Digital Inclusion by Fostering Informatics Competencies

Kirstin Schwidrowski ¹, Peer Stechert ²

¹ Universität Siegen, Germany, schwidrowski@die.informatik.uni-siegen.de
² Universität Siegen, Germany, stechert@die.informatik.uni-siegen.de

Abstract: Employees have developed strategies in handling informatics systems in informal learning processes. Thus, there is no professional support. This is the motivation of the research project "E-Learning to Participate Actively in the Digital Media Upheaval". It investigates an e-learning framework that supports the development of informatics competencies in adulthood. We have started our project by examining education needs. Based on the results an e-learning framework was designed. Furthermore, the e-learning framework was theoretically founded. Learning objectives describe informatics competencies. We provide a knowledge structure and a catalogue of exercise classes, too. These components support the design of learning paths and learning activities.

Keywords: Empowering, Learning Models, Vocational Education

1. Introduction

1.1 Need of Research

The use of informatics systems in almost every domain has caused a lot of changes within communication and information processes. That is why people have had to rethink and adapt their individual habits of interpersonal interaction and information acquisition. These, mostly informal, learning processes are essential to master the challenge of becoming an active participant of knowledge society. Therefore, researchers with expertise in informatics and didactics have to provide educational concepts to equip learners with necessary competencies. Since informatics systems are major components of knowledge society's infrastructure, these educational concepts have to pay particular attention to informatics knowledge [1], [2].
In this paper we focus on employees and their occupational learning demands. Through their work, they are limited by learning times and learning places. Therefore, e-learning has been chosen to reach the group of employees. In particular employees of middle and older generation need to use informatics systems in their daily life. Unlike younger people who learn basic competencies in a safe place like classes, adults often learn to use informatics systems by doing. Therefore, these people do usually not acquire basic knowledge about how informatics systems function. One drawback is that even small errors are not immediately understandable. This might result in misunderstanding or even resignation. To prevent this, research needs to be related to the acquisition of informatics competencies.

1.2 Scientific Questions

Since 2005 the German Research Foundation (DFG) has been promoting the project A8 “Informatics Education and E-Learning to Master the digital media upheaval”. It is part of the collaborative research centre "Media Upheavals" that examines prerequisites and structures of media upheavals at the beginning of the 20th century and at the crossover to the 21st century. The digital media upheaval is a concept to describe and reason changes within media systems and media processes. Consequences for education are an important aspect of it. Our research objective is to investigate cognitive approaches to these changes. Therefore, we describe competencies that foster handling media systems as well as participating in media processes. We assume that informatics competencies are a contribution to media competencies [1]. Thereby, we explore informatics competencies regarding the subject matter Internet. Since the Internet is a complex subject matter, our project focuses on following three priorities

A structure of the Internet,
B communication on the Internet, and
C information security on the Internet.

We call this domain Internetworking. The project focuses on 35- to 45-year-old employees with no previous knowledge in informatics. The scientific questions of the project focus on two issues. First issue is the description of informatics competencies. Second one is the development of them in e-learning processes. Detailed scientific questions regarding the domain Internetworking are as following:

- Which informatics competencies are needed to support using informatics systems in everyday life and especially in occupational situations? How can we describe these competencies? What indicators suggest that the competence acquisition was successful?
- What are terms and conditions for the purchase of informatics competencies with adult learners? How do exercises promote the competence acquisition? How can learning processes be structured?
• What criteria should be considered for the design of e-learning and blended learning processes?

1.3 Research Process

In a first step a concept of an e-learning-course was developed. Therefore, we identified learning objectives and valuable informatics knowledge by analysing standard text books that cover the field of Internet and computer networks [3], [4], [5]. The criteria of fundamental ideas of informatics [6] have been applied in this literature analysis. Another study was a written survey handed out to human resource managers. The results of this study contributed to the identification of educational demands of employees (see 2.1). Based on the developed concept we conducted an e-learning-course to examine conditions of learning at workplace and characteristics of learners in more detail (see 2.3 and 2.4). Due to the small numbers of participants (5 females) this study did not have any significance, but it enabled development of new research hypotheses [7].

The design of a theoretical founded e-learning framework followed the empirical exploration. Due to the research objective that the e-learning framework should be theoretically founded we looked at established concepts in the field of didactics of informatics. Especially the approaches of the concept of educational systems [8] and understanding of informatics system [9] were investigated and used for some elements of the e-learning framework. We considered relations of pre knowledge and learning objectives were described in more detail [10]. For acquiring informatics competencies we needed to design appropriate exercises and developed a catalogue of exercise classes [11].

2. Empirical Study

2.1 Development of Learning Material

Initially, we investigated the educational demands. Therefore, we conducted a written survey among human resource managers. These people were chosen because they have expectations regarding the needed informatics competences in daily working life. The items of the written survey were closed questions and consisted of examples of areas (A) structures of the Internet, (B) communication within the Internet and (C) information security in the internet. The restriction on four options of relevance ("unimportant", "less important", "important" and "very important") should force a trend towards a decision. The choice of topics was very general. Hence, the human resource managers’ lack of knowledge regarding
informatics did not affect negatively the result of the study. We got 14 responses on 71 distributed questionnaires. Interesting topics are as follows:

- Viruses, Trojans, worms, malware (7 very important, 5 important),
- Secure data transmission (6 very important, 7 important),
- Access control, secure user management (6 very important, 7 important),
- Dangers on the Internet (5 very important, 7 important),
- Communication facilities (2 very important, 11 important),
- Communication protocols (1 very important, 7 important).

These issues are connected to basic informatics knowledge. For example, supporting information security awareness bases on the knowledge what is valuable in the Internet. This is achieved by introducing the aspects of the confidentiality, integrity and availability. Another example is the client-server paradigm. It describes typical communication processes within the Internet.

In a next step, learning objectives were described in more detail and appropriate learning matters were determined. Relations to real world scenarios were identified in order to illustrate benefits of learning objectives to learners as well as to support reactivating existing knowledge and experience.

Learning materials were needed for conducting an e-learning course. These materials should satisfy requirements of the target group and be suitable for e-learning processes. The following criteria were taken into account:

- No pre knowledge in informatics is required.
- The materials cope with informatics issues.
- The materials are suitable for adults.

Due to project resources, the course should reuse existing materials with a little effort of adapted. A review of existing materials revealed that there were hardly any good materials that met the criteria. In particular, exercises were missed that involve no special informatics skills like programming. Hence, learning units were developed according to the concept.

Learning objectives of every unit were described at the beginning. Learners could use these descriptions in two ways. First, they could decide whether a learning objective is interesting for them or not. Second, they could compare their learning outcome with the aspired learning objective. Since the learners do not have pre knowledge in informatics the desired cognitive learning objectives usually match level of "remembering" regarding the revised taxonomy of Bloom [12]. Partially, objectives are also assigned to the category of "understanding".

As motivation an example was given that connects matter of the learning unit with real life and showed its relevance.

Learners deal with short texts for acquisition of new knowledge. Theses texts cope with fundamentals of informatics but reduce complexity and focus on a specific aspect. These texts were complemented by some animations.

If someone learns, it should be possible to monitor one's own learning progress. For this purpose, we had developed a test framework that is based on multiple choice questions. To every question of the multiple-choice test, it is possible to
provide learning aids like tips and images. The display of the solutions is not immediately. After answering all questions the learner receives a notice about the success and gets the possibility to repeat and correct. The solution also provides explanations as feedback. This implementation of the test framework used Macromedia Flash technology and Extensible Markup Language (XML). The framework was designed modular. That means that test items can be changed easily as well as tips and explanations. These elements are described by using XML and stored in a file outside of the source code.

To strengthen knowledge, some exercises are offered. The learner could apply the new knowledge and skills. Solutions were sent to the supervisor and the learner received an individual feedback within three days. Based on the submitted solutions the supervisor could observe learning processes.

The learning units were packed in a zipped folder. Within that folder an html-document was the starting point. Within the document links referred to a text document (in PDF format), an animation, a multiple choice test, and an exercise (in PDF format). Both, the animation and the multiple choice test, were embedded in a html-document that also provided some guidelines to use them.

The meta-structure of the course was designed as followed:

- **Introduction phase**: Learners are busy with administrative issues. The course starts with topics that are known to learners like e-mail, World Wide Web and passwords.
- **Load phase**: Learners deal with basic informatics concepts like protocols or client-server-paradigm. Information security awareness is introduced by handling the aspects confidentiality, integrity and availability.
- **Networking phase**: Learners repeat already known issues for consolidation. Previously isolated concepts are networked. Possible issues include filtering spam or functioning of Internet search engines.
- **Project phase**: At the end of the course new knowledge has to be applied by solving a complex task. Examples of tasks are to improve the description of internal security policies or developing a presentation of the Intranet that is easy to understand by others without pre knowledge.

The duration of the course was planned such that the on-line phase took about 16 weeks and project phase lasted 6 weeks.

### 2.2 Conduction of E-Learning Course

An e-learning course was conducted from October 2006 to January 2007 in a medium-sized enterprise [7]. Four team assistants participated. Furthermore, a female senior accompanied the course, too. The e-learning course followed a blended learning approach. It started with a meeting. Following, an on-line phase
took place for 14 weeks. During that phase, learners dealt with weekly learning units.

Conduction of this course showed that the developed concept could not be implemented as planned. Learners handled the weekly learning units partially late or not at all. The course issues were repeated after 6 weeks to get learners back to the course. But this try did not succeed. Hence, the trial stopped after 14 weeks with little participation.

Following, learning processes of the five participants are described:
- Two participants handled two learning units with a delay of one to two weeks. Within the first four weeks they responded to e-mails and said that they cannot learn at workplace. From the fifth week, both fetched only irregularly learning units from the BSCW server and no longer responded to e-mails.
- One participant has only worked the first learning unit. Afterwards she could not fetch another learning unit because of technical problems. This participant did not react on e-mail but regularly fetched learning units after a few weeks.
- Two participants regularly studied learning units and solved most of the exercises.

2.3 Description of the observation results

At the beginning of the course, motivation and knowledge of the participants were identified by a written survey. This showed that all participants had no pre knowledge in informatics and no experience with e-learning. All participants indicated that they need to know more about the Internet and Internet applications. Two participants reported that their boss wanted them to participate.

In a final interview, some reasons for failure of the e-learning course could be identified. The main criticisms were:
- *Workload*: It was not possible for participants to study at work place, because they were repeatedly interrupted.
- *Application orientation*: The lessons learned could only rarely be transferred in the everyday work. An exception was the issue “passwords”.
- *Pre knowledge*: The participants felt overwhelmed. They could only handle applications at a very basic level. They had trouble with technical jargon.
- *Influence of participants*: The participants wanted to select topics already at the beginning of the course.
- *Communication*: Participants wanted to have more communication with the supervisor and regular meetings.
- *Self test*: The multiple choice test was accepted for reviewing learning process.
Based on the lessons learned the concept of the e-learning course was refined to provide a theoretical based e-learning framework. The learning objectives were refined and a competence-oriented approach was used (see 3.1). The components knowledge network and exercise class catalogue of the concept of didactics systems [6] were adapted to the domain Internetworking and characteristics of the target group also influenced this work (see 3.2). The problem of understanding and using technical jargon became a special aspect of the knowledge network and the exercise classes (see 3.3).

3. Theoretical approach for Internetworking in E-Learning

3.1 Learning Objectives and Competency Modelling

Since many employees cope with informatics systems in their daily work a minimum of informatics competences is needed. This supports learners to actively participate in knowledge society. This demand is very abstract. Hence, we have to refine learning objectives in order to develop a theoretical founded e-learning framework. Therefore, learning objectives were considered as output-oriented and described as competencies. This competency orientation arises not only from the experience and current political trends. It also reflects needs of adult learners [13].

In this work, the term competence addresses skills, abilities and knowledge that is available or learnable for individuals in order to solve problems successfully in variable situations. It involves motivational and volitional aspects. According to this definition, following descriptions mention very general learning objectives:

- Evaluating and comparing the application of informatics systems and take part in the decision-making of how informatics systems are designed.
- Using informatics systems in various situations in an effective, efficient and responsible manner to achieve personal goals.

These learning objectives include knowledge and skills that are beyond the use of certain software and memorizing key strokes. Selection of an appropriate informatics system depends on individual preferences and the actual situation. Consequently, there is no solid procedure that can be used without adaptation. The learner needs an access to technical jargon and knowledge of basic informatics concepts. This enables the understanding of how informatics systems function. These competencies are applied in specific situations to solve a certain problem.

Learning objectives have to be formulated on different levels of competences. Each level is characterized by cognitive processes and actions of certain quality. For example, quality is expressed by how much help someone needs to solve a problem. Asking for professional help to configure a computer indicates
informatics competency on a lower level. A higher level of competence would be the use of the user manual.

3.2 Knowledge Structuring and Classes of Exercises

Exercises and learning paths are a necessary contribution to competences acquisition. Knowles et al. [13] determine following characteristics for adult learning:

1. **Transparency**: Learner need to know why, how, and what they learn.
2. **Self-concept**: A learner understands himself as autonomous and independent.
3. **Experiences**: Experiences of a learner have to be taken into account.
4. **Real world**: A learner prefers exercises with relation to real life and they should be developed step by step.
5. **Action orientation**: Learner prefers problem based learning.
6. **Motivation**: A learner wants to achieve a personal benefit by learning.

These properties are taken into account during the design of exercise classes and knowledge networks.

To structure the domain the acquired knowledge, competences and attitudes are described in potential learning paths. Therefore, we have to consider theoretical knowledge like the client-server principle as well as real world application like the interaction between browsers and Web servers. There are different levels of knowledge within the e-learning framework. Basic knowledge is the technical jargon (see Chapter 3.3). Desirable is to identify technical terms in daily life or read easy texts such as user manuals. In addition, optional learning items enable learners to study their individual interests. Basic informatics topics are client-server principle, protocols and IP addressing. These are treated on several levels of difficulty. The learning content is represented according to a static, a dynamic and a quality-oriented perspective [10]. The structures of the Internet reflect the static view. Processes such as the data transmission are matter of the dynamic perspective. The information security is a cross-cutting issue. Therefore, it is picked out as a quality perspective.

Exercises have to demonstrate connections of concepts such that knowledge can be networked. Another requirement is that exercises address typical problems. There are closed questions to check whether a learner has understood a concept. And there are exercises to practice applying an informatics system and connect this skill with theoretical knowledge. This is very difficult. An exercise, which was handed out to learners during the empirical study, was the following one:

*Enter a URL that addresses a non-existing server into the address bar of your browser. Describe what happens.*

In most cases the browser shows a page with information about the error. Besides this expected error, there was also a response that a search result list appears. In this case the browser automatically forwarded a request to an internet
search engine and displayed the result set. This answer is much more complex as the expected one. Taking into account the experience gained during the empirical study and utilizing the approach of the informatics didactic concept of the didactic system an exercise catalogue was designed [9].

3.3 Access to Technical Jargon

Technical jargon serves the exchange of expertise. Experts use it to communicate in an accurate and quick manner. The terms of jargon describe concepts, facts and methods of a subject. Hence, technical jargon is necessarily connected to the acquisition of knowledge. And the use of jargon is an indicator of informatics competences. Managing complex situations and problem includes communication of problems. For informatics contents are the following facts to consider:

- Technical jargon has various degrees of specialization. Terms are often standardized in the field of informatics.
- Technical jargon is dominated by English language. Unlike in France these words are mostly not translated. This may be an additional hurdle.
- Experts like system administrators use technical jargon to exclude novice.
- Technical jargon is ubiquitous.

The aim of access to the jargon of informatics is that learners achieve communicative ability.

4. Summary

The aim of the project was to describe an e-learning framework. It is founded by general didactics, informatics, and subject didactics. This e-learning framework supports designing web-based courses for acquiring informatics competencies. Thereby, we focus on the target group of employees of the middle generation. There are only few education opportunities focusing on teaching informatics competencies to non professionals. The e-learning model consists of a flexible knowledge structure and a catalogue of exercise classes. In addition, an exploration module to support application-oriented learning activities will be designed.
References