e-Inclusion and Knowledge Flows in e-Course Delivery

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Abstract: Our purpose of the study was to use the acceleration of knowledge flow to predict practical use of digital skills. For this purpose, we identified certain variables to be correlated for practical uses probability as a guide for their effectiveness for e-learning assessment. The study was based on evaluating a group of five hundred learners. We designed four types of questionnaires and one telephone survey to assess different aspects of the course topics that affect the practical uses of digital skills. We applied knowledge management theory, basic principles of classical mechanics and statistical analysis. We developed a formula for linear regression equations for practical uses of digital skills probability. As potential predictor for effective delivery of different topics of an e-learning course we obtained knowledge flow acceleration. The results indicated that one of the factors for determining practical uses probability in the e-inclusion model for an e-learning course was related to knowledge flow acceleration.

1 INTRODUCTION

This study aims to address the issue of how to facilitate the inclusion of everybody to enjoy the benefits of information and communication technology (ICT) (European Commission, 2010). The progress report of the EU Digital Agenda states that there still exists a sharp divide in digital use in Europe between different population groups (European Commission, 2011).

Nowadays the digital divide goes beyond the issue of access to technology (Deursen and Dijk, 2009). The focus has shifted from access to ICT to the meaningful use of ICT (Hargittai, 2000); (McLean, 2006). Learning new skills and using them are two separate steps (Lerchner et al., 2007).

This article is concerned with the second digital divide, where individuals does have some digital skills but lacks the ICT skills needed to fully engage in their chosen professions. The second digital divide is a significant issue for many professions and population groups. This article will focus on teachers who were the target group of our study. Our study shows that vocational teachers are increasingly expected to use ICT as a teaching and administrative tool. This issue has been pointed out by the European Commission and a number of scholars who have studies this problem (Uzunboylu and Tuncay, 2010). Digital literacy has today become a "survival skill" for teachers. But teachers often exhibit low self-confidence when applying digital skills to teaching and other professional requirements. Scholars have noted the critical nature of this deficit and argue for the importance of providing teachers with the training needed to allow them to take full advantage of available ICT opportunities (Abrantes et al., 2007); (Cort et al., 2004).

A number of studies have been done regarding the e-inclusion process (FreshMinds and UK Online Centres, 2007). However, there is no unified point of view on how to facilitate the practical use of learned digital skills. This paper continues the authors' investigation on how to promote practical use of learned digital skills (Vitolina and Kapenieks, 2012). The study contributes to research of the factors influencing meaningful ICT use in e-learning contexts by applying knowledge management methods. In this paper it is argued that practical use probability is related to knowledge flows acceleration.

2 KNOWLEDGE FLOWS PROCESSES

Knowledge flows processes are dynamics, they flow in different directions and at different speeds. To

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determine what laws govern the knowledge flow processes several authors based their research on basic laws of physics (Hu and Wang, 2008); (Zhuge et al., 2007). Moreover, Nissen used principles of classical mechanics to describe, explain, and predict knowledge flows processes (2006). For instance, knowledge at rest tends to stay at rest. But some kind of force is required for knowledge at rest to move. Additionally, Nissen applied Newton's famous law: F = ma (that is, force equals mass times acceleration) to analyze knowledge flow processes. According to Nissen, the teacher may represent a force but a simple chunk of knowledge may represent the mass. This means that "the gifted teacher and a simple concept may create rapid and broad knowledge flows. A less-skilled teacher and more complex knowledge may result in comparatively slow and confined knowledge flows, or even no flows at all" (Nissen, 2006, p. 32).

The role of the instructor in sharing knowledge decreases in the e-learning or blended e-learning course. Knowledge sharing depends upon the quality of the content, i.e. learning materials, and the usability of the e-learning environment for convenient use of content and communication with the instructor. We proposed in the e-learning course context to expand the meaning of force (1). We assumed that force (KFF) is related to the instructor's willingness to share knowledge (IWS) and to usability of e-learning environment (eLE) and quality of e-learning materials (eLM). We included student's self-evaluations of his knowledge level before learning of the e-course topic (KLBL) in the force equation as well. We summed values of the instructor willingness to share knowledge, evaluation of the e-learning materials and e-learning environment because they all together present the "teaching force". We determined that students' knowledge level before learning is a critical value for acquiring new knowledge. Therefore, we used KLBL as a multiplier.

$$KFF=(IWS+eLE+eLM)*KLBL \tag{1}$$

We proposed to determine the variable knowledge flow mass (KFM) by the complexity of the e-course topic (CT) (2).

$$KFM=CT \tag{2}$$

According to Newton's law Knowledge flow acceleration (KFA) is knowledge flows force divided by knowledge flows mass (3).

$$KFA=KFF/KFM \tag{3}$$

3 PURPOSE OF STUDY

Our purpose was to use the acceleration of knowledge flow to predict practical use of digital skills for vocational teachers after completing the e-course "Improvement of ICT skills".

4 METHODS

4.1 Participants and Assigned Topics

Our participants were 500 vocational teachers. The testing sample covered 80% of the participants in the blended e-learning course "Improvement of ICT skills". The topics for the course related to the improvement of instrumental knowledge and skills for tool and media usage, advanced skills and knowledge for communication, information management, and meaningful participation in a knowledge society. We analyzed eleven of these topics. They included: setup of peripherals, Image scanning, Web page design, PDF files, Computer security, MS Access, Video processing, E-learning materials, Social networks, Excel and e-mails. Each topic included theoretical material in video and text format and tests for knowledge assessment.

4.2 Measures

We designed four types of questionnaires to assess different aspects that affect the practical use of digital skills. The questionnaires collected information about students' knowledge level before and after each topic that included e-learning environment usability, e-content quality, instructor's willingness to share knowledge, and student's predicted use of digital skills after completing e-course. We used a Likert-type questionnaire on a scale that ranged from 1 – strongly disagree to 5 – strongly agree.

Additionally, we designed a telephone survey to obtain data about the practical use of digital skills after completing the e-learning course. For each topic the students were classed in the three categories depending on usage level of digital skills.

We also classified all topics in the three groups according to their complexity in the range from 1 to 3.

Predictors. One predictor was knowledge flow force (KFF). This was measured by four independent variables: (I) students' evaluation of instructor support in classroom seminars and in the e-learning environment (IWS); (II) students' evaluation of e-learning materials for the course (eLM); (III) students' evaluation of e-learning environment (eLE); (IV) students' self-evaluations of their knowledge level before learning of the topics (KLBL).

The second predictor was knowledge mass. This predictor was measured by the independent variable: the complexity of topic (CT).

Criterion Variables. Practical use probability was the criterion variable. We determined it by three variables: (I) students' prediction of digital skills practical use (by means of the questionnaire), (II) observed practical use of digital skills (by means of the telephone survey) and (III) practical use (by mean of the combination of predicted and observed use).

4.3 Procedure

Data collection. We collected the data from the students by means of questionnaires administered from January 2012 until April 2012. The questionnaires were a section part of the blended e-learning course for digital skills improvement and could be accessed through the Moodle learning system. Moreover, we conducted telephone surveys by phone from March 2012 to May 2012 to determine the extent to which practical use of learned digital skills were applied four to twelve weeks after the course. The number of respondents for each topic differs from 57 to 86 because the completing of the questionnaires was voluntary.

Data analysis. The authors employed correlation and regression calculations with the SPSS for Windows (version 17.0) for analysis.

5 RESULTS

5.1 Knowledge Flow Acceleration

The first step in this study was to calculate the average of the Knowledge flow acceleration (KFA) for all topics following the formula (3). Maximum KFA (100% of possible KFA) was not observed. Our obtained results showed that the percentages of KFA could vary from 38% to 65% (Table 1). Moreover, we observed that the KFA was lower for the topics MS Access (38%), Web page design (38%) and MS Excel (40%). But KFA was higher for other topics such as improved skills for e-mail usage (65%), how to scan image (53%), and how to find e-learning materials on the Web (52%). Our study indicated that knowledge flow acceleration varies according to a topic.

Table 1: Maximum values of the knowledge flow acceleration for various topics.

Topic	KFA (%)
E-mail	65
Image scanning	53
E-learning materials	52
Setup of peripherals	49
PDF files	48
Video processing	47
Social networks	47
Computer security	46
Excel	40
Web page design	38
MS Access	38

5.2 Correlations of Knowledge Flow Acceleration

Then we analyzed the correlations between the percentage of maximum possible knowledge flow acceleration and digital skills practical use probability. Table 2 shows correlation coefficients for all topics.

For all topics predicted use has a statistically significant correlation with knowledge flow acceleration. The topics themselves have medium correlation in the range from .377(**) to .618(**). The highest correlations are for the Video processing topic.

Next, we analyzed observed use. Table 2 shows that correlation between observed use and knowledge flow acceleration is statistically insignificant for most of the topics. In four topics observed, use has a statistically significant correlations in the range from .310* to .392**.

Furthermore, we examined a combination of predicted and observed use. Table 1 illustrates that for all topics the correlation is significant. Moreover, most topics have medium strength correlations in the range from .411(**) to .628(**). The highest correlation is for the topic Social networks. Only one topic MS Excel has correlations that are significant at the 0.05 level: .273(*).

In this study it was found that knowledge flow acceleration is a predictor of the learned skills practical use possibility for vocational tteachers.

Table 2: Correlations between knowledge flow acceleration and probability of practical use.

Topic	PU	OU	PU&OU
E-mail	.423**	.079	.411**
Image scanning	.508**	.184	.490**
E-learning materials	.490**	.215	.479**
Setup of peripherals	.452**	.154	.419**
PDF files	.464**	.387**	.521**
Video processing	.618**	.216	.608**
Social networks	.545**	.392**	.628**
Computer security	.442**	.310*	.524**
Excel	.377**	.023	.273*
Web page design	.524**	.021	.442**
MS Access	.475**	.329**	.518**

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
PU – Predicted use; OU – Observed use

5.3 Linear Regression for the Knowledge Flow Acceleration and Practical use Probability

The results shown on Table 3 demonstrate R Square of the linear regression models. There is a significant relationship ($p < 0.05$) between knowledge flow acceleration and predicted use of digital skills for all the topics, the exception is Excel topic. Moreover, there is a significant relationship between knowledge flow acceleration and predicted and observed use of digital skills.

The linear regression model explained 18% to 38% of the total number of variations for predicted use. The highest percentages of variations were for the Video processing topic. The lowest percentages were for E-mail topic.

For the combination of the predicted and observed use the regression model accounted for 17% to 39% of the variance. Video processing topic had the highest percentage. Again, E-mail topic had the lowest percentage of the identified variations.

Table 4 and 5 present equations for regression models of predicted uses as well as the combination of predicted and observed uses.

Regression coefficients are in the range from 0.027 (E-mail) to 0.125 (Video processing) for the predicted use model. In the model combination of predicted and observed use, regression coefficients are in the range from 0.029 (E-mail) to 0.155 (Video processing).

Table 3: R Square of linear regression model of predicted use (PU) and combination of predicted and observed use (PU&OU).

Topic	R Square PU	R Square PU&OU
E-mail	0.179	0.169
Image scanning	0.258	0.240
E-learning materials	0.240	0.229
Setup of peripherals	0.204	0.176
PDF files	0.215	0.271
Video processing	0.382	0.370
Social networks	0.297	0.394
Computer security	0.196	0.275
Excel	0.142	0.075
Web page design	0.275	0.195
MS Access	0.225	0.269

Table 4: Linear regression equations for predicted use of digital skills.

Topic	Equation
E-mail	PU=0.027KFA+3.069+ε
Image scanning	PU=0.060KFA+2.836+ε
E-learning materials	PU=0.029KFA+2.779+ε
Setup of peripherals	PU=0.057KFA+2.836+ε
PDF files	PU=0.058KFA+2.937+ε
Video processing	PU=0.125KFA+2.262+ε
Social networks	PU=0.041KFA+2.433+ε
Computer security	PU=0.053KFA+3.324+ε
Web page design	PU=0.121KFA+2.129+ε
MS Access	PU=0.097KFA+2.540+ε

The value of constants of the regression equations is in the range from 2.129 (Web page design) to 3.324 (Computer security) for the predicted usage model. However, in the model for combination of predicted and observed use, the range of constants are from 2.492 (Web page design) to 4.174 (E-mail).

In this study it was found that the relationship between knowledge flow acceleration and practical use of digital skills can be modeled by a linear regression equation.

Table 5: Linear regression equations for combination of predicted and observed use of digital skills.

Topic	Equation
E-mail	PU&OU=0.029KFA+4.174+ε
Image scanning	PU&OU=0.074KFA+3.756+ε
E-learning materials	PU&OU=0.037KFA+3.606+ε
Setup of peripherals	PU&OU=0.068KFA+3.796+ε
PDF files	PU&OU=0.093KFA+3.293+ε
Video processing	PU&OU=0.155KFA+2.564+ε
Social networks	PU&OU=0.056KFA+2.691+ε
Computer security	PU&OU=0.079KFA+3.974+ε
Web page design	PU&OU=0.123KFA+2.492+ε
MS Access	PU&OU=0.137KFA+2.559+ε

6 DISCUSSION

The purpose of the study was to predict whether the knowledge flow acceleration has an impact on the practical use of newly learned digital skills for vocational teachers.

First, we observed that for different e-course topics the average of the knowledge flow acceleration varies. Second, our study indicated that knowledge flow acceleration is a predictor of the practical use of newly learned digital skills for vocational teachers in an e-course context. Third, we proposed the linear regression model for predicting practical use possibility for different e-course topics.

On the one hand, our findings about knowledge flow acceleration for the topics means that the level of their complexity may vary. The rate of acceleration was lower for topics that were related to specific software. For example, MS Access, Web page design, and MS Excel. However, acceleration was higher for topics that encompassed lighter themes such as e-mail, image scanning and searching the web for e-learning materials. On the other hand, the variations in knowledge flow acceleration for the assigned topics may also be explained by other factors: the different knowledge levels that the students possessed upon entering the course, the quality of the e-learning environment and materials, and the instructor's willingness to share knowledge.

Furthermore, knowledge flow acceleration was predictor of the practical use of ICT skills possibility. That means that a higher acceleration of knowledge flow leads to a higher possibility of a meaningful use of ICT. Our results showed that the rate of acceleration is related to the instructor's willingness to share knowledge, the quality of the e-learning environment and materials and the student's knowledge upon entering the course.

Our results confirmed the research of our previous study regarding the significance of e-learning material and environment quality as predictors of practical use of digital skills (Vitolina and Kapenieks, 2012). Our findings are in accordance with the results obtained by others researchers studying these issues who argue that when learners felt positively about the quality of the training (learning materials, and environment), they were able to acquire more knowledge and apply acquired skill to their professional and practical lives (Sulčič and Lesjak, 2009).

Our other results indicated to us how various factors influenced future use of newly acquired ICT skills. The models that we developed to profile the linear regression calculations showed that the variation range was 17% to 39% for the different e-course topics for practical use possibility. That means that not only knowledge flow acceleration but also other factors could impact upon learning behavior after e-course completion. We are going to continue our research regarding the other factors that reveal student attitudes, interests and capacity to learn.

Our results for regression coefficients equations indicated that depending on a topic's average value, practical use possibility generally increases by 0.027 to 0.155 for each additional unit that knowledge flow was accelerated. We observed that for more complex topics such as Web page design, Video processing and MS Access practical use possibilities increased at a slower rate than for other topics. We concluded from these results that to reach a higher practical use possibility level for complex topics it is necessary to provide high quality e- learning materials and e-learning environment. Additionally, the instructor's willingness to share knowledge and the learner's knowledge level upon entering the course should be at a high level.

A few methodological limitations should be noted. The sample used in the current study included only vocational teachers and the sample size for specific course topics was relatively small. Further study with a larger sample is needed to analyse the validity of the current findings to obtain more comprehensive and realistic data about practical use of learned digital skills it is necessary to prolong the period of vocational teacher observation from three to six month after completing course training.

7 CONCLUSIONS

Our results identified factors that promote e-inclusion. We concluded that a higher rate of knowledge flow acceleration predicts a higher use possibility of newly acquired digital skills by vocational teachers after e-course completion. The results confirmed the importance of designing quality e-learning materials and e-environment to attract e-excluded individuals. Other important factors that promote e-inclusion are an instructor's capacity to share knowledge and student's knowledge level upon course entry. The implications of the research should encourage organizations and enterprises that are responsible for e-course design to take these factors into account in their future development efforts.

This study addressed the issues concerned with the second digital divide. It focused on identifying relevant factors for narrowing the second digital divide that inhibited vocational teachers from applying digital skills in a meaningful way and showed ways to remove these obstacles so that these teachers could meaningfully participate in their professions and enrich their personal lives. In our study knowledge flow acceleration served as a potential predictor for the effectiveness of e-course delivery for the various topics we had assigned. Moreover, we developed a linear regression model for predicting practical use probability for designing post-course surveys that can measure the long-range impact of a delivery e-course.

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