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SMART EDUCATION AS THE FIRST STEP TOWARD THE NEXT INDUSTRIAL REVOLUTION

Summary

This paper discusses the design of university smart education projects. The IBM's project, called Personalized Education Through Analytics on Learning Systems, or PETALS is an attempt to introduce educational intelligence to universities. PETALS presents a new way of looking at student decision-making, student mobility, profiles and policies of specific university by using analytics technology; The OpenCourseWare Consortium providing a knowledge and best practices that can shared for innovative and effective approaches in education. The Korean Smart Education project and Samsung School are the examples of public policy prioritizing educational quality and where local society owns the means of education and each student does the studies that he can do and receives the money and resources he needs. Student in that smart education environment feels an strong attachment to smart university. Smart university allows the student to experience how he or she will be seen in the future smart environment (smart manufactories, smart grid companies, smart society). Smart Education Polska (access: smarteducation.pl) is an introducing attempt aiming in bridging the gap between smart education concept and educational practice in Poland. We discuss the design of these initiatives in terms of the mechanism, the use of innovation smart technology, and creating the vision of smart university.
Keywords: smart education, smart university, industrial revolution

Introduction

This paper discusses the design of smart education projects in the context of education initiatives for the next industrial revolution. The Smart University non

profit consortium comprising, among others, MIT Sloan School of Management, Stanford University, and University of California at Berkeley[1] is providing free access to courses content, encouraging to use social constructivism, and action based learning methods which seems to be more congruent to the environment of the new industrial revolution, and offering skills based learning needed in this new environment. Smart University[2] – European advanced educational programme is focused on ICT education workshops dedicated to state of the art ICT technologies. The IBM's project, called Personalized Education Through Analytics on Learning Systems (PETALS)[3], is an extension of the IBM concept of Smarter Planet, and is a part of a trend of broadening the range of Educational Data Mining (EDM) for student decision-making, student mobility, profiles and policies of specific university. The OpenCourseWare Consortium[4], is a worldwide community of higher education institutions and associated organizations, comprising, among others, MIT OpenCourware (OCW)[5], and Open AGH[6], committed to advancing open education and its impact on global education providing a knowledge and best practices that can shared for innovative and effective approaches in education. The South Korean KERIS's Smart Education Scheme[7], is a part of the Korean government „Promotion Strategy for Smart Education" concerning establishing wireless networks, an education information system, and smart TVs. Samsung School[8], is an example of mobility model of education, in which an access to educational content and services is provided by mobile devices. We discuss the design of these initiatives in terms of conceptual frameworks based on the next industrial revolution, referring to the ability of establishing a vision of smart university as an implementation of smart environment (smart manufactories, smart grid companies, smart society), and paradigm shift occurring in education from teacher-centric (lecture, reading, audio-visual, demonstration) to student-centric (group discussion, practice by doing, teach others/immediate use) learning methods.

1. Smart revolution

This section summarizes the next industrial revolution concepts and their consequence and opportunity for university research and education. Main focus is put on the two following ideas: 3rd Industry Revolution, and Industrie 4.0. The 3rd In-

[1] Access: www.smart-university.org.
[2] Access: www.smart-university.eu.
[3] Access: www.ibm.com.
[4] Access: www.ocwconsortium.org.
[5] Access: ocw.mit.edu.
[6] Access: open.agh.edu.pl.
[7] Access: english.keris.or.kr.
[8] Access: www.samsung.com.

dustry Revolution problems are the subject of research from a variety of frameworks: as a manifestation of diversification of energy production, enabling small scale energy production in the local environment (smart electrical pools), and setting virtual power plants (Rifkin 2011), in the context of widely accessible fab labs created at the MIT in 2002, enabling personal digital manufacturing (Gershenfeld 2005, 2012), as a new form of manufacturing based on the idea of pooled manufacturing resources (Anderson 2012). In that context, the universities are interested in learning to build, and testifying these new smart concepts. There are many university initiatives (or municipally initiatives with engagement of universities) referring to this vision, including the following:

- AGH University of Science and Technology, Cracow initiatives: establishing AGH UST Centre of Energetics as a part of the European Institute of Innovation and Technology (EIT) – distributed research institution, and agreement between AGH UST and GE signed in October 17, 2012 on cooperation in development of Smart Grid concept, focused on building smart grid infrastructure for conducting research and development activities, and creation of (Smart Grid) Green AGH UST campus,
- City Science, an MIT Media Lab initiative[9],
- EUREF Campus in Berlin-Schöneberg,
- Fab Foundation, emerged from MIT's Center for Bits & Atoms Fab Lab Program[10],
- Far Eastern Federal University (FEFU) project of Smart Campus in Vladivostok, Russia,
- Open University[11] project helping helps Milton Keynes to become a smart city,
- Russia FabLab@School: Experimentarium 1502 MPEI – Moscow, Russia,
- SENSEable City Laboratory, research initiative at the MIT[12],
- Smart Campus Project run by Helsinki Metropolia of Applied Sciences,
- Tacoma FabLab[13],
- Transformative Learning Technologies Lab (TLTL) project at Stanford University: US FabLab@School[14].

Industrie 4.0 (Baum et al. 2013) is forward-looking vision of manufacturing based on the concepts of the Internet of Things and Services (IoTS) (Ashton 2009), and Cyber-Physical Systems (CPS) (Lee, Seshia 2011), autonomously exchanging information, triggering actions, controlling each other, and visible for the enterprise

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[9] Access: cities.media.mit.edu.

[10] Access: www.fabfoundation.org, www.principalvoices.com/2007/technology.innovation/video/neil.gershenfeld/, ng.cba.mit.edu/show/13.09.fab.show.html, fab.cba.mit.edu/about/labs/.

[11] Access: www.open.ac.uk.

[12] Access: senseable.mit.edu.

[13] Access: www.fablabtacoma.com.

[14] Access: tltl.stanford.edu/projects/fablabschool.

as objects in the internet cloud (Kagermann 2013), indicating the end of fixed and predefined manufacturing structures, and as a consequence of this – triumph of distributed innovation in business ecosystem (manufacturing pools) across the whole digital value chain. Manufacturing pools in that sense are production networks, dynamic, and self-coordinating established as a result of innovation policy in business ecosystems around smart cities, enabling combination of components from different manufacturers, and taking context-related tasks autonomously (Klasen 2012). Standards concerning smart manufacturing are still at an early stage of development. Gao et al. show in conceptual model of multi-agent business collaboration based on cloud workflow, that smart manufacturing will have multi tier architecture, including manufacturing resources, manufacturing services, manufacturing businesses, and manufacturing applications (Gao et al. 2013). The main project of Industrie 4.0. concept is SmartFactory^{KL} in Kaiserslautern[15] in Germany, a manufacturer-independent, model, demonstration and research platform, built in 2007 by the German Research Center for Artificial Intelligence (DFKI) with 20 industrial and research partners.

This mentioned above accelerated development of science and technology determinates change in education and revise the rules of performance of universities. Today universities focus heavily on innovation and entrepreneurship in order to strengthen regional economies, create jobs and keep regions competitive. From the point of view of the aim of the paper, the most important determinants include smart education and smart university.

2. Smart education and smart university

Smart Education is defined various ways (Noh et al. 2011, Jo et al. 2012, Kim et al. 2012), as Educational Intelligence tailored learning based on ICT or smart devices, enabling learners' differing learning styles and capabilities, focuses on increasing development in learners' thinking skills, communication skills, problem solving skills etc, and providing chances for cooperation learning and individual learning (Kim et al. 2013), or intelligent and adaptive teaching and learning system to enable new pedagogy, curriculum, assessment, teacher, etc. which are required for the 21st century knowledge society, learning format which is integrating social learning and adaptive learning in the best communication environment (MEST 2011), or fostering innovation in the education and training system, through the development of information systems, technological solutions, and functioning and empowering ICT system components, that enable users to activate and implement new models of individual and class instruction and learning, to realise advanced

[15] Access: www.smartfactory-kl.de.

systems of assessment, to develop e-education services, and improve on existing models of interaction between education and training institutions and the public and private labour market (Avvisati et al. 2013). Researches on smart education have so far focused on learning contents, infrastructure, the quality of teaching and learning method. We take a different approach, providing Smart University concept. According to (Morze, 2013), there are 5 key characteristics of the Smart University:

- social orientation (the personalization of education, building of the individual education smart cards, organization of the efficient communication and collaboration in education, cooperation, application of design and game techniques, communication via social networks services etc.),
- mobility (an access to the educational content through mobile devices and their use for scientific researches, payment transactions, implementation of feedback with the teacher or the representatives from the dean office or departments, etc, and an access of each student and teacher to the educational services from any place and at any time),
- accessibility (a single point of entry to e-learning and scientific databases, media library, information kiosks, online resources and access control systems to them etc.),
- technological effectiveness (a viability of the IT infrastructure by the means of cloud-technologies, innovative technologies of virtualization, open interfaces, based on the principles of simplicity, modularity, scalability etc.),
- openness (availability of the open repositories of educational materials for forming e-learning courses and providing training for students, open access to scientific articles and conducted researches and their results).

All these new digital facilities at the university, mentioned above, as well as new models of learning aim at establishing the environment resembling this which is expected in the future smart organization. Smart university will thus follow the process of organizational transformation, observed e.g. in smart manufacturing environment (Gontar 2013). The roadmap to smart education at smart university thus outlines, how the university transform into smart organization:

- launch a number of smart initiatives and enter into collaboration with smart industry, resembling these of AGH University of Science and Technology, Cracow,
- turn university campus into a smart campus, resembling FEFU project of Smart Campus in Vladivostok, Russia to effectively manage the university's infrastructure, education and administrative procedures, and to incorporate smart ICT technologies to faculty, students and administrative staff,
- create smart learning grid, combining network connections in the form of OpenCourseWare Consortium enabling establishing smart university in the sense of smart organization,

- establishing a smart university competency center responsible for Educational Data Mining (EDM) analysis,
- create smart university.

One of the possible direction of development smart university is the CLUSTER (Consortium Linking Universities of Science and Technology for Education and Research) consortium of 12 elite European Universities in Science and Engineering (and architecture) with associate members from around the world[16].

3. Discussion on case studies

The OpenCourseWare Consortium, and similar projects including lynda.com, Khan Academy, and Udacity offers access to free, open digital courses prepared by universities (e.g. MIT OpenCourware, Open AGH), the ability to adapt, use, and develop courses. The Consortium would have in the future distributed structure with the following characteristics: dominance of innovation unit, responsible for dynamical planning of educational „products" and processes, modularity of educational processes enabling establishing educational pools with dynamic structure, interconnections resembling to those of smart manufacturing, i.e. vertical integration and networked educational system, and horizontal integration through education value networks, education of any scale. The Smart University is even closer to the idea of smart university described in the paper. This project is characterized by the use of Social Constructivism, and Action Based Learning methods, access to OpenCourseWare Consortium courses, and skills based learning from thought leaders around the world. European Smart University project refers to education, and training workshops dedicated to latest advances in ICT technologies that will drive future growth and innovation of enterprises/organizations. It points the direction of specializations in smart university concept. Personalized Education Through Analytics on Learning Systems (PETALS) gives the view of what educational intelligence would be. Dynamical planning of educational „products" and processes, mentioned above would be possible only through control of the processes online using business intelligent systems. KERIS's Smart Education Scheme refers to establishing wireless networks, and education information systems to allow students to learn through digital content. Samsung School gives access to educational content and services provided by mobile devices, combining the tablet with a range of classroom technology, all tied together with Samsung's learning management and interactive teaching software – to create an interactive, student-centric learning environment enabling dynamic instruction, interaction, and collaboration in the following areas: Interactive Teaching, Learning Management. Educational Data

[16] Access: www.cluster.org.

Mining (EDM) is an emerging discipline for developing methods to explore unique types of data from educational context. In fact, EDM is an application of data mining techniques implemented in the area of education for obtaining better comprehension on students' learning processes and acknowledging the ways they participate in it, in order to improve the quality of the educational system. Smart Education Polska tries to familiarize the latest achievements of digital learning.

Conclusions

We present a model for smart university, as a Cyber-Physical System that delivers context data to drive the analysis and control of an education environment, from the perspective of a new industrial revolution. Industrie 4.0, and related approaches offer a new perspective on global economic governance, aimed at reindustrialization as a reaction for deindustrialization occurred rapidly in recent years, and chance for increase economic development and growth of smart cities. Appropriate time period of Industrie 4.0 implementation is estimated to be 20 years (Nikolaus, 2013). The paper indicates the end of fixed and predefined university structures, and as a consequence of this – the emergence of distributed education in education ecosystem (education pools). Our approach is characterized by the following elements:

- considering smart university as a network of education systems,
- concentrate on disruptive innovation as a base of integration of this network.

Analysis of smart education initiatives indicates, that it could be as a trend called a process outsourcing, which allows for emergence of universities, in which education base could be located in education pools, resembling smart manufacturing initiatives.

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INTELIGENTNA EDUKACJA JAKO PIERWSZY SZCZEBEL NA DRODZE DO NASTĘPNEJ REWOLUCJI PRZEMYSŁOWEJ

Streszczenie

W artykule omówiono plany projektów i inicjatyw edukacyjnych związanych z koncepcją inteligentnego uniwersytetu. Projekt IBM, Personalized Education Through

Analytics on Learning (PETALS) to próba wprowadzenia na uniwersytety edukacyjnej eksploracji danych. Projekt PETALS proponuje nowe podejście do analizy wyborów podejmowanych przez studentów w trakcie studiowania, analizy mobilności studentów oraz analizy zmian profilu i polityki uniwersytetu poprzez zastosowanie metod analitycznych opartych na analizie dostępnych danych i informacji. Konsorcjum OpenCourseWare koncentruje się na dostarczaniu wiedzy i najlepszych praktyk do zastosowania wśród innowacyjnych rozwiązań w edukacji. Południowokoreański projekt Smart Education oraz rozwiązania Samsung School to przykłady działań w zakresie polityki Społecznej, które wyznaczają główne priorytety odnoszące się do jakości kształcenia i dostarczają lokalnym społecznościom podstawowe narzędzia do realizacji inteligentnej polityki edukacyjnej. W tak skonstruowanym inteligentnym środowisku edukacyjnym, każdy student otrzymuje wsparcie w wyborze ścieżki edukacyjnej, rozwijając jednocześnie swoje więzi z uniwersytetem. Inteligentny uniwersytet pozwala również studentom uczestniczyć w inicjatywach, które są bezpośrednio związane z nową rewolucją przemysłową (inteligentna produkcja przemysłowa, inteligentne zarządzanie energią elektryczną, inteligentne społeczeństwo). Smart Education Polska (smarteducation.pl) to próba wprowadzenia koncepcji inteligentnej edukacji w Polsce. W artykule omawiamy plany tych inicjatyw w sensie ich mechanizmów, wykorzystania innowacyjnych technologii i stworzenia wizji inteligentnego uniwersytetu.

Słowa kluczowe: inteligentna edukacja, inteligentny uniwersytet, rewolucja przemysłowa

Tłumaczenie Zbigniew Gontar