Personality", Jelgava, Latvia: LLU, 07-08.02.2014.
- eBig3 course „23 Things for Business Beginners": First Results and Ulterior Plans of ePortfolio System Possible Integration within the eBig3 Components // International Conference „New Media for Active Learning in the Digital Age", Siauliai University, Lithuania, 07.-08.06.2013.
- Advancement of e-Portfolio System to Improve Competence Levels // International Scientific Conference "Society, Integration, Education", Rēzeknes Augstskola (Latvija) and University of Udine (Italy), Rēzekne, 24.-25.05.2013.

- Smart ePortfolio System: Experimental Prototype Testing in Living Lab and Further Artificial Intelligence Implementation Design within ePortfolio system // The 5th International Conference on Computer Supported Education (CSEDU 2013), Aachen, Germany, 06-08.05.2013.
- An Effect of ePortfolio System on Competence Improvement at the Different Stages of the Course // The 6th International Scientific Conference REEP-2013 : „Rural Environment. Education. Personality", Jelgava, Latvia: LLU, Institute of Education and Home Economics, 20-21.03.2013.
- Embedded into LMS Engaging Collaborative ePortfolio System // International Conference ALTA'12 "Open educational resources", Kaunas, Lithuania: Kaunas University of Technology, 27.11.2012.
- Competence Enhancement Scaffolding ePortfolio System // The 3rd International Workshop on Intelligent Educational Systems and Technology-enhanced Learning "INTEL-EDU 2012", Riga, 10.10.2012.
- Competence Based Assessment Considerations within ePortfolio System // The 10th ePortfolio and Identity Conference „ePIC 2012", London, 09-11.07.2012.
- Competences Development Process Recording for Multi-Competence e-Course // The International Scientific Conference „Society, Integration, Education", Rēzekne, 25-26.05.2012.
- Competence matrix approach in ePortfolios as the way to improve own competencies // Riga Technical University 52nd International Scientific Conference, Section Electronics, Telecomunications and eSociety. Riga, 13-14.10.2011.
- Design of E-Portfolio System's Model with Artificial Intelligence Traits // The 5th International Conference on Information Technology (ICIT 2011), Amman, Jordan, 11-13.05.2011.
- ePortfolio as the Part of Information System // Riga Technical University's 51st International Scientific Conference, Riga, 14-15.10.2010.
- Actuality of Interactive E-Portfolio Systems // The International Conference on e-Learning and the Knowledge Society - e-Learning'10, Latvija, Rīga, 26-27.08.2010.
- ePortfolios Solutions in Nowadays Education // Riga Technical University's 50th International Scientific Conference, Riga, 14-16.10.2009.

Research results have been published in 17 **scientific articles**:

- Gorbunovs, A., Kapenieks, A., Kapenieks, K., Jekabsone-Snepste, G. Advances of eBig3 Course Implementation and a Vision on the ePortfolio System Possible Integration// Proceedings of the 7th International Scientific Conference REEP-2014 : „Rural Environment. Education. Personality", Vol.7. - Jelgava, Latvia: LLU, 2014. – pp.231-238.
- Gorbunovs, A., Kapenieks, A., Kudina, I. Advancement of e-portfolio system to improve competence levels// Proceedings of the International Scientific Conference "Society, Integration, Education",Vol.1. - Rezekne: Rezeknes Augstskola, 2013. pp. 61-72. ISSN 1691-5887.
- Gorbunovs, A. All-Embracing Digitalization or 10 Things to be Done in School Education till 2030. In C. Redecker, Castano, J. (Ed.), Open Education 2030// Vision Papers. Part II: School Education. - Seville: European Commission, JRC-IPTS, 2013(d). - pp.64-67. / Internet [accessed 17.05.2013]. - http://blogs.ec.europa.eu/ openeducation2030/files/2013/05/ Booklet-OE-SE-fin-REV3.pdf
- Gorbunovs, A. Smart ePortfolio System: Experimental Prototype Testing in Living Lab and Further Artificial Intelligence Implementation Design within ePortfolio system// Proceedings of the 5th International Conference on Computer Supported Education CSEDU 2013. - Aachen, Germany: SCITEPRESS, 2013. - pp. 238-241. ISBN 9789898565532.
- Gorbunovs, A. Synergy of Engaging Technology Enhanced Learning Approaches and New Generation Smart E-Portfolio Systems. In C. Redecker, Castano, J. (Ed.), Open Education 2030 // Call for Vision Papers. Part I: Lifelong Learning. - Seville: European Commission, JRC-IPTS, 2013(b). - pp.61-66. / Internet [accessed 06.04.2013] - http://blogs.ec.europa.eu/openeducation2030/files/2013/04/OE2030_LLL_Booklet.pdf
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- Gorbunovs A. New Insight in Actuality of e-Portfolio Systems// Communication & Cognition, Vol. 44, No.2. - C&C, 2011. - pp.95-110. / Internets [accessed 07.07.2012.] - http://www.e-webtec.com/c_c and http://lotuswebtec.com/index.php?page=shop. product_details&category_id=220&flypage=flypage.tpl&product_id=169&option=com_virtuemart&Itemid=112
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- Gorbunovs A. Mobile Learning Synergy – The Star Model// Modern Information Technologies in the Sphere of Security and Defence, Vol.3, No.9. – Kiev: National Defence University of Ukraine, 2010. - pp. 51-55. UDK: 378.147:355.23.
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Structure of the Dissertation

The dissertation consists of an introduction, four chapters, conclusions, appendices and bibliography. The dissertation contains 211 pages: 143 pages of the body, 36 figures, 12 tables and 36 appendices; the bibliography includes 208 titles of information sources.

The introduction actualizes research theme, fortifies the problem situation, sets the goal and objectives, formulates the theses for defence, describes applied research methods, explains the scientific novelty, theoretical and practical application of research outcomes, as well system's validation and verification results.

Chapter 1 is devoted to overview of information systems in educational sphere with main attention turned to ePortfolio systems as the aggregate instrument of collaboration and reflection.

Chapter 2 describes the actuality of creating of ePortfolio systems for the facilitation of learning process and enhancement of learning outcomes. This chapter gives an overview into the essence of ePortfolio systems, provides several examples of best practices, as well gives considerations and proposals for further improvement of such systems and their implementation into learning process to achieve better learning outcomes. The chapter evaluates also implementation of existing ePortfolio systems, their division in groups, as well the newest trends in their development.

Chapter 3 gives the description and justification of developed ePortfolio sistem's algorithmic model, conceptual design, system architecture, data model, use of technology and system altogether.

Chapter 4 shows achieved ePortfolio system approbation results realized in Living Lab, and, as a result, underlines stated for the defence the doctoral theses.

At the end of the Paper the author summarizes research outcomes and conclusions, gives recommendations for implementation of reflection stimulating ePortfolio systems in educational organizations, and as well adumbrates further research directions.

1. ACTUALIZATION OF THE PROBLEM. INFORMATION SYSTEMS IN EDUCATION IN A FORM OF ePORTFOLIOS TO GAIN HIGHER LEARNING OUTCOMES

The chapter consists of 8 pages.

Nowadays global trade market dictates implementation of innovative technologies and development of new information systems to improve learners' competence levels. It sets new challenges for both teachers and learners. Yet more this influences information system developers in findings of innovative solutions.

One of lifelong learning tasks might be delegated to appropriate ePortfolio systems which would embody in efficient competence development and reflection enhancement tools. Synergetic merging with organization's existing information system and proper implementation of assessment tools can substantially improve efficiency of assessment and achievable goals. ePortfolio systems might be accepted as a favorable environment for fulfilment of assessment tasks and system users involvement in knowledge acquisition, critical thinking and reflection processes (Cambridge, 2001). Two main features inhere to modern ePortfolio systems which detach them from each other: they have begun the change process of their face and tasks from simple show-windows of person's achievements to on processes oriented systems which become more and more important in educational process (Barrett, 2009). The main essence of ePortfolio systems is in their ability to provide support for learners reflection on evidencies of accomplished tasks (Lyons, 1998). The reflection, in the concrete, the ability to improve own accomplishments based on critical thinking conclusions, should be recognized as an analytic and creativity process which promotes comprehensive understanding about acquiring learning themes (Jasper, 2006b). Educational organizations, especially – universities, endeavour improving their curricula, methods, tools and information systems. Despite continual positive progress in this area, there is still actual necessity for creation of efficacious learners' reflection stimulating information system which would enhance students' competence development.

Nonetheless rather detailed research activities related to the synergy of ePortfolio systems competence development and assessment enhancement tools hitherto have not been carried out. Predominantly we can find educational organizations' given descriptions or overview of their experience in adoption or implementation of ePortfolio systems, as well theoretical considerations both from pedagogical and information system's tools implementation point of view. The choice of engineering solutions in ePortfolio systems domain is limited.

Currently, although scientists and engineers have been finding and introducing new technologies, tools and information systems which enhance and motivate persons' and organizations' inclusion into competence development and knowledge management, the competence acquiring process itself, namely – its implementation way, mainly falls upon the learner and/or more or less depends on learning course attractive features, tutors experience, usability of employed technologies, and other factors. We still face a lack of assessment tools in ePortfolio systems (Barrett, 2012a) which would ensure efficient valuation of system users' competence levels. We also should not forget about assessment process and provided feedback impact on users further competence development by showing the most useful learning paths which depend on choosen learning goals (Schoonenboom, 2007). Thus,

information system with embedded competence enhancement tools might give appropriate recommendations to the student to correct possible mistakes, improve accomplished tasks, and elicit new learning paths.

Despite available potentialities of modern ePortfolio systems in enabling of reflective expressions, more detailed in-depth findings, which would justify efficiency of introduced ePortfolio systems from a point of view of their reflective features, system users' competence levels improvement, as well motivating impact on the user and improvement of other user's activities, were still not realized. In ePortfolio experts conclusions it is stated that even though activities within ePortfolio system enhances its users' involvement in learning process and improvement of reflection abilities (Rhodes, 2011), nonetheless there is the lack of detailed and precise research issues which would be supported with data verification. Abovementioned considerations rouse the creation of new reflection stimulating ePortfolio system to improve learning outcomes.

2. ACTUALITY OF DEVELOPMENT OF ePORTFOLIO SYSTEMS TO FACILITATE STUDY PROCESS AND ACHIEVE LEARNING OUTCOMES

The chapter consists of 31 pages and 1 figure.

2.1. The essence of ePortfolio

ePortfolio is not just a signboard which could be used to show somebody's achievements to others. It might be used for both students and teachers: for students – to study, improve learning outcomes, assist fellow-students, make peer and self-assessments; for teachers – to tutor learners and monitor their progress, make assessment of study process and provide necessary steps to improve curriculum. Summarizing in subchapter mentioned definitions (Brown, 1992; Jasper, 2003; Rassin, 2006; Redman, 1994; Timmins, 2008), which are narrowly focussed in their substance, to give likely a full notion about ePortfolios, the following formulation is proposed: "ePortfolio is digitally prepared person's body of track records which embodies relevant evidences of competence, learning and/or professional activity developments, ability to achieve the goals, communicate, collaborate, think critically, analyse and constantly perfect him/herself, as well personal reflection, contemplation and action results based on mentioned evidences." Namely, information system, which pretends to be called as the ePortfolio system, at least has to ensure performance measures noted in this formulation.

2.2. ePortfolio and learning needs

There is a lack of common approach in preparing assessors of students ePortfolios (Scholes, 2004). Subjectivity risks, the lack of common approach and conformable research activities in the sphere of assessment standards rouse an idea about setting the objectives and new research directions which would make clear and solve the problems of assessment issues in ePortfolios.

The quantity and quality of ePortfolio system services still can be improved. In many cases, in the light of lifelong learning, these services are insufficient. For instance, at the moment ePortfolio system, which could offer its user new qualification or competence acquiring possibilities based on user prior acquired and acknowledged competence levels, does not exist. And this might be considered as the one of possible further research directions. At the same time, a necessity of system user's competence improvement is recognized; nonetheless innovative solutions here also are missed.

2.3. Critical thinking and reflection in ePortfolio context

Reflection is the constituent part of critical thinking (Barnett, 1998) which ought to be displayed during the entire length of study and reflect learner's critical thinking and response on different aspects and problems to be solved. The use of reflection within ePortfolio system can enhance student's critical thinking. The reflection ought to be come in sight not only about comprehensive issues in overall, but also about likely large-scale of speciefied theoretical and practical questions, problem-solving suggestions and own actions.

2.4. ePortfolio system – assessment, critical thinking, reflection and competence development instrument

There is a tight linkage between competent professional activities and critical thinking abilities. However, a correlation of this linkage is not studied yet (May, 1999) which might be another one research direction. ePortfolio systems allow its users developing their critical thinking and reflection skills, and as a result – also the competence levels.

ePortfolios are widely used as the students assessment, self-assessment, reflection and competence development instrument. Competence development environment within ePortfolio system should be considered as a very welcomed alternative in comparison to academic approaches used before. ePortfolios, built on such systems, enhance students progress (Casey, 2001).

2.5. The structure and scope of ePortfolio

Presenting of evidences within ePortfolios allows to testify learners achievements. One of such evidences along with documentation of track records might be found in reflection on own and others work performed in a form of feedback (Jasper, 2006a). An expose of ePortfolio structural forms is much multishaped and depends on set targets.

2.6. Groups of ePortfolio tools and systems

Having regard of multiformity of ePortfolio systems and tools, it would be important to classify them in groups. The most comprehensive studies on this level belong to Dr. Helenn Barrett, the professor of the Ancourage State University, USA, who has marked six ePortfolio tools and systems categories or groups depending on various levels of interactivity, personal expression and creativity (Barrett, 2012a). In her's research results we can find that interactivity indicators go up in direction from the first group (for example, text editors, presentation software, etc.) to the sixth one (for example, data management systems, interactivity tools and reporting systems), but personal expression and creativity level of ePortfolio user, i.e. portfolio developer, growth in the other way round – from the sixth to the first group.

The first group – authoring tools which ensure interactivity. They include software which support the user becoming the developer of own portfolio, for example, to prepare the data in textual form, add pictures, audio and video files; Microsoft Office or open-source software text editors, presentation software, Adobe products, wide spectrum of audio and video editing tools, as well Web authoring tools, such as Frontpage, Dreamweaver, etc. are used. Commonly such ePortfolios are made offline. However, to publish them, Web server resources are required. Individual ePortfolios within this group can be published also onto portable data storages: CDs, DVDs, and so on.

The second group – static Web services (for example, Screenr, Yola, Merlot, etc.). This group is characterized with little (Web 1.0) or almost no interactivity. These static services allow user or organization developing and publishing own or organization's ePortfolio presentations onto service provider's site.

The third group – interactive Web services which, similarly to the second group, also are devised for eportfolio developing and publishing (for example, WikiSpaces, Google Docs, Google Sites, Blogger, WordPress, etc.). Though, this group is characterized with more interactivity than previous one. It is provided by involvement of Web 2.0 tools.

The fourth group – information systems (ISs) which organizations have to install onto own servers and ensure enough space resources for the hosting of ePortfolio system. These ISs (for example, Blackboard, Drupal, Plone, Mahara, etc.) have interactivity. However, they have not characteristics which belong to data management systems.

The fifth group – ISs which organizations adopt for own needs but usually use ePortfolio system on its provider's server. These ISs (for example, GoogleApps for Education, Epsilen, My eCoach, PebblePad, etc.) have interactivity; and, as the fourth group systems, they also have not characteristics which belong to data management systems.

The sixth group – ISs which organizations adopt for their needs, and use completely on hosted, ePortfolio system provider's, servers. These ISs (for example, TaskStream, FolioTek, Chalk&Wire, Richer Picture, etc.) embody interactivity tools, data management systems and reporting instruments for assessment requirements.

Providers of ISs of the fifh and sixth groups mainly offer a wide range of cloud-based hosting solutions. The requirement for a student to belong to particular institution and be tied with educational organization could be seen as the disadvantage of these groups. Not everyone institution permits keeping of former student's profile and his/her individual ePortfolio after the graduation.

It could be inferred that ePortfolio systems can offer both user's self-expression tools and critical thinking vehicle for the assessment of user's success achieved, which are realized in textual, audio and video forms, as well in the way of textual templates which aid social communication, blogging, feedback and assessments. On the other hand, there was not found the synergetic solution of feedback to assess system users' achievements by combining of system group participants and tutors given recommendations in textual form and marks for further improvement of accomplished tasks, wherewith enabling better reflection and homework improvements, and which would be compared with system users' self-assessments, as a result, giving a possibility to improve the form and content of the educational programme and learning process.

2.7. New initiatives in ePortfolio system development

The TENCompetence (TENCompetence, 2006) iniciative, funded by European Commission, has started with creating some ePortfolio tools. For instance, within this iniative there was developed so called Personal Competence Manager (TENCompetence, 2009) which, based on the user's self-assessment, shows to him/her required study courses to be finished to be eligible for corresponding professional vacancy.

On the first January, 2013, again with European Commission financial support, the project "Europortfolio: a European Network of Eportfolio Experts and Practitioners" (Europortfolio, 2013) was launced. Its aim is till the 31st of December, 2015, to develop common vision on further development of ePortfolio systems, facilitate providing of urgent functions in developing information systems, as well establish common collaboration and communication platform for discussing of ePortfolio systems development actual problems.

If less than ten years ago for ePortfolio systems typical reflection and communication activities were realized in the form of short messaging, so, with entering of smartphones into the market the ePortfolio tools increasingly are offered for mobile application software (Barrett, 2011a). All-embracing adoption of mPortfolio tools meanwile is not taken at full stretch because of majority of conventional cell phones users. Besides, due to the states regulations all over the world there are significant restrictions regarding mobile phones use in many educational organizations (Barrett, 2013). This might explain the phenomena of the SMS usage to achieve learning goals. Short messages can not provide right enough and efficience reflection because of limited sending/receiving data amount, which usually does not exceed one and a half hundred characters. However, it is found that there are no sound arguments which would support the use of short messages for ensuring of ePortfolio functions neither by use of mobile phones, nor tweets. Accordingly, the development of appropriate mobile application software becomes increasingly important. It applies not only on updating of existing ePortfolio systems and tools for mPortfolio aims, but also – on development of specific independent mPortfolio tools which inter alia embody also creating of video content editing tools.

The Association for the Advancement of Authentic and Experience-Based Education (AAEEBL) led by Dr. Helen Berrett has started the work on marshalling and developing of mPortfolio area. Smartphones in mPortfolio case ought to provide existing ePortfolio functions (Barrett, 2011a):

a) Receiving and saving of users' achievement evidences (smartphones with built-in photo and video cameras can receive and save pictures and audio/video files, which afterwards might be uploaded onto computer or Web page, e.g. ePortfolio system);

b) Reflection (there are modifications of ePortfolio systems and tools adapted for mobile applications, as well independent blog creating tools);

c) Feedback (mobile Web browsers (*Androoid, iOS, Windows*, *etc.*) should ensure the reading of online documents and blogs, as well providing comments or participation in the project);

d) Planning and setting the objectives (i.e., the function form of reflection);

e) Collaboration (the use of collaboration tools to communicate to each other which might be realized by adoption of online communities and services, for instance, *Wiki* or *GoogleDocs*);

f) Demonstration of track records (some software applications enable preparation of presentations and project them by the use of hardware connections).

2.8. Summary of the overview

In the light of available scientific publications **it could be concluded** in brief that:

1) ePortfolio is an excellent tool which enhances educational process, encourages and motivates learners.

2) ePortfolio might be used to assess learners competence levels.

3) ePortfolio allows students to develop their reflection abilities, and, as a result – also their competence levels.

4) Presentation of achievements evidences within ePortfolio is very important; evidences allow testifying what ePortfolio user is achieved or made.

5) An expose of ePortfolio structural forms is much multishaped and depends on set targets.

6) To ensure comprehensive establishing of ePortfolio systems in educational organizations, both students and teachers ought to be additionaly informed about ePortfolio benefits. An implementation of this task at the initial stage of implementation might be especially complicated from the organizing point of view.

Formulation of research directions and goals

Research questions of ePortfolio systems are relatively new. This explains some gaps the lack of in-depth studies in this field which might display possible further research directions and goals. First of all it could be concluded that:

1) The studies related to the competence assessment based on evidence approach are not enough.

2) There is the lack of common approach in training of ePortfolio assessors which might signifintly impact assessment tasks and fulfilment quality.

3) Despite increasing use of ePortfolio systems in educational organizations, particularly in medical schools, an impact rate on competences development is still not measured yet.

4) Even though it was found that a link between competent professional activity and critical thinking, as well reflection, exists, at the same time the correlation of these parameters is not enough studied yet. The determination of such dependances during system's approbation might testify the validity of developed reflection stimulating ePortfolio system.

5) There were not determined and measured correlations related to the usage of ePortfolio system, implementation of activities and achievement of required goals within the system, e.g., improvement of own achievements, increasing of competence levels, furtherance of reflection abilities by making self-assessments and group members assessments, giving them suggestions, overall stimulating of motivation which expresses itself in manifestation of brisk pace other task activities within and outside the system.

6) There is the necessity of development and implementation of information system in a form of ePortfolio which through system users' critical thinking and reflection activation processes would allow achieving students learning outcomes (i.e., competences levels) enhancement much stronger than in a case when the system is not used.

7) Albeit some ePortfolio systems offer limited critical thinking and reflection application solutions, they are not offered complimentary, and the use of these systems involving considerable financial expenses which must cover educational organizations or students. Besides, these systems do not emobody efficient assessment and competence enhancement environment.

8) The quantity and quality of services offered by existing ePortfolio systems, which, pursuant to lifelong learning demands, in some cases is not enough, still can be improved. For instance, currently not any of examined ePortfolio systems, in correspondence with analysis results of available scientific publications, do not offer to students synergetic approach of own competence assessment combinied with assessments given by particular group participants, critical thinking cognitions which would allow identifying possible problem, succeeding learning learnt, and, putting reflective approach in use, improve not only own homework, i.e. previous accomplishements, but also receive enough data for the improvement of own competence levels and learning outcomes. To ensure this development process, it would be important to monitor learners' competence development on regular basis, collaboration with particular ePortfolio system group members, as well teaching staff support both within and outside the system.

Against this background and in accordance with research goals, objectives and theses formulated in this work, the development of reflection stimulating ePortfolio system, which would consolidate the aggregate of technological and educational aspects to enhance system users competence and reflection enhancement, is actualized.

3. ePORTFOLIO SYSTEM MODEL, PROTOTYPE AND USE OF TECHNOLOGY

The chapter consists of 23 pages and 20 figures.

3.1. Reflection stimulating ePortfolio system model

The model of created ePortfolio system basically is in line with charasteristics of information systems and is built upon three basic processes (Laudon, 2007): data input, processing processes and output; than the feedback processes follow-on. It is planned that created model (Fig. 3.1.) should provide the input of system users' accomplishements in a form of homeworks into the ePortfolio system where they are processed within created groups of users: there are enabled downloading, processing and analysing processes of submitted homework files (it enhances critical thinking and reflection processes), assessment and self-assessment of obtained data (homework files), preparing suggestions for the improvement. After noted processes the model provides data output processes, ensuring a supply of the assessments and suggestions of the input data to the corresponding homework author. Based on findings and other group participants' given assessments and recommendations for further possible improvements, system user accordingly reflects on them and makes necessary activities for the improvement of his/her initially submitted homework and its re-submittion – input into the system.

Based on an assumption that extra scaffolding information system, represented here in the model of ePortfolio system, ought to additionally encourage, motivate and engage learners, a conformable learning scenario was composed, and students were asked to develop it further. Pursuant to given task to build up own business idea (the task of the course subject) students develop it in few stages or series. Students' individual homework development in each stage starts with background information and explanation of the theme. Students' collaborative learning during all stages is widely supported by teaching staff and peers within ePortfolio groups. Each new task is set against previous level of knowledge in particular field, as well successfully accomplished prior tasks. Instructors' and colleagues' assistance to other students in groups, emphasizing key elements of the task, and giving necessary advice, encouraging learners to think critically and reflect on risen suggestions, is crucial in scaffolding educational systems (Wood, 1976). To keep learners response time shorter, ePortfolio groups were formed in the sequence based on homework submission time.

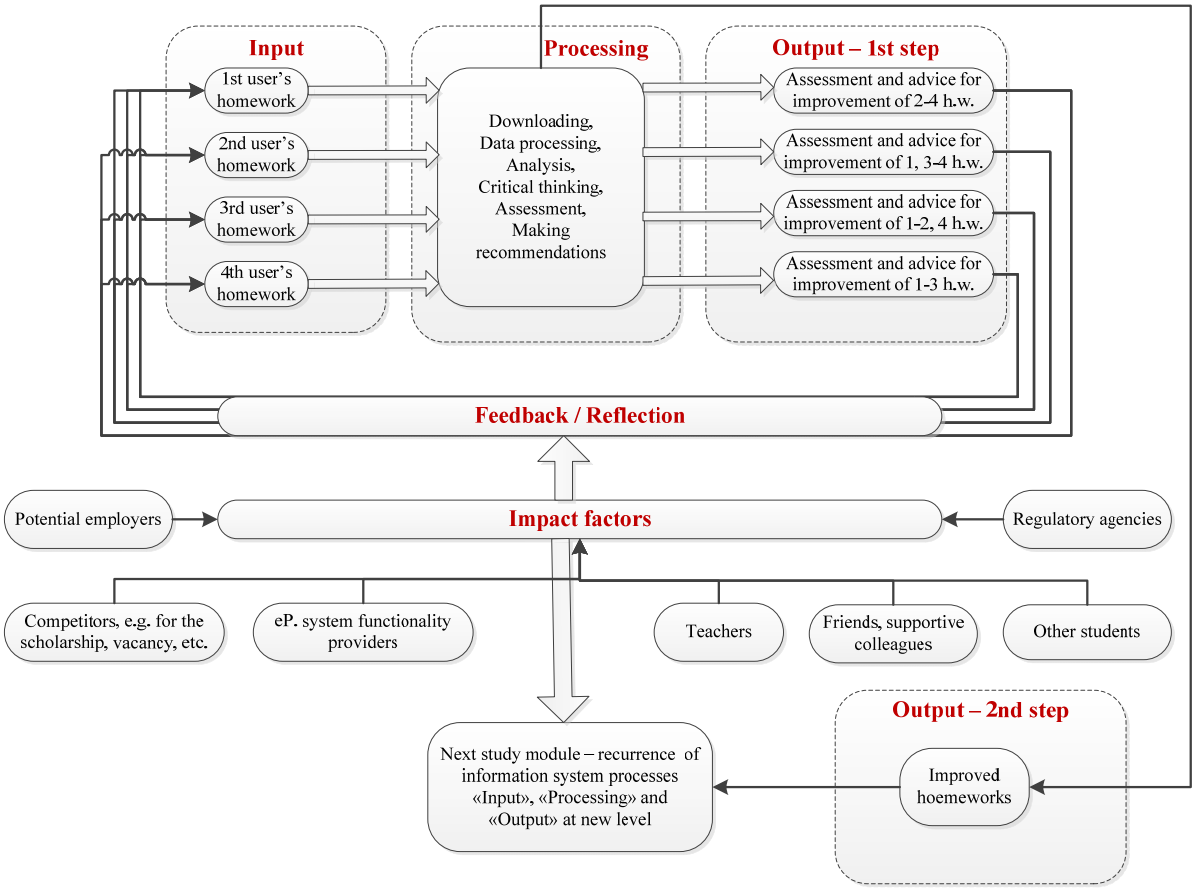


Fig. 3.1. Reflection stimulating ePortfolio system model

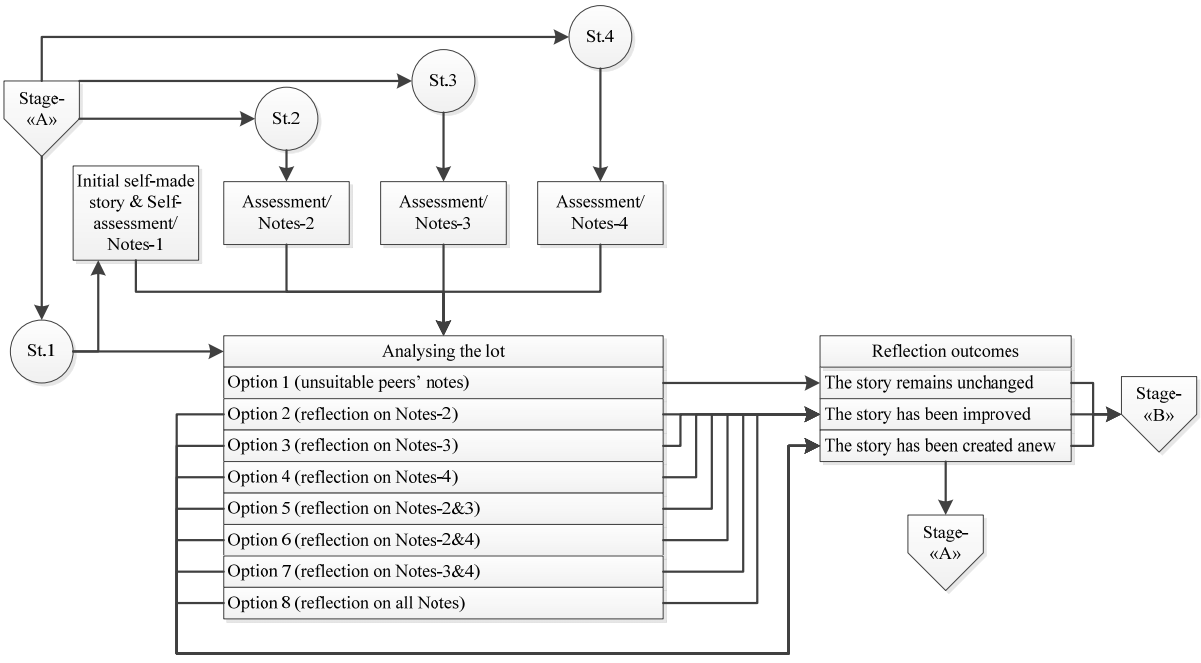


Fig. 3.2. Reflection activization model

Figure 3.2 in the view of flow diagram illustrates a part of the scenario for the first student (St.1) in the team of four learners. It shows possible scenario progressions. Badges of

the stages „A", „B" etc. include already basic and advanced introduction into corresponding theme (stage), an instruction of follow-up tasks and actions following with students homework and submission of draft papers. The first student can look at the critical thinking notes in the lot written by peers, analyse them and choose suitable option related to further work developments. The learner may use suggestions of one or more students, or decide to ignore them. The most important aspect here is that all students are involved in collaborative work and reflection. We hold a view that reflection is one of the key elements in competence development process. Introduced ePortfolio system enhances reflection and encourages students to think critically.

3.2. ePortfolio system algorithmic model, conceptual design and data model

It is necessary to specify that university's e-content and learning management system (LCMS) and created ePortfolio system are two independent information systems. Activities within ePortfolio system are available when system administrator or course tutor manually copies fulfilled homework files from the university's LCMS database to ePortfolio system.

Before ePortfolio system enables any activities, students fulfil first assignments: take a test to assess initial level of their competences, make self-appraisal and submit first homework. All these data go into university's LCMS database. After submission of the homework at the first onset the tutor inputs it to ePortfolio data base. Based on a time sequence of submitted homeworks, ePortfolio system forms groups of four students each

ePortfolio system algorithmic model (Fig. 3.3) is tailored to the students homework files submission, own accomplished tasks self-appraisal and particular group participants homeworks assessment both in a form of marks in the scale from 1 to 10 (where 1 is the lowest assessment mark and 10 – the highest one) and reflection expressions, e.g., suggestions, recommendations, which are displayed in textual form.

Based on peers made evaluation, the student takes steps to improve own homework and proceeds to the next course module, or, if he/she decides that there is nothing to be improved in the homework, peers remarks are taken into account and the learner also proceeds to the next course module. In the case if the homework is improved, it will come to university's database for the additional reviewing. The model can provide also re-submission of improved files back to ePortfolio collaborative group-working environment. However, due to limited time schedule this option was not broadly applied.

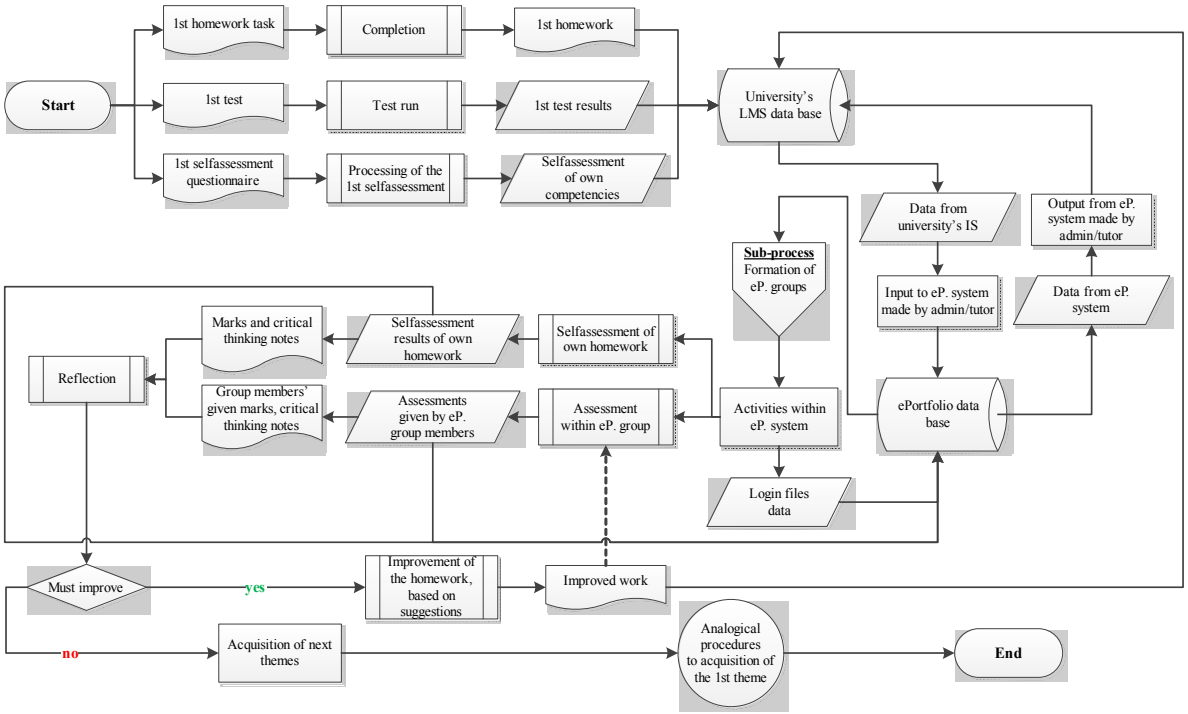


Fig. 3.3. Algorithmic model

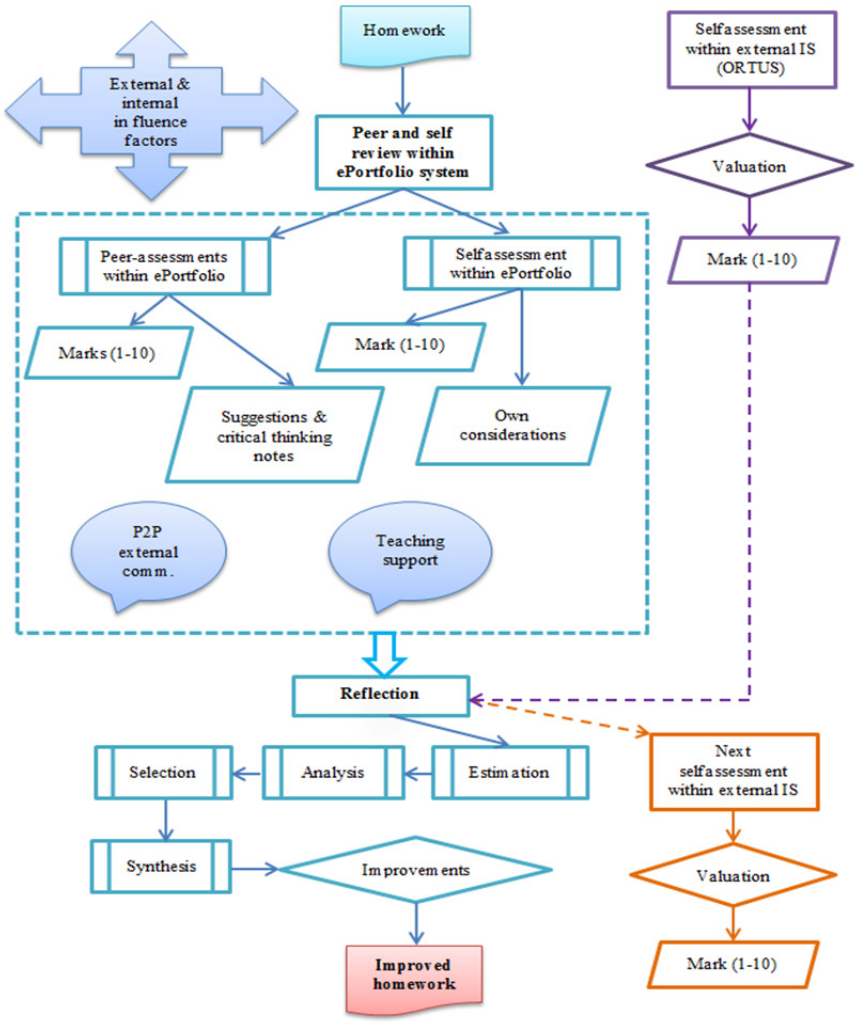


Fig. 3.4. Conceptual design

Conceptual design (Fig. 3.4) is tailored to include ePortfolio system into joint motivating learning outcomes enhancing system:

- ePortfolio, onto scaffolding approach built on information system, which provides acquisition of new themes, based on previous learning modules and group-working activities within the system which empower improvement of critical thinking and reflection;

- University's LCMS 'ORTUS' where e-learning objects, as well self-assessments sites, e.g. tests and self-assessment questionnaires are placed.

Proposed ePortfolio system model is realized in the prototype of client-server form. Fig. 3.5 gives an adumbration of the arhitecture of the created and existing information system (IS) from a view of used technologies. Keeping in mind that university's LCMS and created ePortfolio system are two independent ISs, their client-server sides are separated, and request processes to servers' databases for each of them are organized apart.

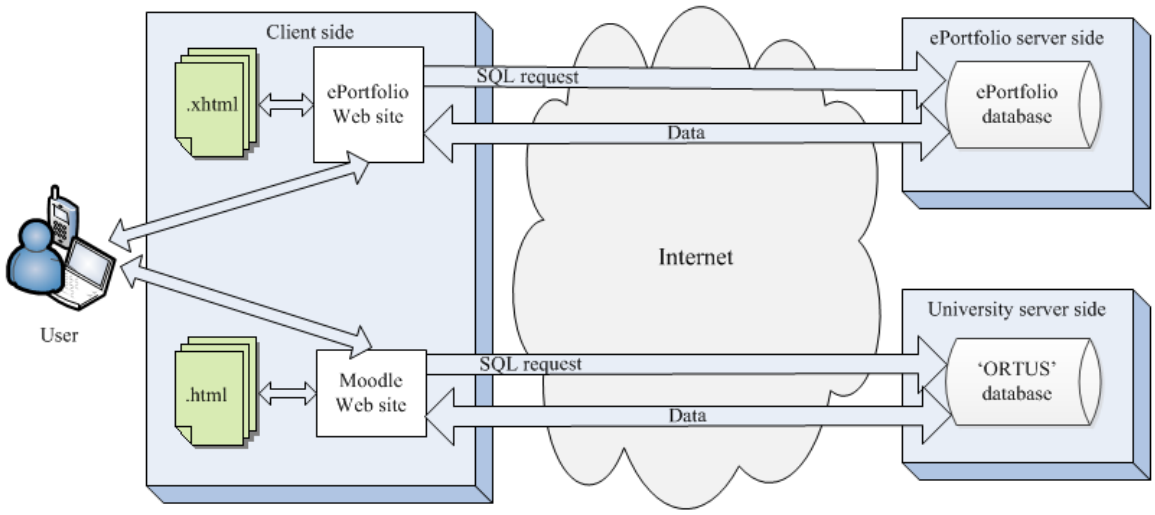


Fig. 3.5. Arhitecture of the created information system from a view of used technologies

In existing university's LCMS (at the bottom of the Fig. 3.5) on the client side the user-student, to request the data (for instance, e-learning objects, records of lectures, presentations, own learning progress track records, and so on), communicates with the university's Moodle Web site by sending it the query, which makes SQL request to university's database. On the university's server side the database ('ORTUS') server realizes searching of requested data; further the university's Moodle Web site receives found data and presents they to the user-student. Sending of the data goes on also in the other way round – from the client side to the university server side, for instance, when the student submits requested homeworks. The user-teacher, in his/her turn, obtains students' submitted homework files by sending the quiry to the university's Web site which makes SQL request to university's database. On the client side there are files in HTML format which keep inwardly

fragments of e-learning objects, tests, several formulations of the self-assessments, enforceable tasks, planned activities within eportfolio system, etc.

In created ePortfolio system (on the top of the Fig. 3.5) on the client side the user-student, to request the data (for instance, particular system group partcipants homework files and assessments regarding own accomplished tasks given by this group other students), communicates with the ePortfolio Web site by sending it the query, which makes SQL request to ePortfolio database. On the ePortfolio server side the database server responses/realizes searching of requested data; further the ePortfolio Web site receives found data and presents they to the user-student. Sending of the data goes on also in the other way round – from the client side to the ePortfolio server side, for instance, when the student makes self-assessment and realizes his/her ePortfolio system group participants' homework assessments. Consequently, ePortfolio system user-student obtains necessary data to fulfil asked activities within the system, which enhance reflection and improvement of own accomplishments. The user-teacher realizes sending the data in the direction from the client side to ePortfolio server side when provides suggestions and comments to stududents for possible improvements.

On the ePortfolio client side there are files in XHTML format which keep inwardly description of executable tasks and activities within ePortfolio system, formulations of the assessment criterions, etc.

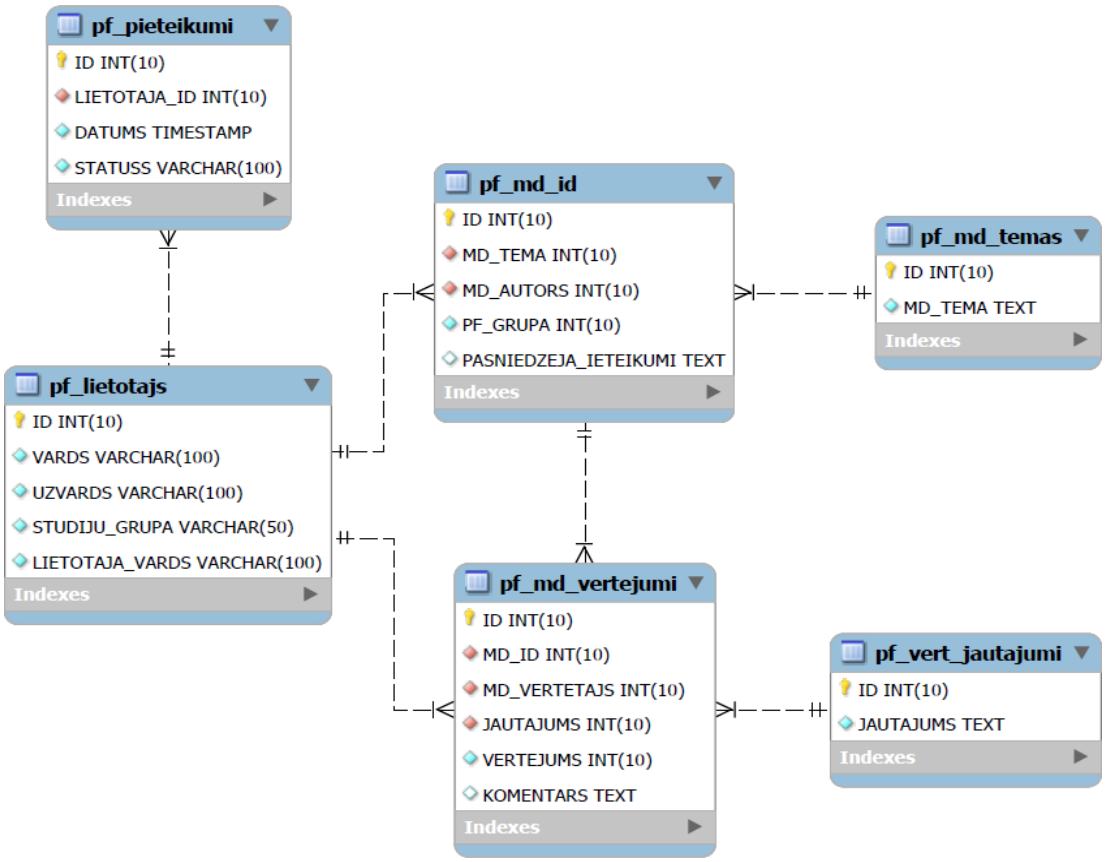


Fig. 3.6. Data model

ePortfolio system data model is developed up by using of MySQL Workbench software. ePortfolio system database is realized by implementing of MySQL 5.5.16 database management system. It includes the tables as follows (Fig. 3.6):

- the table „pf_lietotajs" keeps the data about students: ePortfolio system user's name (VARDS VARCHAR (100)), surname (UZVARDS VARCHAR (100)), university student's group number (STUDIJU GRUPA VARCHAR (50)) and username (LIETOTAJA VARDS VARCHAR (100)). This table hereafter in case of need could be increased with additional fields which would contain other student's descriptive attributes, for instance, e-mail address, phone number, and so on;

- the table „pf_pieteikumi" keeps ePortfolio system user's login and logout data: user's identifier (LIETOTAJA_ID INT (10)), which is related to the ID of the table „pf_lietotajs" about each login and logout in/to the system, their login and logout date and time (DATUMS TIMESTAMP), as well the login status within ePortfolio system (STATUSS VARCHAR (100));

- the table „pf_md_temas" keeps the themes names of fulfilled homework assignments (MD_TEMA TEXT);

- the table „pf_md_id" contains the data about user's fulfilled homeworks: homework identifier (MD_TEMA INT(10)) which is related to the ID of the table „pf_md_temas", the identifier of fulfilled homework (MD_AUTORS INT(10)) which is related to the ID of the table „pf_lietotajs", ePortfolio group number (PF_GRUPA INT(10)), as well teacher's given recommendations for homework further improvement (PASNIEDZEJA_IETEIKUMI TEXT);

- the table „pf_vert_jautajumi" keeps the questions (JAUTAJUMS TEXT) to assess students homeworks;

- the table „pf_md_vertejumi" contains the data about assessment of users-students fulfilled homeworks: the identifier of the assessed homework (MD_ID INT(10)) which is related to the ID of the table „pf_md_id", the identifier of the particular homework assessor (MD_VERTETAJS INT(10)) which is related to the ID of the table „pf_lietotajs", the identifier of the assessment question (JAUTAJUMS INT(10)) which is related to the ID of the table „pf_vert_jautajumi", as well assessments given by ePortfolio group members in the form of marks (VERTEJUMS INT (10)) and suggestions (KOMENTARS TEXT).

3.3. Justification for the choice of software

Software preference statement of reasons was done based on considerations that a new application software should be programmed to ensure students groupworking which would be exactly suited to students needs as an extra module to existing module in the Moodle environment, as the scaffolding system with the functionality of groupworking, which was not available in existing Moodle environment. The system is created within an open source integrated development environment *Netbeans* (http://netbeans.org/). Programming language *Java* is chosen, and the fundamental principle of the three-pronged architecture MVC (*Model View Controller*) is applied.

On the Model level, object-oriented data level, *Hibernate* (http://www.hibernate.org/) library packages which ensure transaction mechanism in database, are utilized. On the View Controller level JSF (*Java Server Faces*) library packages are used (http://javaserverfaces.java.net/). JSF provides the foundation of auxiliary and controller classes, as well on the View level XHTML in the standard pages – input and depiction of the objects. Navigation between pages is provided by the definition of JSF configuration in the file *faces-config.xhml*. JSF provides also the functionality of AJAX (*Asynchronous JavaScript and XML*) which allows shunning of the *JavaScript* code which might embarrass the user.

Experimental ePortfolio system is hosted on the application server *Glassfish 3.1* (http://glassfish.java.net/). Received data are collected, saved and maintained in the *MySQL 5.5.16* database which offers easy importing and exporting the data from/to *Moodle MySQL* database. *Java Development Kit 1.6.0_24* is used.

3.4. ePortfolio system's use of technology and operation in the system

The Reflection stimulating information system prototype and the system' use of technology has been developed which expects the user's login into the system, acquaint him/herself with system group members homeworks, assessment of these homeworks, including self-assessment, by putting marks and suggestions in specific fields.

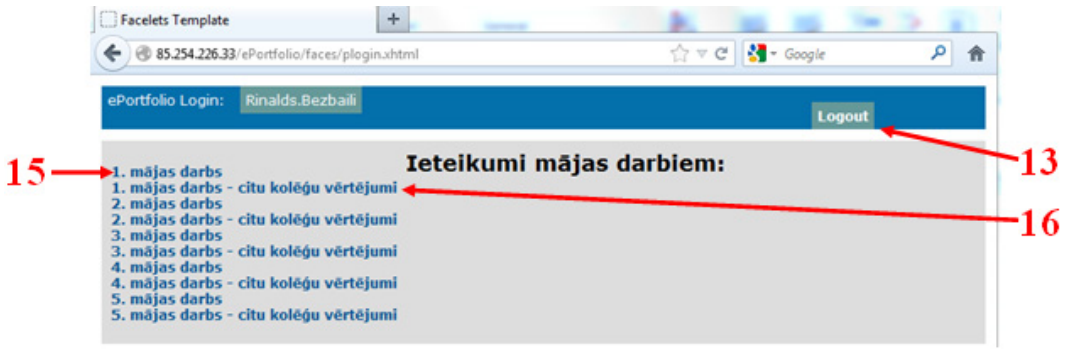


Fig. 3.7. ePortfolio system user's desktop

The learner reaches ePortfolio system either by the link from university's LCMS or by typing in Internet browser ePortfolio address: http://85.254.226.33/ePortfolio/. After login ePortfolio user's main page with personal desktop opens (Fig. 3.7) and offers assessment activities within groups (for, instance, in the case of the first homework – indication No.15 in Fig. 3.7) of four students each, as well opportunity for reflection by acquaint him/herself with group members given suggestions groups (for, instance, indication No. 16 in Fig. 3.7)

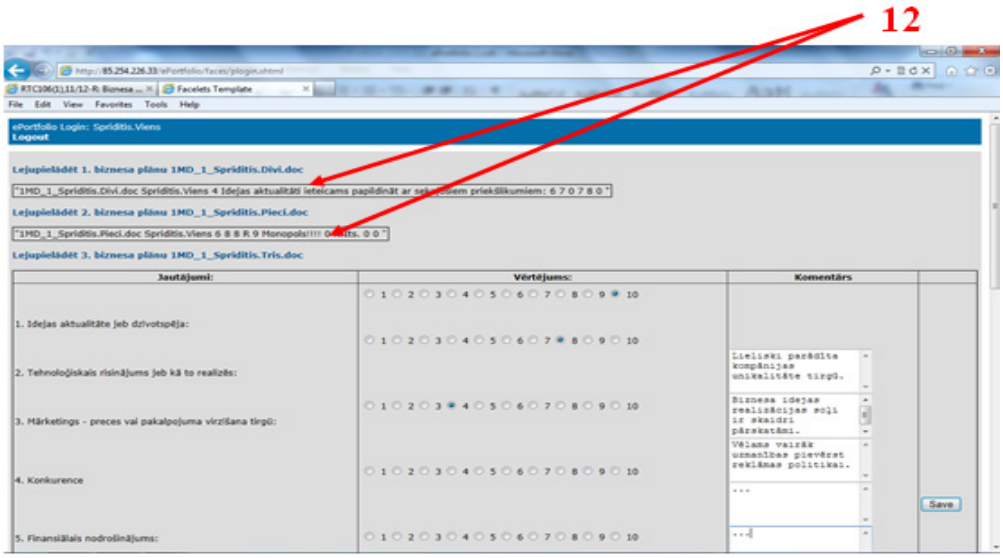
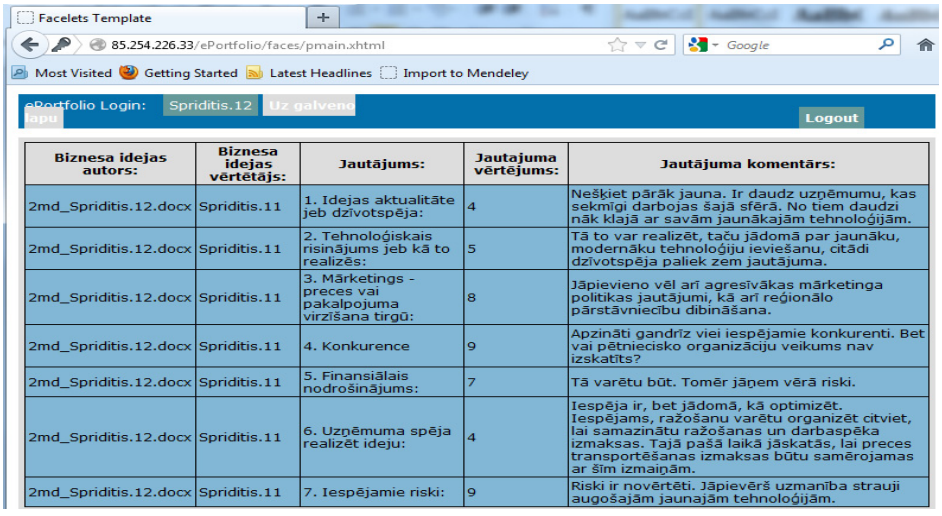


Fig. 3.8. Students work assessments page

In groupworking activities (Fig. 3.8) the student has to make self-assessment and assess other three students in his/her group in compliance with 7 criterions (questions) which are in line with defined BPOM (*Business Planning for Open Markets*) course competencies: estimating a viability of business idea, company's ability to carry out business idea, marketing, awareness of competition factors, estimating of financial resources, assessement and development of company's ability to carry out business idea, identification of risks.



Biznesa idejas autors:	Biznesa idejas vērtētājs:	Jautājums:	Jautājuma vērtējums:	Jautājuma komentārs:
2md_Spriditis.12.docx	Spriditis.11	1. Idejas aktualitāte jeb dzīvotspēja:	4	Nešķiet pārāk jauna. Ir daudz uzņēmumu, kas sekmīgi darbojas šajā sfērā. No tiem daudzi nāk klajā ar savām jaunākajām tehnoloģijām.
2md_Spriditis.12.docx	Spriditis.11	2. Tehnoloģiskais risinājums jeb kā to realizēs:	5	Tā to var realizēt, taču jādomā par jaunāku, modernāku tehnoloģiju ieviešanu, citādi dzīvotspēja paliek zem jautājuma.
2md_Spriditis.12.docx	Spriditis.11	3. Mārketings - preces vai pakalpojuma virzīšana tirgū:	8	Jāpievieno vēl arī agresīvākas mārketinga politikas jautājumi, kā arī reģionālo pārstāvniecību dibināšana.
2md_Spriditis.12.docx	Spriditis.11	4. Konkurence	9	Apzināti gandrīz viei iespējamie konkurenti. Bet vai pētniecisko organizāciju veikums nav izskatīts?
2md_Spriditis.12.docx	Spriditis.11	5. Finansiālais nodrošinājums:	7	Tā varētu būt. Tomēr jāņem vērā riski.
2md_Spriditis.12.docx	Spriditis.11	6. Uzņēmuma spēja realizēt ideju:	4	Iespēja ir, bet jādomā, kā optimizēt. Iespējams, ražošanu varētu organizēt citviet, lai samazinātu ražošanas un darbaspēka izmaksas. Tajā pašā laikā jāskatās, lai preces transportēšanas izmaksas būtu samērojamas ar šīm izmaiņām.
2md_Spriditis.12.docx	Spriditis.11	7. Iespējamie riski:	9	Riski ir novērtēti. Jāpievērš uzmanība strauji augošajām jaunajām tehnoloģijām.

Fig. 3.9. An overview of made assessments within ePortfolio group

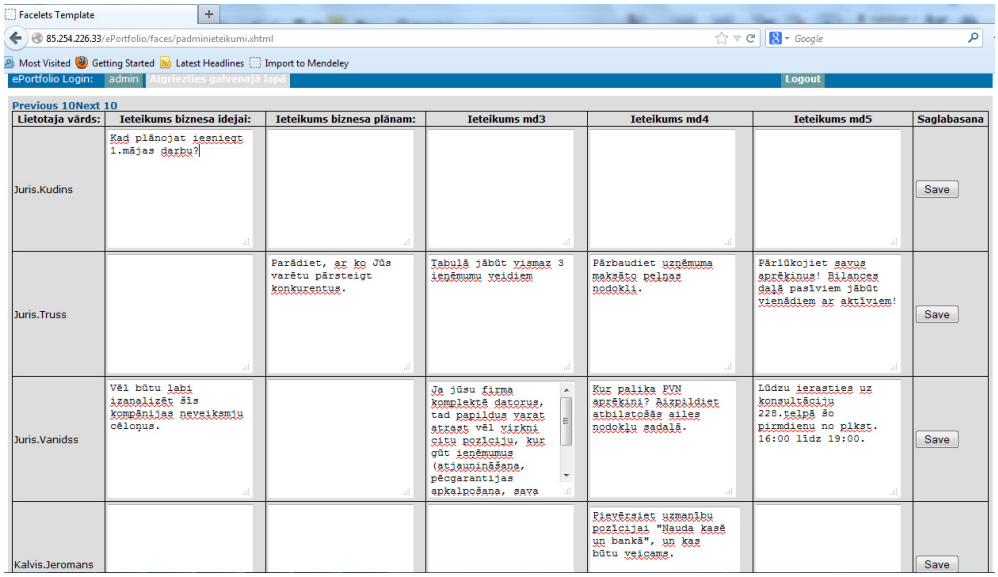


Fig. 3.10. Tutors' recommendations input window

After assessment tasks in groupworking activities the user can see own remarks in the students work assessments page (Fig. 3.8, indication No. 12), as well acquin him/herself with other students given critical thinking notes (Fig. 3.9), which enhance the reflection and improvement of corresponding works. Similar effect is reached also by teachers suggestions made in the tutors' recommendation input window (Fig. 3.10).

4. APPROBATION OF ePORTFOLIO SYSTEM IN LIVING LAB

The chapter consists of 43 pages, 12 tables and 16 figures.

4.1. ePortfolio prototype and its approbation by Living Lab research method

Considering that Living Lab research approach includes several research methods and consists of target-group identification, development of scenarious, creation of prototypes, estimation, interviews, groupworking activities, surveys, feedbacks and studies of taget-group activities (Fulgencio, 2012), and is defined as the environment where users validate new information and communication technology solutions (Følstad, 2008), this approach is chosen for the efficiency determination of created ePortfolio system. By changing of ePortfolio system input parameters (namely – the number of activities within the system (from 0 to 5) and log-files (starting from 0)) the output parameters (namely – the number of improved homeworks – as the reflection characteristic feature, and exam results – as the competence levels development feature) were analized, all-in-all forming the validation of created system.

4.2. Verification and validation of the first ePortfolio system prototype in Living Lab

To validate initially developed ePortfolio system model, an appropriate prototype was built and approbated in Living Lab in 2011/12 academic year (from the September 5, 2011 till January 27, 2012) at the Distance Education Study Centre, Riga Technical University (RTU). In the panel sampling strategy the formation of an accessibility/convenience representative sample was used (Mārtinsone, 2011). The sample consisted of 145 RTU first year students who had attended blended learning course „Business Planning for Open Markets (BPOM)".

Valuation of created ePortfolio system included: (a) its validation, i.e., the process at the final stage of system development to be satisfied that achieved results answer the purpose (Dosbergs, 2013b), realized by prototype examination, including users activities in Living Lab, their survey results regarding system's usability and efficacy, experts' opinions, among them – at the international scientific conferences and reviews of publications; (b) verification, i.e., the analysis by use of statistical data processing methods, including Excel 2010 and SPSS-21 software, and setting the system non-user group data against user group data.

Approbation results in Living Lab show effectiveness of the system which stimulates system users' reflection and improves particular to the course competence levels (Fig. 4.1).

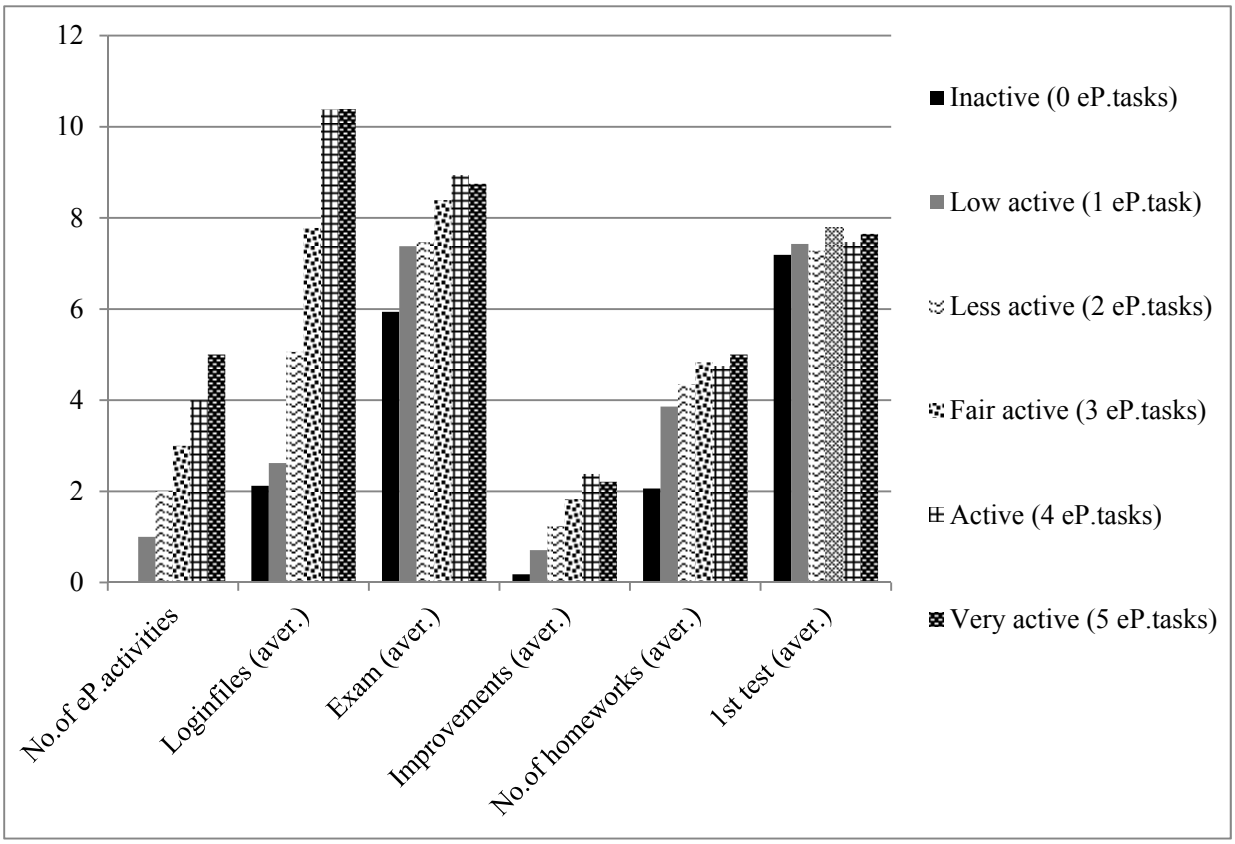


Fig. 4.1. Learning outcomes depending on activities within ePortfolio system

To find relationship between input and output parameters of developed ePortfolio system, representative sample of 145 students was discrete ranked into two groups: non-users group (20 students) and experimental group – ePortfolio system users with at least one login (125 students). There was impossible to set up equal quantitative structure of both groups due to a principle of voluntary participation in research activities.

To find competence distribution in whole sample and within groups, Kolmogorov-Smirnov test was used to prove null hypothesis H_0 - competence distribution within group forms normal distribution, and alternative one H_a - competence distribution within group does not form normal distribution. During the test, which value did not exceed critical values, with 95 per cent level of confidence, it was found that the distribution of initial competences (initial test) for whole sample and active users forms normal distribution, affirming null hypothesis H_0; but distribution of final competences (exam) at the end of the course does not form normal distribution, rejecting null hypothesis H_0. Wherewith, it confirms the impact of created ePortfolio system on users learning outcomes. Analysis for each separate login file was not made due to excessive number of login files (from 1 to 38) and insufficient number of users in each. Consequently, the distribution of achieved competence levels at the end of the course does not form normal distribution in active users' experimental group. However, as soon as we start analysing users activity within the system, exponential distribution appears. It could be concluded that the more the user logins the better results he/she achieves.

For comparing mark distribution in two populations (non-users and experimental ePortfolio system users group) Mann-Whitney nonparametric test was used to test null hypothesis H_0 that competence distribution in both populations have identical distribution functions against the alternative hypothesis H_a that competence distribution in two distribution functions differs. During the test, with 95% level of confidence, it was found that distribution of initial competence levels in both non-users and users' groups is identical, affirming null hypothesis H_0; but distribution of final competence levels in two these groups differs, rejecting null hypothesis H_0. It could be concluded that experimental group, which took part in ePortfolio activities, achieved better results than non-users group.

For comparing significant difference of arithmetic means between two groups (experimental and non-users ones) the T-test was used. As the T-test value -1,304 does not exceed critical values, with 95% level of confidence we can conclude that both groups have the same on average initial competence level (average initial competence level value-judgement of non-users is 7,29 and users – 7,55). But, as the T-test value -7,112 exceeds critical values, with 95% level of confidence we can conclude that there is a difference in

achieved competence levels at the end of the course between non-users and users groups (average final competence level value-judgement of non-users is 5,65 and users – 8,43). Namely, ePortfolio system users achieve better learning outcomes than non-users, and we can gain the justification of set dissertation theses.

To find relationships, their strength and way between input and output parameters, the correlation coefficients were calculated. They completely justified and proved proposed theses, i.e. created ePortfolio system's efficiency regarding enhancement of its users reflection and competence development. It was found that:

- There is a moderate positive correlation between activities within ePortfolio system and the number of improved homeworks – the main parameter of reflection (correlation coefficient r= 0,492, correlation is significant at the 0.01 level (α= 0,01));

- There is a moderate positive correlation between activities within ePortfolio system and achieved competence levels at the end of the course (r= 0,475, α= 0,01) which justifies created system's positive impact on learning outcomes;

- There is a moderate positive correlation between activities within ePortfolio system and fulfilled external tasks (r= 0,613, α= 0,01) which also justifies created system's positive impact on learning outcomes;

- There is a moderate positive correlation between activities within ePortfolio system and login files (r= 0,454, α= 0,01). At the same time there is weak correlation between activities within ePortfolio system and initial test results (r= 0,169, α= 0,05). As a result, it could be concluded that approbated ePortfolio system has considerable impact on learners' activities apart from initial competence levels;

- There is also a positive correlation between the number of login files and the number of improved homeworks (r= 0,356, α= 0,01), as well achieved competence levels at the end of the course (r= 0,269, α= 0,01);

- There is a weak positive correlation between initial test results and the number of improved homeworks (r= 0,129), as well exam results (r= 0,258, α= 0,01). It could be concluded that ePortfolio system impacts its users' competence development and reflection improvement apart from initial competence levels.

Evaluating system users' achievements in correspondence with their initial self-assessments, it was found that these self-assessments do not correlate with initial test results. Initially self-overestimated students' self-assessments go down in next self-appraisal phase, but self-undervalued students' self-assessments – jump. Changes in learning themes or

introduction of new learning methods impact the competence change dynamic. For example, competence growth becomes slower when facing the problem of financial calculations; however, competence growth continues when constructive support within ePortfolio system groups is provided. During the course students achieved acceptable more or less similar competence levels which had been stated as the aim of the course. It could be said that during the course the specific competence development spectrum are being developed. It characterizes the changesa of competence levels changes corresponding to acquired learning modules and activities within ePortfolio system (Fig. 4.2). Self-assessment tools, embedded in ePortfolio system and university's LCMS, allow establishing the impact of created ePortfolio system on its users accomplishment changes at the moment of implementation of this experimental information system and the use of particular learning object.

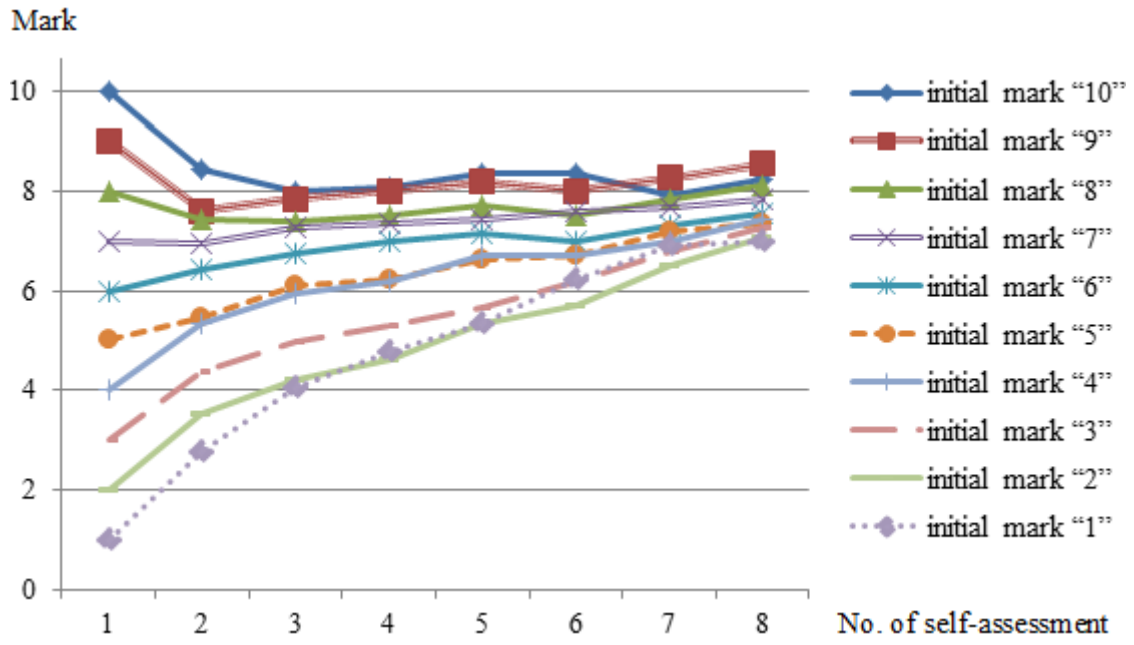


Fig. 4.2. Competence development spectrum

ePortfolio system users survey results also demonstrate system's importance on improvement of learners competence levels (Fig. 4.3) and reflection (Fig. 4.4). Considering that these surveys were organised apart, the number of respondents vary.

In the first questionnaire students were asked to mark in the scale from 1 to 10 (from the worst answer to the best one, i.e., mark "1" meant that the system had not an impact, mark "2" – the impact was negligible, mark "10" – the system had the most impact), how much ePortfolio system improved their competence levels. 112 users participated in this survey. Majority of them – 77 learners (or 68 per cent) had a strong confidence about system's (or 10 per cent) – held a view that the system had a minor impact on their competence improvement, only 3 participants (or less than 3 per cent) said that they did not notice any system's impact.

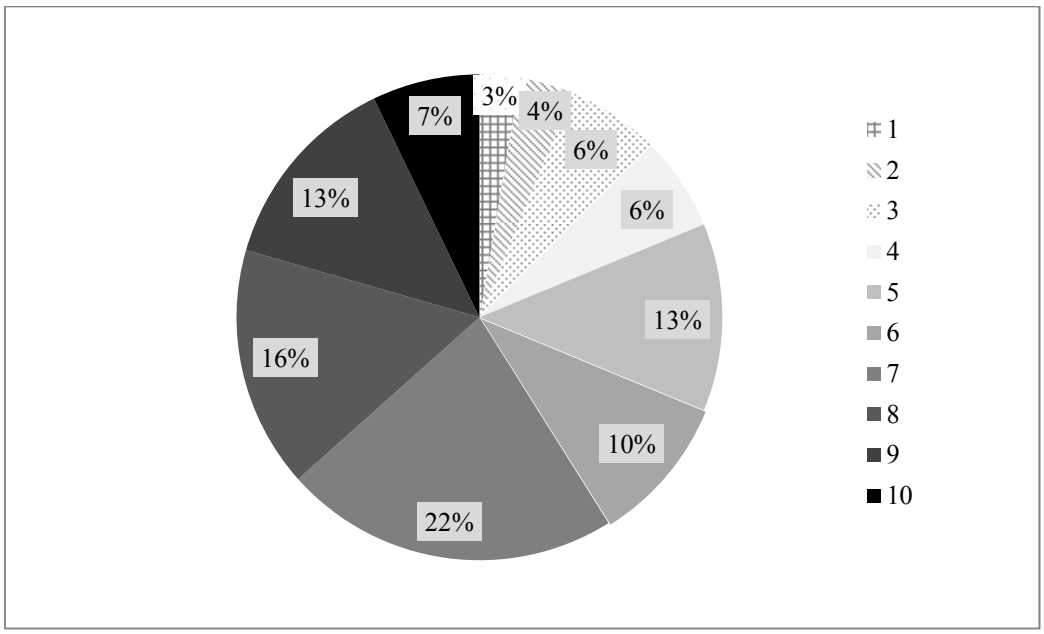


Fig. 4.3. Users' opinions related ePortfolio system's impact on their competence improvement

In the second questionnaire students were asked how much ePortfolio system improved their reflection abilities. From 116 users participated in this survey majority – 103 respondents (or 88 per cent) had a strong confidence about system's positive impact on their reflection, 12 students (or 11 per cent) ware rather satisfied, and only 1 learner (or less than 1 per cent) admitted unsubstantial impact of the system. There was nobody who would say that the system did not improve his/her reflection abilities.

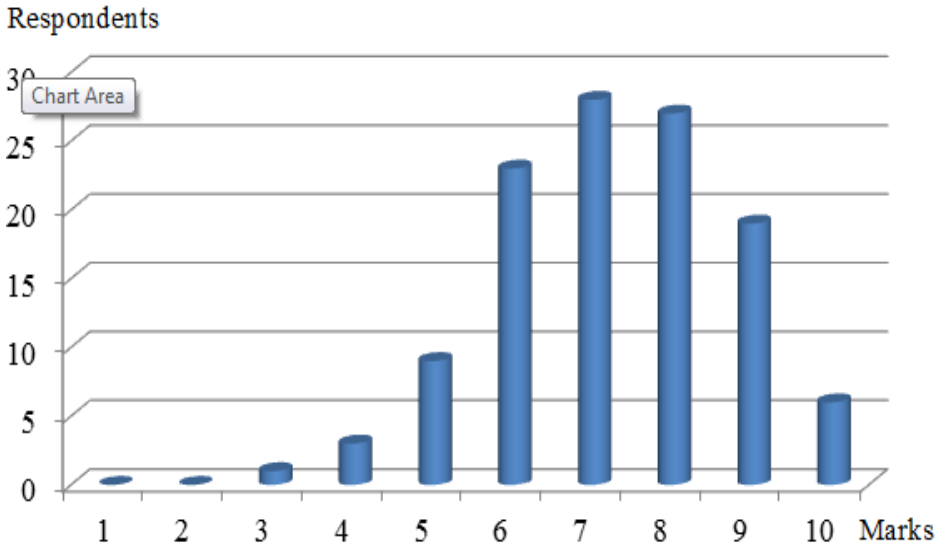


Fig. 4.4. Users' opinions related ePortfolio system's impact on their reflection

4.3. Approbation of modified ePortfolio model in Living Lab in 2012/2013 academic year

To ensure learners more active participation in created ePortfolio system activities, and, as a result of this, to improve students' competence levels achieved at the end of the course, after the first system model its modified version was developed.

To validate modified ePortfolio system model, an appropriate prototype was built and approbated in 2012/13 academic year at the Riga Technical University. Approbation results in Living Lab show again effectiveness of the system.

Like in previous year, survey results regarding modified system's impact on users' competence improvement and reflection development mainly displayed students' confidence about system's positive impact on their reflection and competence improvement.

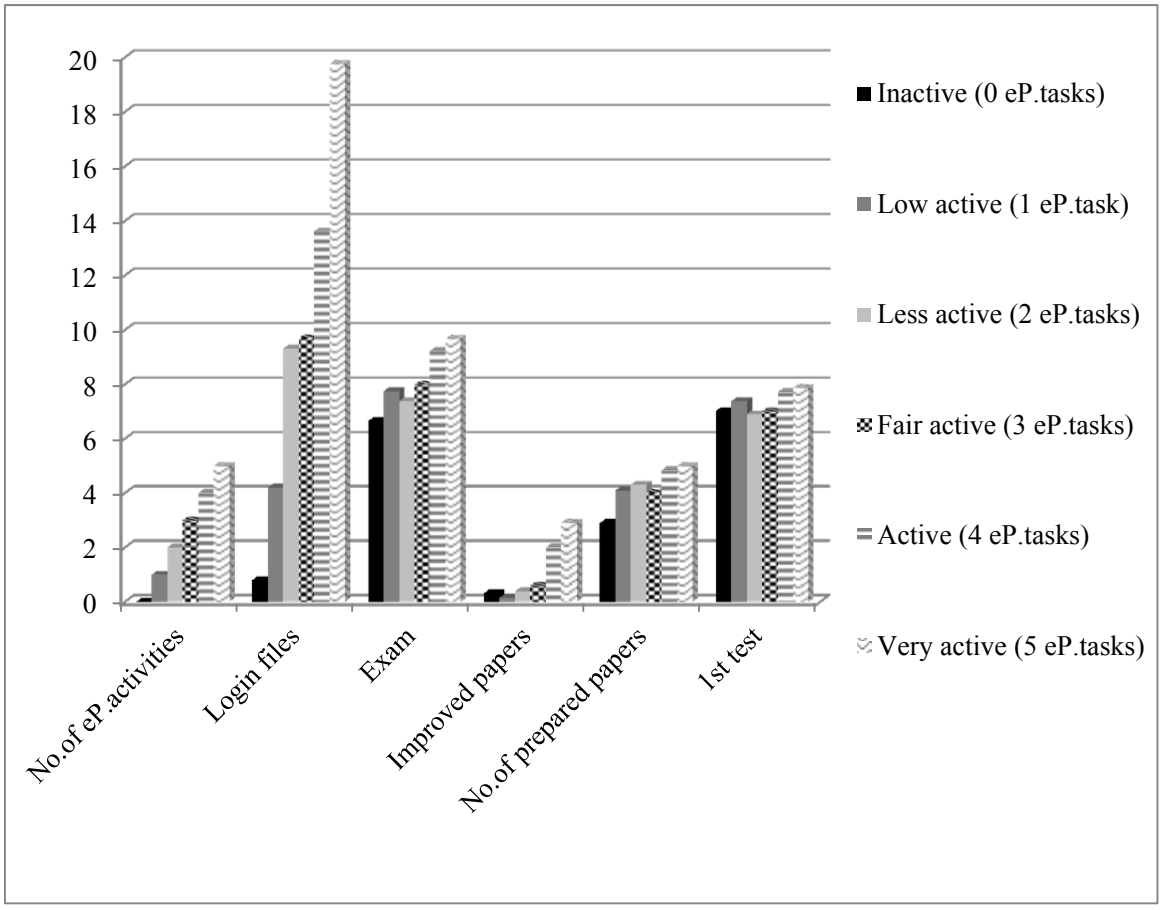


Fig. 4.5. Learning outcomes depending on activities within modified ePortfolio system

In contradistinction to the first version of developed ePortfolio system, where group composition remained unchanged from initial ePortfolio activity till the end of the course, its modified version provides group formation anew for each activity module.

Due to the fact that the university's LCMS and ePortfolio system are two independent information systems, partial automation was made. Namely, course instructor regularly

downloaded all students' papers into one directory (c:\ePortfolio). The system divided these files into groups – registered submitted papers (files) and group numbers in ePortfolio system data base. New approach and implementation of automation tool ensured regular group completing and permanence of quantitative structure, although the amount of all groups was decreased.

Approbation results in Living Lab again show effectiveness of the system which stimulates system users' reflection and improves particular to the course competence levels (Fig. 4.5).

At the model's verification stage to find relationship between input and output parameters of modified ePortfolio system, representative sample of 99 students was ranked discrete into two groups: non-users group (18 students) and experimental group – ePortfolio system users with at least one login (91 students).

After completion of Kolmogorov-Smirnov, Mann-Whitney and T-tests, where tests' values did not exceed critical values, with 95 per cent level of confidence, as well after determination of possible correlations with at least 95 to 99 per cent level of confidence, it was established that tests' results are similar to previous ones made for the first prototype in 2011/12 academic year. However, comparison and analysis of correlation coefficients in both cases gave some suggestions regarding efficiency of developed systems. Thus:

- There is a moderate positive correlation between activities within modified ePortfolio system and the number of improved homeworks – the main parameter of reflection ($r= 0,446$, $\alpha= 0,01$);

- There is a moderate positive correlation between activities within modified ePortfolio system and achieved competence levels at the end of the course ($r= 0,565$, $\alpha= 0,01$);

- There is a moderate positive correlation between activities within ePortfolio system and fulfilled external tasks ($r= 0,493$, $\alpha= 0,01$);

- There is also positive correlation between the number of login files and the number of improved homeworks ($r= 0,304$, $\alpha= 0,01$), as well achieved competence levels at the end of the course ($r= 0,393$, $\alpha= 0,01$);

- There is no correlation between initial test results and the number of improved homeworks ($r= 0,023$), as well exam results ($r= 0,070$). It could be said that ePortfolio system impacts its users' competence development and reflection improvement apart from initial competence levels.

CONCLUSIONS

Conclusions consist of 6 pages and 1 figure.

Conclusions

During the development of the dissertation the existing research thoughts, available publications on the ePortfolio and reflection stimulating information systems level were carried out; ePortfolio system data and algorithmic model was developed; ePortfolio system prototype was created; ePortfolio system model was approbated, i.e. validated and verified; an acquisition, systematization, generalization and evaluation of ePortfolio system approbation data regarding system users activity and learning outcomes results were carried out; it was evaluated, how much experimental information system output parameters were changing against changed input parameters, ensuring achievement of research goals and these doctoral theses; the proposals regarding further improvement of created ePortfolio system were provided; and recommendations for implementation of developed ePortfolio system in educational organisations were formulated.

During this research the purpose of the dissertation is achieved – the reflection stimulating ePortfolio system, which would merge a scope of technological and educational aspects to facilitate system users' better achievements, is developed; as well as corresponding tasks are fulfilled. Affirmations of research theses were achieved. Namely:

1) Developed algorithmic model ensures creation and functioning of reflection stimulating ePortfolio system which has direct impact on system users' achievements / learning outcomes. During the research, based on developed algorithmic model, the initial ePortfolio system prototype was created and successfully approbated in 2011/2012 academic year. Further, the modified model, equipped with group formation automatation tools, was developed and also successfully approbated in 2012/2013 academic year.

Their validation was made by implementing of Living Lab research method, as well by realizing of expert-surveys and receiving positive expert-reviewers appreciations regarding published papers in scientanific journals and presentations at the Latvian and international scientific conferences and workshops. Created ePortfolio system users' opinions regarding system's impact on their learning progress also are mainly positive ones.

The verification of developed ePortfolio system prototypes was made by applying of statistical data processing software SPSS-21 and Excel 2010, which gave conclusive proof of positive impact of both created ePortfolio system versions on their users achievements and learning outcomes, comparing them with non-users data.

2) Embedded into ePortfolio system self- and peer-assessment tool facilitates feedback swell which becomes apparent in the main indicator of reflection – in increased number of task improved accomplishments. Synergetic learners' collaboration, activities implementation, assessment and self-assessment setting are created, which in this way showed on reflection and competence improvement turned better showings than existing ePortfolio systems.

The new point of view and considerations about assessment and self-assessment essence, and the embedding of corresponding tools into information system, as well the effect of equipped with the noted assessment and self-assement instruments ePortfolio system on its users' achievements and learning outcomes improvement were made.

ePortfolio system users survey results, made during the system development and approbation years, are also indicative about the direct impact of the introduced information technology on the reflection enhancement.

In addition to that, the new term "competence development spectrum" was introduced. It characterizes system user's competence level changes accordingly acquired learning modules and activities within ePortfolio system. This term might become an important set of parameters of next ePortfolio systems, would be developed in future to adapt system usability for the implementation of various tasks with specific defined aims, and to improve functionality and efficiency of the system. Self-assessment tools, embedded in created ePortfolio system and university's existing information system, allow determinating of ePortfolio system impact on its user's changes of achievements at different moments of use of definite learning object and experimental information system.

3) Actions and other activities within ePortfolio system facilitate improvement of users' reflection. Thus, there is considerable positive correlation between activities within ePortfolio system and the number of improved homeworks – the main parameter of reflection, both in the case of the first ePortfolio system version ($r= 0,492$, $\alpha= 0,01$) and modified one ($r= 0,446$, $\alpha= 0,01$).

4) Competence levels development is directly dependent on ePortfolio system users' activities in corresponding task work within the system. There is considerable positive correlation between the numbers of activities within ePortfolio system and learning outcomes, i.e., achieved results at the final course exam both in case of the first prototype ($r= 0,475$, $\alpha= 0,01$), and the second one ($r= 0,565$, $\alpha= 0,01$). At these final examinations the students achieved competence levels were assessed. This argument about term of "competences" was taken into consideration because of the essence and structure of the exam. Thus, students were

asked to demonstrate in entirety a cluster of reached appropriate “abilities, commitments, knowledge and skills” (BusinessDictionary.com, 2013).

It was approved that developed ePortfolio system has positive impact on students learning activities also outside this information system. Namely, there is considerable positive correlation between the the numbers of fulfilled homeworks and activities within ePortfolio system both in case of the first prototype ($r= 0,613$, $\alpha= 0,01$), and the second one ($r= 0,493$, $\alpha= 0,01$).

Furthermore, the first, i.e. initial, test assessment results do not correlate with ePortfolio users achieved results at the end of the course, and the number of improved homeworks – the main parameter which characterizes reflection, as well the number of fulfilled tasks outside ePortfolio system. It allows drowing the conclusion that exactly the developed ePortfolio system outreaches its users learning outcomes and reflection with respect of initial competence levels. Hence it might be concluded that learners’ achievements are not affected by their prior competence levels; the other way round, created ePortfolio system and users activities within the system enables better achievements. Namely, developed ePortfolio system directly and positively impacts students’ learning outcomes.

During research activities, even though it has not been raised in the population of doctoral theses, it was found another one positive factor of implementation of ePortfolio system, i.e. save up course tutors margin of time to manage extra educational activities and advisory work.

The new, unused before in ePortfolio systems in this way, tool for system users inclusion into groups of definite number of participants depending on their fulfilled homework tasks submissions, is carried into effect. To accomplish assigned tasks withim ePortfolio system, the scaffolding system approach was applied. It enabled thorough efficacious application of the system.

Created ePortfolio system offers to its users learning outcomes’ improvement instruments which information systems of Riga Technical University and other higher educational institutions cannot provide. Proposed solution gives university the possibility to manage own ePortfolio system independently.

Recommendations to implement reflection stimulating ePortfolio systems in educational organizations

Realized in this work studies and achieved results open up new opportunities for educational organizations in implementing of new methods and approaches to involve in and motivate learners, as well improve their critical thinking and reflection abilities.

The proposed ePortfolio system model enables active inclusion of the students in the improvement of their own competence levels and reflection through collaboration with other ePortfolio system users – particular group participants: on the one hand – by assessing their fulfilled tasks, making critical thinking decisions regarding different aspects of these accomplishments, making recommendations for improving of homeworks; and on the other hand - by critical approaching to own fulfilments and achievements, through reflective approach finding the most appropriate ways to improve own competences, motivating themselves, as well with own positive example (in terms of results and attitudes) motivating and encouraging others.

Scaffolding system approach, used in the system's model, enables acguiring of new themes and building of new knowledge based on previous learning modules and gained appropriate competences. It also motivates students to learn the subject matter in consecutive way.

ePortfolio group participants' recommendations and constructive assistance motivate system user for his/her work further improvements, as well involvement in acquiring of next course modules. Mentioned approach is important and might be very useful in mastering of specific learning subjects and themes in secondary schools and higher educational institutions.

Created ePortfolio system has demonstrated in practice its efficiency and impact on system users' competence levels improvement much more in comparison with system non-users results. Proposed ePortfolio system facilitates also reflection and improvements of the system users' other achievements outside the system.

In both ePortfolio system approbation stages students acted mainly in e-environment. Although many of them successfully used also m-environment – by applying of smartphones to quickly review the group members' proposals and recommendations regarding possible improvements, as well to give assessments of the group members' performance. In a case if the use of ePortfolio system would be mandatory one (hitherto the acting within ePortfolio collaborative environment has had just a recommendation nature), the efficiency of this system might be improved.

Proposed ePortfolio system may offer to educational organizations with a large (over a hundred) number of learners a possibility little bit unburden course teachers.

All abovementioned things considered, Latvian and worldwide educational organizations might successfully adopt and put into daily practice proposed reflection stimulating ePortfolio system model, modify its algorithmic model and protorype corresponding to their curruicula and courses aims. Proposed ePortfolio system might be used

also as an integrated part of e-, t-, and m- learning, as well a powerful instrument for improvement of learners' knowledge, skills, abilities and commitments in traditional full-time education. This system might be successfully applied both in universities, colleges and secondary schools. It could contribute also in supporting for the the formal and informal education.

Possible directions of further research

The uppermost, created ePortfolio system ought to be further developed, providing more interactivity for its users, embedding of additional communication and collaboration tools. The development of user's profile within ePortfolio system yet more might improve system users' motivation and their willingness to be involved in activities which are implemented both within and outside ePortfolio system.

Secondly, further research questions may concern the development of ePortfolio system in expert systems directions, assigning to such information system the decision making abilities of a human-expert (P. Jackson, 1998). This intention could be realized by equipping of ePortfolio system with artificial intelligence tools which would ensure the generating of recommendations and suggestions for acquisition of required competences based on the data about the person's existing competence levels (Gorbunovs, 2012b). Fig. 4.6 provides a futuristic view on such information system development.

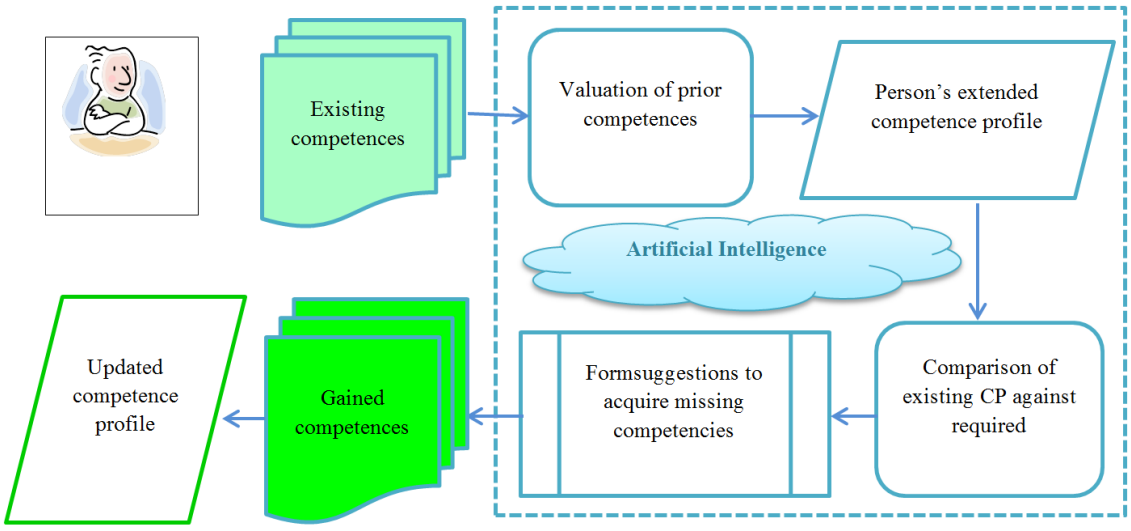


Fig. 4.6. Further prospective ePortfolio system rough model

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