Reflective ePortfolio System
Development and Assessment in Living Lab

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Abstract: Modern technologies, information systems, tools, methods and approaches give us new potentialities to ensure better learning outcomes. One of such systems, which are kept high on the agenda, is ePortfolios. ePortfolio systems are considered as an excellent tool to improve learners' competence levels, critical thinking and reflection. This paper shows an approbation of reflection stimulating ePortfolio system developed by the Distance Education Study Centre, Riga Technical University. Introduced system merges a scope of technological and educational aspects to facilitate system users' better achievements. The author underpins Living Lab research method which was used to approbate new system implementation. Experimental part of the work is proved by verification of the ePortfolio system including necessary statistical data analysis. Approbation results show that the developed algorithmic model ensures the formation and functioning of the reflection stimulating ePortfolio system which has direct positive impact on students' competence development, achievements and learning outcomes.

1 INTRODUCTION

Nowadays technologies and information systems bring new potentialities for both teaching staff and learners. Innovative approaches together with technologies and systems ought to ensure lifelong learning demands. As a result, information system developers have been facing the problems of working up appropriate solutions to facilitate better learning outcomes. One of such systems, which are kept high on the agenda, is ePortfolios. More and more educational organisations all over the world embody ePortfolio systems in their curricula (Timmins, 2008). ePortfolio is considered as an excellent tool to improve information system users' competence levels, critical thinking and reflection.

Usually educators and ePortfolio system developers introduce their experience, approach, methodology, educational tools and systems, which display students' achievements or allow some interaction in the form of blogs, reflection of peers' comments regarding particular tasks, etc. (Barrett, 2009, 2011). However, until this day there is still a lack of comprehensive research activities and data analysis related to measurement of ePortfolio systems effectiveness. Experts in this field suggest evaluating system efficiency by measuring activity evidences of its users; characteristic features of the reflection are underlined as the key components in this case (Haig et al., 2007).

Pursuant to actuality of efficiency studies of ePortfolios and a necessity to improve learning outcomes, conformable purpose of the research was formulated – to develop and approbate reflection stimulating ePortfolio system which would merge a scope of technological and educational aspects to facilitate system users' better achievements.

2 DEVELOPMENT AND ASSESSMENT OF THE MODEL

2.1 Tools and Methods

After completed theoretical investigation (Gorbunovs, 2011) the development of reflective stimulating ePortfolio system was continued by practical research activities. They included the development of appropriate system algorithmic model based on Enterprise Knowledge Development (EKD) Methodology (Kirikova, Stecjuka, 2008), simulation scenarios output (Quinn, 2005) and data flow modelling.

Keeping in mind that Living Lab research

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method is defined as an environment where information system users evaluate and validate novel systems and technologies (Følstad, 2008), this method was used to assess new ePortfolio algorithmic model. Corresponding prototype was created, validated and verified in Living Lab in 2011/12 and 2012/13 academic year. Statistical data analysis was done by Excel 2010 and SPSS 21 software; Kolmogorov-Smirnov and Mann-Whitney non-parametric tests, statistical hypothesis T-test, and determination of correlations were used.

Additionally, positive feedback regarding system impact was received from particular scientific field experts at the international scientific conferences and domestic seminars. Several inquiries were organised also after each completed course to make out students perceptions and their thoughts about used information system's effect on their reflection and competence levels improvement.

2.2 Model Development

Based on an idea that humans do like teach others rather learn themselves (Adler, 2013), as well the statement that Living Labs involve users in the innovation, knowledge sharing, exploration, experimentation, assessment, and co-creation process (Pallot, 2009), respective algorithmic model was developed (Fig.1). It enables group formation, self- and peer-assessment within groups, responsibility for own attitude, activation of critical thinking and reflection, and as a result – improvement of learning outcomes.

First of all, it is necessary to specify that university's learning and content 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 homeworks from the LCMS data base 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 data base. 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 (Fig.2).

Activities in ePortfolio system start with user's authentication and authorization. Login files data are collected in ePortfolio data base. Students assess other group members' homeworks in a form of suggestions and scores in the scale from 1 to 10, where 1 is the lowest estimation and 10 – the highest one.

The same procedure applies on self-assessment of own homework. Both approaches stimulate

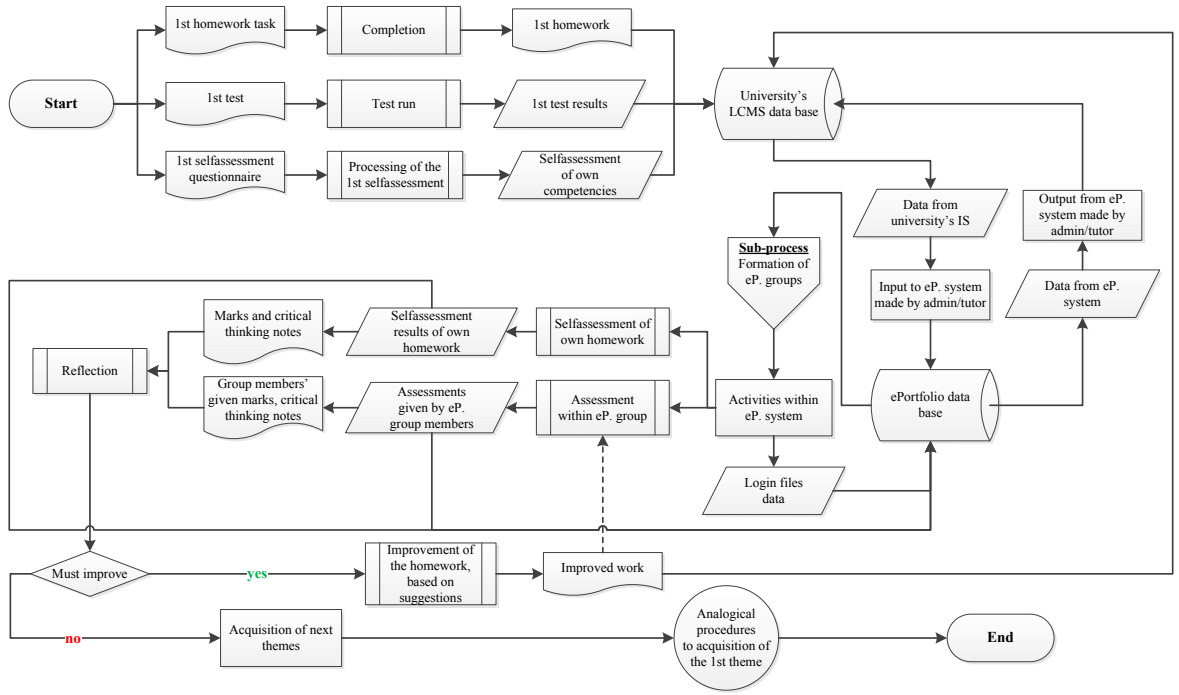

Figure 1: Reflection stimulating ePortfolio system's algorithmic model.

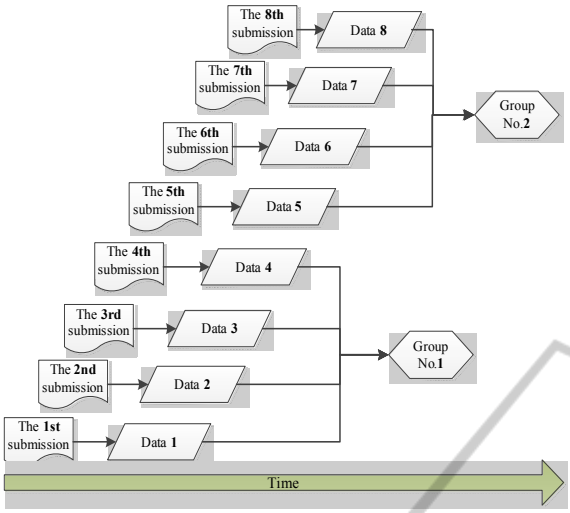

Figure 2: Group formation within ePortfolio system.

reflection and impact an improvement of previous documents. 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.

During 2011/12 and 2012/13 academic year all improved papers were sent to university's LCMS. However, the algorithmic model allows developing in future another prototype which would return all improvements back to ePortfolio group collaborative environment for reviewing.

2.3 Assessment of ePortfolio System in Living Lab

2.3.1 Validation

To validate the first developed ePortfolio system model, an appropriate prototype was built and approbated in 2011/12 academic year at Riga Technical University. Approbation results in Living Lab show effectiveness of the system which stimulates system users' reflection and improves particular to the course competence levels (Fig.3). It was concluded that the improvement of learning outcomes, i.e. competence levels (measured by exam results), reflection (measured by a number of improved papers) and accomplishments outside the system (measured by a number of prepared papers), were directly dependent on system users activities within the system, i.e. fulfilled tasks in group-working activities and login files.

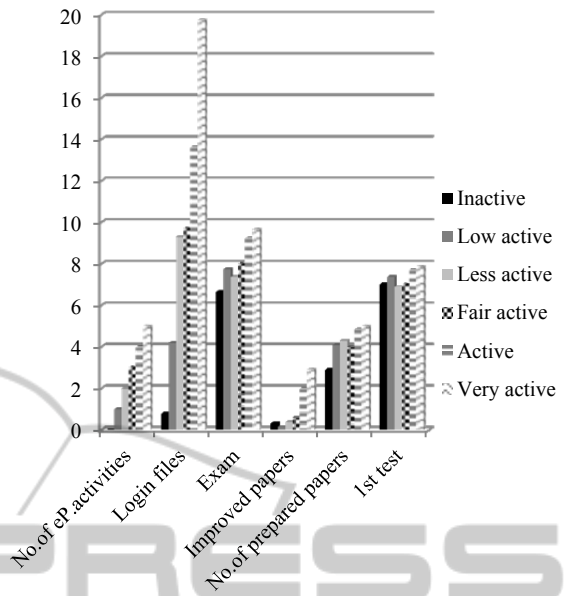

Figure 3: Learning outcomes depending on activities within ePortfolio system.

ePortfolio system users survey results also demonstrate system's importance on improvement of learners competence levels (Fig.4) and reflection (Fig.5). 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, and only 3 participants (or less than 3 per cent) said that they did not notice any system's impact.

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.

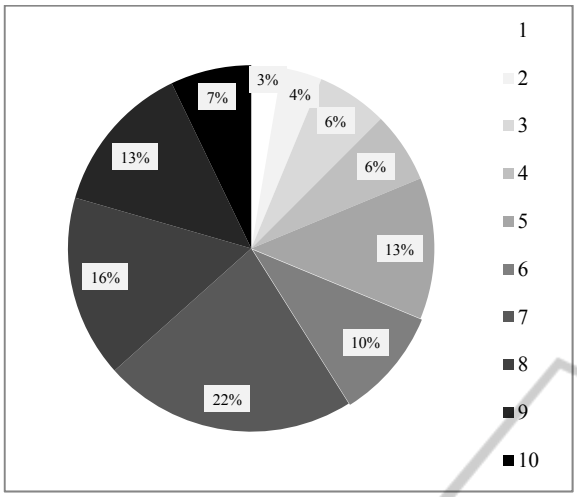

Figure 4: Users' opinions related ePortfolio system's impact on their competence improvement.

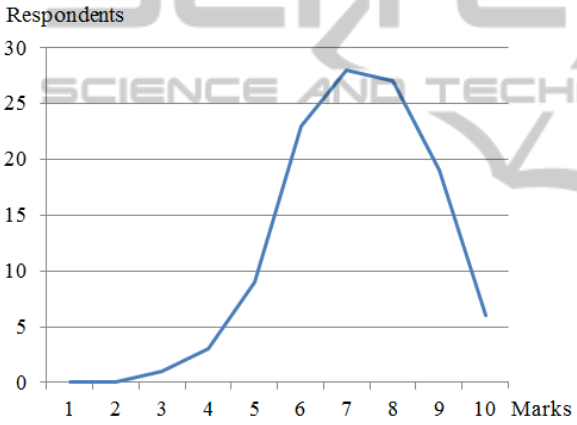

Figure 5: Users' opinions related ePortfolio system's impact on their reflection.

2.3.2 Verification

To find relationship between input and output parameters of developed ePortfolio system, representative sample of 145 students was ranked discrete 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 H0 - competence distribution within group forms normal distribution, and alternative one Ha - competence distribution within group does not form normal distribution.

Table 1: K-S test for the whole sample.

		Initial test	Exam
N		145	145
Normal Parameters[a,b]	Mean	7,5176	8,05
	Std. Deviation	,85006	1,883
Most Extreme Differences	Absolute	,085	,207
	Positive	,041	,155
	Negative	-,085	-,207
Kolmogorov-Smirnov Z		1,022	2,493
Asymp. Sig. (2-tailed)		,247	,000

The distribution of initial competences (initial test) for whole sample forms normal distribution (Table 1) – as asymptotic significance 0,247 > 0,05 and test value does not exceed critical values, the hypothesis H_0 is affirmed with 95% level of confidence. The distribution of final competences (exam) at the end of the course does not form normal distribution – as asymptotic significance 0,00 < 0,05, the hypothesis H_0 is not affirmed. Wherewith, it confirms the impact of created ePortfolio system on users learning outcomes.

Table 2: K-S test for experimental group.

		Exam	Initial test
N		125	125
Normal Parameters[a,b]	Mean	8,43	7,5543
	Std. Deviation	1,278	,82982
Most Extreme Differences	Absolute	,200	,074
	Positive	,152	,058
	Negative	-,200	-,074
Kolmogorov-Smirnov Z		2,231	,826
Asymp. Sig. (2-tailed)		,000	,502

During Kolmogorov-Smirnov test for experimental group (Table 2) it is found that as asymptotic significance of initial test 0,502 > 0,05, and test value does not exceed the critical one, the null hypothesis H_0 is affirmed with 95% level of confidence. It means that the distribution of initial competences for experimental group forms normal distribution. The distribution of final competences does not form normal distribution – as asymptotic significance 0,00 < 0,05, the null hypothesis H_0 is rejected. 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. We can conclude 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 (Table 3) 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.

Table 3: Mann-Whitney test.

	Initial test	Exam
Mann-Whitney U	1095,000	356,000
Wilcoxon W	1305,000	566,000
Z	-,890	-5,284
Asymp. Sig. (2-tailed)	,374	,000

a. Grouping Variable: dd

During Mann-Whitney test it was found that: as asymptotic significance of initial test 0,374 > 0,05, the null hypothesis H_0 is affirmed with 95% level of confidence. It means that distribution of initial competence levels in both non-users and users' groups is identical. As asymptotic significance of exam (i.e. achieved competence levels at the end of the course) 0,00 < 0,05, the null hypothesis H_0 is rejected, and alternative hypothesis H_a is affirmed – distribution of final competence levels in two groups differs. 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 (Table 4). 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 (i.e. competence levels) than non-users.

To find relationships, their strength and way between input and output parameters, the correlation coefficients were calculated. 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));

Table 4: T-test.

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Initial test	Equal variances assumed	,484	,488	-1,304	143	,194	-,26632	,20423	-,67001	,13737
	Equal variances not assumed			-1,174	23,781	,252	-,26632	,22675	-,73454	,20190
Exam	Equal variances assumed	26,073	,000	-7,112	143	,000	-2,782	,391	-3,555	-2,009
	Equal variances not assumed			-4,048	20,095	,001	-2,782	,687	-4,215	-1,349

- 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);

- There is a moderate positive correlation between activities within ePortfolio system and fulfilled external tasks (r= 0,613, α= 0,01);

- 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.

2.3.3 Assessment of Modified Model

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.

To validate modified ePortfolio system model, an appropriate prototype was built and approbated in 2012/13 academic year at 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.

At the model's verification stage to find relationship between input and output parameters of modified ePortfolio system, representative sample of 99 students was discrete ranked 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, as well determination of possible correlations, it was observed 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.

3 CONCLUSIONS

Approbated ePortfolio system encourages learners' reflection, which is the part of critical thinking process, and is realised through feedback links, enables competence levels improvement, enhance learning outcomes, and stimulates activities also outside the system.

This model ensures system users' active availability for work and participation in group-working activities to develop own reflection and competence levels. This could be done through collaboration with peers within ePortfolio groups by assessing group members' papers and suggesting them necessary improvements, as well by thinking critically on the own accomplishments. Reflective approach brings new attitudes and better learning outcomes.

Based on test results it might be concluded that modified ePortfolio system has greater impact on its users' competence levels improvement than previous system (accordingly, $r= 0,565$ against $r= 0,475$). On the other side, the first developed ePortfolio system has better results than modified system version in facilitation of users' reflection (accordingly, $r= 0,492$ against $r= 0,475$) and fulfilled external tasks outside the system (accordingly, $r= 0,613$ against $r= 0,493$).

Developed ePortfolio system algorithmic model could be used as a base for creation of further modifications of reflection and competence enhancement information systems.

Living Lab research method ought to be considered as an excellent approach to validate and verify information system models in educational environment.

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