Uniwersytet Ekonomiczny w Katowicach

Studia Ekonomiczne. Zeszyty Naukowe
Uniwersytetu Ekonomicznego w Katowicach
ISSN 2083-8611 Nr 296 · 2016

Informatyka i Ekonometria 6

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UNIVERSITY 3.0 AS A VIABLE SYSTEM IN ARCHIMATE 3.3

Summary: In the paper, a unified architecture model for the development of University 3.0 student learning environment is proposed. The architecture model combines different technologies for a student learning comfortability including technologies for learning contents' extraction and presentation, reasoning, recommendations and knowledge acquisition controlling in open and closed environment. There are two models, i.e., University 3.0 as viable system and its architecture model. So, the University 3.0 is interpreted as a viable system. Finally, there is a discussion of various issues that arrive in the context of University 3.0 modeling.

Keywords: University 3.0, viable system, architecture modeling, ArchiMate 3.3.

Introduction

The explosion of desktop applications, Web applications, mobile applications, and computing devices that are capable of capturing different aspects of students' daily lives have resulted in a continuous streams of digital data. Harnessing the individual as well as organizational streams of data represents an interesting research problem in the areas of university modeling as well as encourage to the exploitation of the data captured in these models. Therefore, in the article, an architecture for ubiquitous learning at university level is presented and discussed. The architecture collects the streams of data generated by students during their daily activities at university and uses the evolving set of concepts in domain-specific ontologies to extract relationships between the different data produced by the different mediums. In the next section of the article, Uni-

versity 3.0 characteristics are presented. The second part comprises an interpretation of University 3.0 as an autopoietic organization and in the Section 3 the University 3.0 architecture model is presented and issues arising from the modeling systems are discussed.

1. University 3.0 characteristics

Pfeffer [1] argues that freedom to openly exchange ideas and knowledge is the basis of scientific communication and to put all parts of scientific knowledge in the public domain is a core requirement. The use of scientific knowledge represented in a scientific publications cannot exclude use by others and should not limit another scholars' access and benefit. Several European universities and high schools are using Google Apps for education. In some cases contractual guarantees are negotiated with Google to overcome problems of ownership and security of school's data. The trends towards sharing software programmes (i.e., open source software) and research outcomes (i.e., open access publishing) seem to be strong and complemented by the trend towards sharing the learning resources [2]. The reasons for individuals and institutions to use, produce, and share openly research results can be divided into basic technological, economic, social and legal drivers. The technological and economic drivers include improved, less costly and more user-friendly information technology infrastructure, distributed software and hardware. Legal drivers are new licensing schemas that facilitate free sharing and reuse of contents. Government supported research institutions allow for free sharing and reuse of resources, assuming that open sharing speeds up the development of new learning resources, stimulates internal improvements, innovation and further reuses. However, the existence of universities in this new environment requires certain preparations, therefore, it is demanded to do some research on risks and opportunities of university openness development and on the other hand − establishing the principles and good practices for university organization and management in new circumstances [3].

University 3.0 can be defined by analogy to Web 3.0. The term "University 2.0" is considered to specify the web modern power from University 1.0. University 1.0 allowed users, i.e. students to passively accept the content provided by formal education teachers. University 2.0 allows students generate, share and develop the content by using diversified technologies (including You Tube, chats, Podcasts, blogs, online grading, quiz and assessments tools, social networking and publishing, cloud computing) [4]. The above technologies are

widely used for educational purposes. The University 3.0 is associated with web 3.0 technologies [5], [6]. University 3.0 is to combine technological advances and social dimensions of various Web services and Internet applications.

In this work, University 3.0 is considered as an academic institution providing formal and informal education, as well as the institution strongly supported by Information Communication Technology (ICT), so using web-based digital and mobile technology, including applications, hardware and software for education and education management processes. The idea of University 3.0 should go beyond e-learning and traditional face-to-face (F2F) university education. The University 3.0 aims at creation an integrated environment of open scholarship, where research, publishing and learning resources are available openly for people who are interested in knowledge sharing. The formal education is assumed to be the basic activity realized by schools and universities. In Europe, that activity is regulated by the principles of Bologna Process and all universities are required to implement European Credit Transfer System (ECTS), European Qualification Framework (EQF) and National Qualification Framework (NQF), which are instruments for the classification of qualifications according to a set of criteria for specified levels of learning achieved. That instruments were developed to integrate and coordinate national qualifications subsystems and improve the transparency, access, progress and quality of qualifications in relations to the demand on the labor market [7]. The traditional emphasis on factual knowledge provided by universities no longer meets the requirements of a changing society. The word "competence" is more attractive for both educators and employers, because it is easily identified with value capabilities, qualifications and expertise. Competences are defined as knowledge, skills and attitudes. University knowledge represents the intellectual capital and allows to use information in a sensible and meaningful way. The information from observations, personal experiences, beliefs and prejudices in everyday life are also referred to as supporting the knowledge development. Skills are associated with activities like problem solving, reasoning, assessing, and concluding, so they cover the mental process of analysis, synthesis, and evaluation. The cognitive skills are observable in practice, but social competences, i.e., attitudes are revealed in student behavior. The formal education process focuses on Student Learning Outcomes (SLOs), which describe what student is expected to learn in a result of participation in academic activities [8], [9], [10]. Beyond SLOs, Student Progress Outcomes (SPOs) are implemented to reveal student progress in course regimen and in degree programs. SLOs are monitored, registered, evaluated and stored in a documentation computerized system [11].

In contrast to formal learning, informal learning is organized by students. It has no objectives in terms of learning outcomes or acquisition of any competences [12]. It includes socialization, support, gathering opinions, consultancy, and self-directed learning. It can be widely used in a community of students supporting themselves in knowledge creation. In informal learning process, students read self-selected books, participate in self-study programs, watching YouTube films, navigate e-learning materials online and offline, searching advices from peers, participate in virtual communities of practice. Informal learning occurs in community, even if participants only observe, play or take part in social events. Students are seeking educational materials everywhere for their self-studying and for the extension of their regular courses contents on their own terms. The formal and informal learning processes are realized simultaneously, and thanks to the mobile devices in real time. Mobile users withdraw daily news, i.e., stock quotes, weather information, entertainment, sport scores from their mobile devices. Mobile devices permit students for the quick verification of program and plan of studies, as well as course schedule, and course venue. Nowadays, students have a possibility to use the same mobile device as a phone, calculator, private notes' archives or spreadsheets. M-learning is to support individual learning in the student location context. Glossaries, dictionaries, phrasebooks, learning tips, case studies, games constitute the most important learning aids in m-learning.

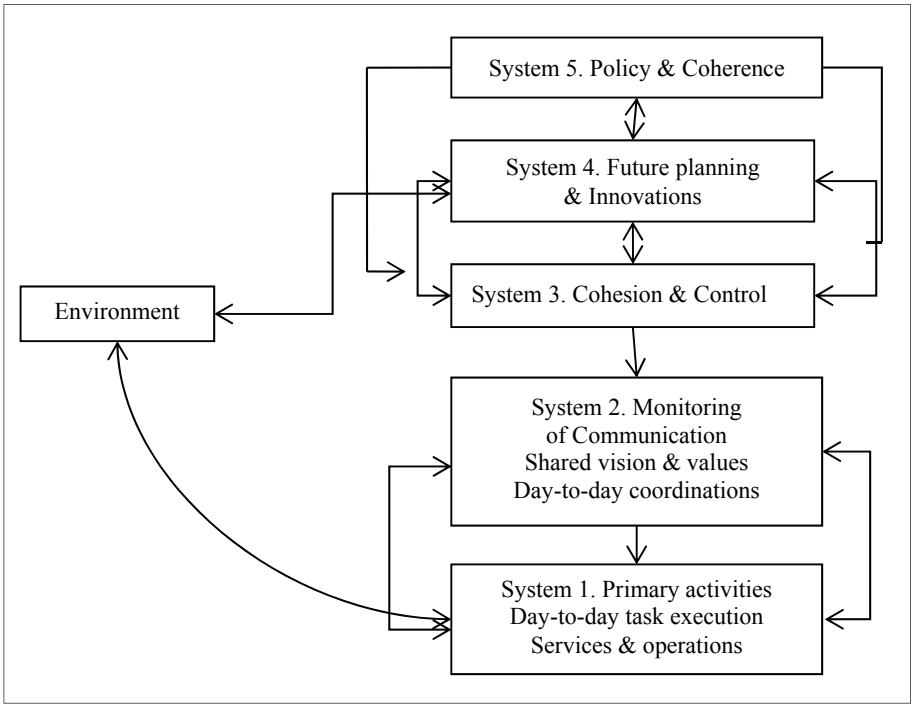
2. Viable System Theory

Social knowledge is a component of the autopoietic (self-productive) process. It is history dependent, context sensitive and embodied in the individuals. A key aspect of knowledge autopoiesis is that it is self-referential, i.e., it includes potential future knowledge as well as past knowledge. Self-referential system are open systems that refers only to themselves in terms of their intentional purposeful organizational behaviors. According to Thannhuber [3], autopoiesis is the ability of a system (e.g., knowledge system) to generate its specific constitution, its components (structure) and their interplay (organization) [14]. Autopoietic system constantly reproduce their organization based on their previous organization. Self-production and self-organization are not deterministic, but they are products of a constant social negotiation, continual change of work culture and decision processes, where outcomes stages arise from previous history and context. Autopoietic systems are able to respond to the environment and

they are self-organized in that responding. Strictly they do not adapt, but they simply self-change and they self-produce. Autopoietic systems are organizationally closed, but interactively or structurally open. They interact with their environment through their structure [15].

The features of autopoietic systems are included in the viable systems. The viable system model was developed by Beer, who first applied its principles. According to Beer, a viable system is able to maintain a separate existence and to maintain its identity independently of other such organizations within an environment [16], [17]. Like any model, the Viable System Model (VSM) is a generalized model that can be used to describe any organization. De Haes and Van Grembergen argue that all self-organizing systems confirm to that model [13]. The VSM considers an organization as an information processing system as it strive to maintain a balance. It provides a framework for diagnosing the structure of an organization, its ability to communicate inside and outside (i.e., with its environment) and its effectiveness in controlling the development of its resources.

Figure 1. Viable System Model general view



Source: [18].

Taking into account the general view in Figure 1, the university as viable systems can be discussed. The System 1 Production covers the primary activities in educational processes realized by teaching staff at faculties and divisions. At that first (i.e., bottom) level, different educational projects are undertaken by individuals and research groups, which benefit from sharing knowledge and from mutual communications at university. Basically the communications are formal as basic education is formal, however informal education activities are also realized as supplementary at that level. The last ones are enhanced by an atmosphere of trust and openness. Controversially, they may be constrained by internal competition, intolerance and lack of mutual understanding.

The System 2 is oriented towards harmonization and coordination the System 1 activities, therefore, sources of disturbances and conflicts in the aspect of educational resources, i.e., human, material and financial should be revealed at that level. The threats ought to be recognized and removed, but opportunities and facilities must be reinforced. The System 2 is to provide a specific type of regulation. Proprietary and open-source knowledge and information need to be accessible for audit of educational processes. Students and academic staff collect SLOs evidence in manual and computerized systems. They back up the exam documentation, research works, software for learning, and the software manuals. Teachers practice their skills. Although, they find it time-consuming to keep themselves organized, university self-controlling system stimulate them to that practices. The System 2 concentrates on gathering teaching schedules, teaching verification protocols, research publications, diploma works, certificates, and licenses, and on maintaining evidence such as Web sites, course catalogue brochures, and guide books.

The System 3 monitors the procedures, which were implemented by the System 2, so the System 3 is developed for executive decision making and for implementation of the laws and regulations imposed by the university external authorities (i.e., Ministry of High Education). The System 3 is to monitor the university internal units integration, as well as for monitoring of implemented policies, resource allocations, and synergy generation.

The System 4 collects together all the functions, which are oriented towards the university future and it determines the communications among the functions. The distinct roles of the knowledge workers and research managers are to be emphasized. A focus on the future is essential for the management of intellectual capital, as well as the academic staff perspectives' integration, ICT infrastructure, market knowledge, and innovations in the educational and research processes. The System 4 encourages to simulation and exploration of different sce-

narios. It must take a practice view of the development of intellectual capital. The System 4 activities include personal marketing, pursuing of the self-development activities, cultivating social relationships and the various formal and informal means of education and knowledge acquisition. For the future development of university, the System 4 activities cover also travels, conference participations, workshops, and intensive reading.

On the top level, the System 5 focuses on strategy policy and includes functions of setting context, building and maintaining identity, as well as monitoring the balance between the System 4 and the System 3.

That all five management systems of the viable system model cover the intellectual capital and knowledge management, which must be considered and maintained as a whole by the university [17], [1]. Organizations, networks and individuals face with the need to constantly adopt themselves to their environment. The usage of the viable system model is a way of interpretation of university as an autopoietic organization of scientific knowledge and as a model of the university dynamics.

3. Formal and informal education in ArchiMate 3.3 model

The ArchiMate 3.3 metamodel is an open, independent and general modeling language for enterprise architecture (EA) [19], [20], [21]. The TOGAF (The Open Group Architecture Framework) community is mostly supporting the ArchiMate 3.3 language and tools [22], [23]. In the TOGAF community as well as for other the EA frameworks, enterprise is identified with business system, which covers people using ICTs for business goal achievement in an efficient way, i.e., low costly [24]. The primary focus of ArchiMate 3.3 is to support the stakeholders to address concerns regarding their business and the ICT systems. The ArchiMate 3.3 model consists of three layers: the Business layer, the Application layer, and the Technology layer. In the EA model, the technology supports application, which in turn supports the business. Beyond that, the earlier version of that tool i.e., the ArchiMate 2.0 introduced the additional extensions, i.e., the Motivation [25]. That layer is further enhanced in the ArchiMate 3.3. version.

The University 3.0 ArchiMate 3.3 model is organized into the following layers (Figure 2):

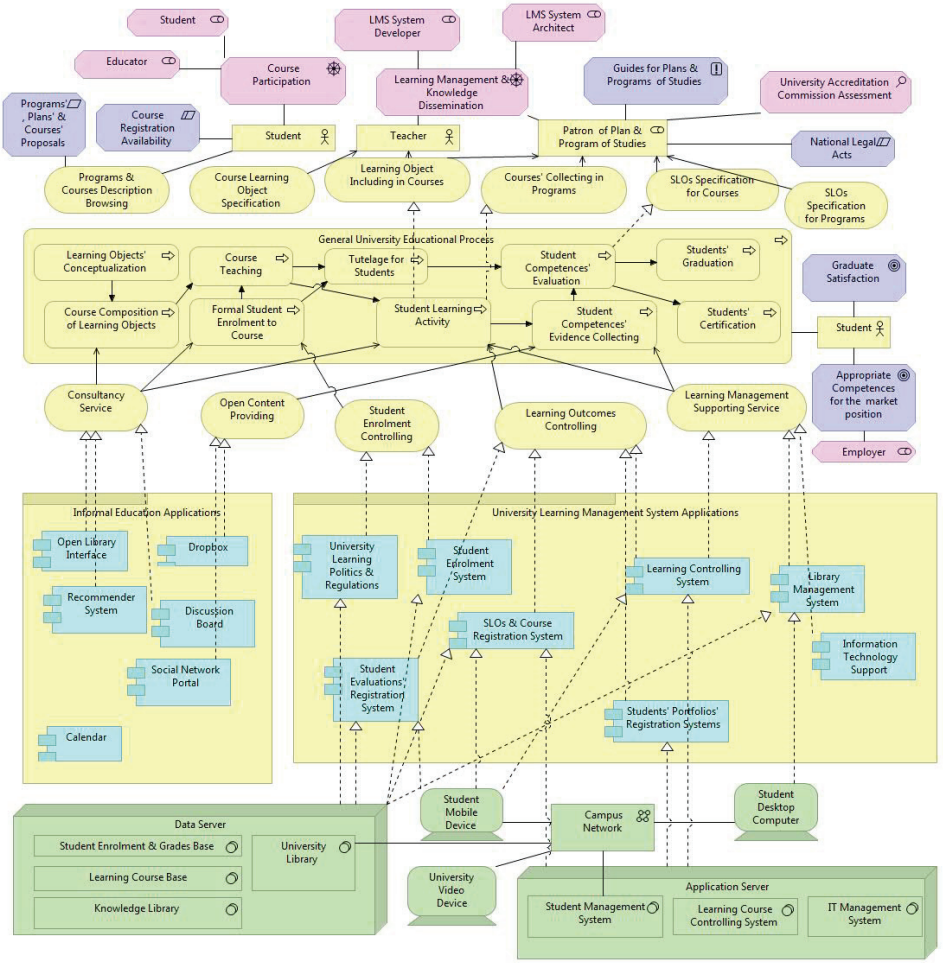
1. BUSINESS containing following elements: actor (i.e., Student, Teacher), roles (i.e., Patron of Plans and Programs of Studies), process (i.e., General University Education Process consisting of ten sub-processes), service (i.e., Course Learning Object Specification, Program and Course Description

Browsing, Courses' Collecting in Programs, SLOs Specification, Student Enrollment Controlling, Learning Outcomes Controlling, and Learning Management Supporting Service, Consultancy Service, Open Content Providing). In this article, each course is assumed to consist of some components, i.e., Learning Objects which are developed by teachers and frequently re-used.

2. APPLICATION including elements such as University Learning Politics and Regulations, Student Enrolment System, Students' Evaluation System, Learning Controlling System for control the course realization by teachers, Students' Portfolios' Registration System for the controlling of the progress of students' work, and the university IT (Information Technology) support as well as SLOs and Course Registration System, Library Management System.
3. TECHNOLOGY including elements such as Data Server and Application Server as well as more than one − Student Mobile Devices, University Video Device, Student Desktop Computer connected together with Services in University Campus Network.
4. MOTIVATION containing the following elements: drivers (i.e., Course Participation, Learning Management and Knowledge Dissemination), principles (i.e., Guides for Plans and Programs of Studies), assessments (e.g., Accreditation Commission Assessment), goals (i.e., Graduate Satisfaction, Appropriate Competences for the market position,), requirements (i.e., Studies' Programs, Plans of Studies, and Courses' Proposals), stakeholders (i.e., Student, Teacher, Employer, LMS System Architect, LMS System Developer), and constraints covering course Registration Availability and National Legal Acts (Figure 2).

Links among entities in ArchiMate 3.3 language are supplemental to the specified model objects belonging to each of the layers in Figure 2. Although, Figure 2 includes many links, there are some critical for informal and formal education. So in Figure 2, Student is associated with the Course Participation, what is a natural his/her duty. LMS System Architect and Developer are associated with Learning Management Knowledge Dissemination because they are involved to achieved that goal. Patrons of Plans and Programs of Studies are collaborating with University Accreditation Commission for regular university assessment. That patrons must respect national and international legal acts and they are involved in SLOs Specification for Programs and for Courses. The General University Education Process comprises a sequence of sub-processes, i.e., Learning Objects' Conceptualization, Course Composition of Learning Objects, Course Teaching, Formal Enrolment to Course, Tutelage for Students, Student Learning Activity, Student Competences' Evidence Collecting, Students' Graduation, and Students' Certification.

Figure 2. ArchiMate 3.3 model of University 3.0



The General University Education Process is constantly self-organizing because of the internal self-organization and self-improvement of each components, so finally the whole over-process is self-producing and self-controlled. For the realization of that sub-processes and services, different software applications are utilized. Generally, they are divided into two groups, i.e., Informal Education Applications and University Learning Management System Applications (Figure 2). The first group covers Open Library Interface, Dropbox as exemplary open repository, Recommender System, Discussion Board, Social Network Portal and Calendar showing events important for students. The second group includes Student Enrolment System, Learning Politics and Regulations,

Students Evaluations System, SLOs and Course Registration System, Learning Controlling System, Students' Portfolios' Registration Systems, Library Management System and Information Technology Support. All the applications are localized on the servers.

Conclusions

University education is constantly changing because of legal, organizational and technical impact factors influence. Autonomy of universities enables to consider them as autopoietic organizations as well as viable systems, which through self-organization adapt to the environment. The self-organization and autopoiesis are possible because of the self-creation of each components, which were presented in Figure 1. Assuming that University 3.0 covers formal and informal learning, the general model of University 3.0 architecture is visualized in ArchiMate 3.3 language in Figure 2. Such visualization is to support the contemporary learning strategy development. In this paper that interpretation was applied to support the development of university formal as well as informal learning. The further research will focus on semantic modeling of the University 3.0 for constant improvement of learning.

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UNIWERSYTET 3.0 JAKO REALISTYCZNY SYSTEM W ARCHIMATE 3.3

Streszczenie: W tym artykule został przedstawiony ujednolicony model architektury systemowej dla rozwoju środowiska kształcenia studentów określanego jako Uniwersytet 3.0. Model architektury łączy różne technologie istotne dla efektywnego kształcenia studentów, czyli obejmuje wykorzystanie technologii ekstrakcji i prezentacji treści dydaktycznych, wnioskowania, rekomendacji i kontrolingu akwizycji wiedzy w otwartych i zamkniętych systemach. W artykule przedstawiono dwa modele, tj. model realistyczny Uniwersytet 3.0 i model jego architektury systemowej, który został opracowany przy wykorzystaniu języka i narzędzia ArchiMate 3.3. Przedstawione w końcowej części wnioski dotyczą problemów, które występują w kontekście przedstawionego w artykule modelowania.

Słowa kluczowe: Uniwersytet 3.0, system realistyczny, modelowanie architektury, ArchiMate 3.3.