Knowledge flow analysis to support the IT ecosystem in the process of continuing education

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Abstract

Continuing education is an important activity for the active involvement in a social environment and enhancement of competitiveness. Knowledge flows are invisible but very essential to achieve individual or organizational success. The application of information technologies in the continuation of education facilitates knowledge flow and makes its contents accessible regardless of an individual’s location and time. Each of the applied technologies in continuing education provide a particular service or help to find a solution for a specific problem. The various applications of technologies ensure the potential for acquisition of diverse learning contents; on the other hand, it may impede the learning process due to underestimation of its use in the particular situation. Application of ecosystem theories in the development of an information technology model offers a possibility to evaluate and predict the impact of technologies on the implementation of continuing education processes and the required time for an individual to achieve the desired competencies. The objective of this article is to show the results of implementation of ecosystem principles to support the knowledge flow analysis within educational processes.

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Selection and peer-review under responsibility of the Sociotechnical Systems Engineering Institute of Vidzeme University of Applied Sciences

Keywords: Information technologies (IT); Ecosystem; Knowledge flow; Continuing education.

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1. Introduction

In our modern and ever-changing world knowledge has become one of the preconditions for an individual’s work and social life. Not only the success and self-sufficiency of an organization, but also those of an individual depend on their ability to develop and use the surrounding environment for creation and application of knowledge, and to enhance their competences for acquisition of new knowledge and provision of knowledge flow. The use of information technologies has become an integral part of the educational process. The wide spectrum of available information technologies, versatile methods and learning contents provide far-reaching continuing education possibilities to every individual. Consequently, it creates a need for a model of mutual interaction of information technologies to promote continuing education. It would help to forecast the acquisition time of learning content and enhancement of competences in compliance with the application of the technologies and the student’s e-portfolio.

The following sentences briefly outline the main points of the paper proposed to reach the defined goal. Concepts of information technologies and knowledge flow in the process of continuing education are analysed in Section 2. Section 3 describes related work. Section 4 reflects on the conceptual model of the continuing education IT ecosystem. Section 5 describes the algorithm and software prototype for knowledge flow analysis to support the continuing education IT ecosystem. Conclusions are formulated in section 6.

2. Concepts of information technologies and knowledge flow in the process of continuing education

Information technologies are becoming an integral part of the educational process. They provide for initiation of new activities, their implementation, and assessment of students’ knowledge.

Information technologies planned for continuing education in the context of IT ecosystem are defined as hardware, software and service package used by people for the provision of the process of continuing education both from the service provider and the service receiver. An educational IT ecosystem in the context of this paper is defined as a digital environment which supports the continuing education process according to the learner’s needs and competences.

Knowledge flow in the context of knowledge-intensive teamwork is the passing of knowledge within a team. Knowledge flow begins and ends at a knowledge node. A knowledge node is either a team member or a role that can generate, process, or deliver knowledge. From the organizational perspective, knowledge flow is defined as a method that supports knowledge accumulation and sharing. In the context of an educational IT ecosystem, knowledge flow is the passing of knowledge between knowledge nodes which are between the continuing education content provider and the consumer of education. The provider of the continuing education content is a teacher in the education institution or another professional in this field. The consumer of the content is student.

Knowledge flow is provided in the IT ecosystem of continuing education with the help of technologies. There are three kinds of technologies which are used for the provision of knowledge flow and the continuing education service:

• Service provider technologies – technologies necessary for the development of learning contents, for instance, Camtasia, which is a tool for creating different multimedia materials;
• Service receiver technologies – they provide access to continuing education contents, for instance, mobile technologies, which are becoming increasingly popular;
• Technologies for the supply/maintenance of continuing education contents – technologies providing access to the contents of continuing education, for instance, the Moodle learning management system, as well as physical supply of contents through different types of communication channels.

Fig. 1 represents the concept of knowledge flow in the IT ecosystem of continuing education. According to Fig. 1, knowledge content is provided by the knowledge provider – a teacher or other professional. The knowledge content is the learning object which is delivered through the Internet in the knowledge space. The knowledge repository collects knowledge metadata for the educational IT ecosystem to provide knowledge flow analysis. The main issues related to work in the IT ecosystem field are shown in Fig.1.
3. Related work

The related work on technological issues of the IT ecosystem for continuing education includes various interpretations of an IT ecosystem approach, which describe communication between technologies, their functionalities and information sharing.

Research directions found in scientific literature are given in Fig. 2. The author has identified three main research directions:

- IT ecosystem approach to improve the educational process which comprises the definition of elements of the educational process and reflection of interaction of the processes;
- IT ecosystem approach to support the educational process which provides the application of natural ecosystem principles in analysis and development of educational IT;
- Analysis and modelling of knowledge flow both at the university and in a production company.

The research spectrum of other authors is broad and each of the developed models or approaches characterises a situation in continuing education and application of a certain technology, but none of them give scientifically and methodologically grounded answers on how to estimate the application of a technology in a particular context for enhancement of an individual’s specific competencies. This is particular area is the interest of this paper.

4. Conceptual model of the continuing education IT ecosystem

The conceptual model was developed in two stages. Initially the author researched traditional system analysis and methods of reflection of conceptual operation. After their comparison the most appropriate method was selected for the development of the continuing education IT ecosystem. After evaluating alternative variants of methodologies the author has come to the conclusion that for the conception analysis of the continuing education IT ecosystem model the most appropriate approach would be a combination of two methods, namely, Zachman’s architecture and socio-instrumental service modelling. Such an approach ensures meeting all the criteria and inclusion of all components of the continuing education IT ecosystem in the conceptual support model. This section presents a conceptual reflection of operation of the support system for the continuing education IT ecosystem using Zachman’s architecture and socio-instrumental service modelling approach.
The continuing education IT ecosystem concept model is shown in Fig. 3. It shows the two main system borderlines:

- A situation with no knowledge contents, and the individual acquires knowledge without a special learning material; in this case competence development is ten times slower than in cases when such a material exists;
- A situation with learning material (learning object) which indicates searching for further knowledge contents, finding the best ‘learning object’ and competency development in the system of the continuing education IT ecosystem.

Fig. 3 depicts a scheme of operational principles of the continuing education IT ecosystem which shows that initially the student makes a decision of finding a learning object. This is followed by searching for learning objects. During this stage the student learns by developing his/her meta-competencies. In this case technologies may help in finding the learning object. When the respective learning object has been found, the real learning process starts, as a result of which competencies are developed. In such a case the knowledge contents are offered in the form of e-learning, t-learning and m-learning. After the learning process is completed, it is evaluated and a decision is made whether to continue competency development or to finish studies. At this moment the knowledge flow analysis system may be very useful as it indicates perspectives and possibilities of further competence development.
Fig. 4 shows that there are interesting and useful approaches available in the IT ecosystem field from the point of view of technical solutions. However it is not clear how these approaches support user behaviour aware teaching systems. This model could meet the challenge of supporting learning communities with well organized, maintainable and technological solutions which could be customised for educational purposes.

5. Algorithm and software prototype for knowledge flow analysis to support the continuing education IT ecosystem

The system’s main algorithm is shown in Fig. 5. It reflects the way the system evaluates possible learning paths by calculating possible learning time in the existing system and finding the most beneficial ways for the user to develop competencies and meta-competences.
The total structure of the knowledge flows analysis system is given in Fig. 4. The picture includes two modules that differ from each other in their functionality:

- A knowledge flow analysis system which includes a module of competence and meta-competence acquisition analysis;
- A personal portfolio system which includes analysis of the learning path and knowledge analysis in business processes giving an additional opportunity to use the system in companies for continuing education and employee competence development.

Fig. 4. Architecture of experimental software.

Fig. 5 reflects how initially knowledge content ('learning object') metadata is read from the knowledge base. Further on the learning object metadata analysis is carried out according to competency levels, the program selects learning objects that develop the respective competences. The next step in the system is to arrange the 'learning objects' according to the initial competencies and selecting the closest learning object in compliance with the law which prescribes to offer the user a learning object, the initial competency of which does not exceed 50% of the student’s competence in the respective field. Then the system prepares the output of all possible learning paths and finds the most beneficial path for the student.

The functional part of the experimental software prototype is given in Fig. 6. The prototype includes three main functionalities:

- reflection of learning object metadata that has been previously downloaded into the system or specially downloaded in a specific package;
- graphic representation of learning object metadata; it gives a graphic picture of obtainable competency ranges of learning objects;
Fig. 5. Knowledge flow analysis software prototype for support of the continuing education IT ecosystem.
A graph of learning object overlap shows the possible existence of the learning objects (learning object) in the total system.

The charts in Fig. 6 show learning object metadata analysis. The algorithm analyses the space of knowledge contents, investigates it and depending on whether such learning objects exist in the given competence development situation, it defines a definite timeframe quotient for the competence acquisition which has been set for ten previously done research cases.

In case the learning objects exist, competence development takes place in compliance with standards accepted in the education system of the Republic of Latvia, namely, one credit corresponds to one week (or 40 working hours) of work.

Fig. 6 shows a graph of knowledge density and overlap presenting available learning objects for the development of the competencies. The appropriate competency levels are saved in the metadata of each learning object. The given picture shows the available number of learning objects for the required competence level. Such a graph makes it possible to have an overview of the learning objects field and survey the missing learning objects in certain competence levels.

Fig. 6. Chart of knowledge density and overlapping.
The developed software prototype was evaluated in a student group at Vidzeme University of Applied Sciences in two stages. In the first stage it was demonstrated to a student group to determine their opinions about usefulness of such a program, its functionality and comprehensibility. After the presentation it was amended and supplemented.

6. Conclusions

The main conclusions are the following:

- The effectiveness of knowledge flows and competence development support depends on the evaluation of knowledge flows;
- The developed software prototype gives an opportunity to carry out analysis of a student’s possible learning paths, thus helping to find the shortest possible learning path according to the competence and meta-competence levels of the particular student;
- The character of learning contents is determined by the level of meta-competencies; a higher level of meta-competencies provides shorter competency acquisition in the ecosystem;
- The knowledge flow support prototype for the continuing education IT ecosystem should include competency analysis and offer learning paths for the participants of the continuing education process;
- The developed software prototype analyses the spectrum of student competencies and selects the most appropriate learning path;
- The developed prototype offers a possibility to select the most relevant competency development way for the student and do it more accurately and faster.

Possible directions of further research will be:

- Knowledge flow analysis from the perspective of the continuing education content provider;
- Use of social network possibilities for knowledge flow analysis in the continuing education IT ecosystem;
- Automatic retrieval and storage of learning object metadata in the common database of the continuing education IT ecosystem.

References