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## **EDUCATIONAL SYSTEM INTEROPERABILITY – CHALLENGES FOR OPEN LEARNING AND TRAINING PROGRAMS**

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### **Open innovation and open education**

Information, knowledge, and competencies are the key driver for the further development in each area of society. Intellectual and knowledge based capital has important influence of investments, innovation and growth in economies (OECD, 2013; p7ff). Especially, the knowledge and intellectual resources are becoming increasingly important regarding the transition to information society focused on the digital transformation because information and knowledge will be made available regardless of time and space. Digital learners and coaches are required for the digital society.

Innovation is one of the most essential driving forces behind competitiveness and changes. Competitiveness means superior growth and performance of system in general. The individualization by the citizens geared to the target group orientation as well as the competitive constrains generated by the increasing globalization and deregulation of the key sectors force the urgency and pace for innovations today. Innovators as professionals are the source for the innovations needed in all sectors of the society for solving the challenges of the future. Innovation based on the generation of new knowledge as the result of organizational and individual learning processes. But, knowledge has to be shared to be able to create new knowledge and to lead to innovations. The higher the intellectual capital is developed, the better it acts as a catalyst for knowledge sharing and innovation (Saenz, Aramburu, & Rivera, 2010).

Innovation is a term in economics for improvements accompanied by technical, social and economic changes. All attempts to define the term are characterized by (a) Novelty or replacement at least one object or social action for the system under consideration; (b) Modifications or changes by the innovation in and by the organization, i.e. innovations needs to be discovered, invented, introduced, used, applied and institutionalized (Gabler Wirtschaftslexikon, n.d.). Because knowledge and information are goods that are difficult to control and aspire for open use, the public and private guardians of competitiveness usually tend to an artificial shortage. Such strategies of scarcity are counterproductive for innovation per se. The constructive alternative is to use innovation and creativity, particularly in relation

to knowledge as well as to the possibility of being able to freely access information products that represent knowledge (Kuhlen, 2006).

Open innovation provides as an adaptation the approaches developed in the open as well as free software and open access principles for free use of information and knowledge products. Open innovation becomes part of the open society including free movement of people and other resources supplemented by the openness of knowledge sharing and education. Therefore, investments in organizational change and the creation of open educational resources should be realized in the context of the digital society based on digital infrastructure, devices and competencies as well as high quality educational software. Open and innovative education and training reflect aspects such as innovative and active pedagogies, participatory education governance, synergies between education, research and innovation, ICT as driver of the systemic change, open and digital resources, digital skills and competencies at all levels of learning (European Commission, 2015).

### Openness for learning and training programs

Open education requires the willingness of the owners of information and knowledge to make the resources available for use by demanders. There are different forms of motivations to push open solutions of education and training. The spread ranges from the socially competent individualist via the public organization up to the commercial supplier. The reasons depend on the specific target systems including especially strategy, structure and information technology for the open educational approach (Rivard, & Aubert, 2004). But, if the decision for opening the accesses to the own information and knowledge resources was made, a variety of possible relations for the knowledge transfer will be available as single- or multi-channel support services.

The kind of openness is influenced by primary as well as secondary and tertiary aspects. The primary hard facts are volume, time and costs for the knowledge transfer supplemented by the form, technology and structure for the provision and completed by framework conditions of policy, culture and regulations. (Figure 1)

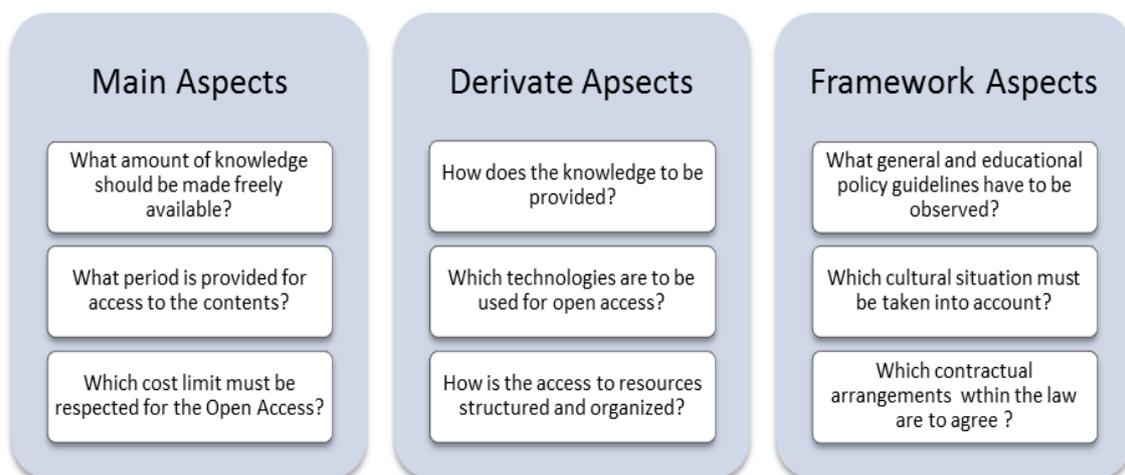


Figure 5. Influences for openness of education and training

The opening of the knowledge base can be carried out at different levels: statement, sequence, module, course or program. It is necessary to define which elements are from what level made freely available. In addition, it must be decided whether the elements will be single used or linked due to their context. Usually, several elements are interdependent and form an educational program of any length. The prior art is to integrate these elements in the program.

### **Interoperability and integration in education**

The pure doctrine of the past was to integrate functions, processes or systems for using different applications in one extended functional context based on several subcomponents. The learning platform of the first party provider was combined with the content development system of the second party provider and with the document management system of the third party provider and so on. The subsystems will be connected by defined and fixed interfaces. If the interfaces are standardized, each component will be able to use the same interface. Otherwise, the interfaces are unique for the one or few integrated solutions. The result is that the users buy common solutions ready-made. The only way for including flexibility and application-specifics is the customizing approach taking in account that the systems become larger and more cumbersome.

The same problem with integration of different systems, subsystems and components is generated by using several teaching and learning concepts, methods, programs, modules etc. in the level above. The components of various educational providers have to be integrated by defined interfaces. Otherwise, redundancies and inconsistencies are threatening whereby the learning processes are hampered or disturbed in further consequence. The state of the art is today, that one or several educational providers offer integrated programs. (Figure 2)

The interfaces have to be regularly adjusted if the structure of the content of one of the provider will be changed. If a third party provider would be added, he would have to take over unchanged interfaces or interfaces would have to be adjusted again. Nowadays, an alternative is offered by interoperability concerning primarily interconnection of systems but also the interaction of the components. Interoperability between different objects such as platforms or knowledge bases allows the connection and communication of different components based on their own flexibility, smartness and universality instead of only fixed interfaces. In addition, it increases the value of applications for users by facilitating access to wide ranges of functions and content, too. Interoperability increases attractiveness of the applications for the consumers and generates new incentives of the providers to co-operate (OECD, 2013; p.50).

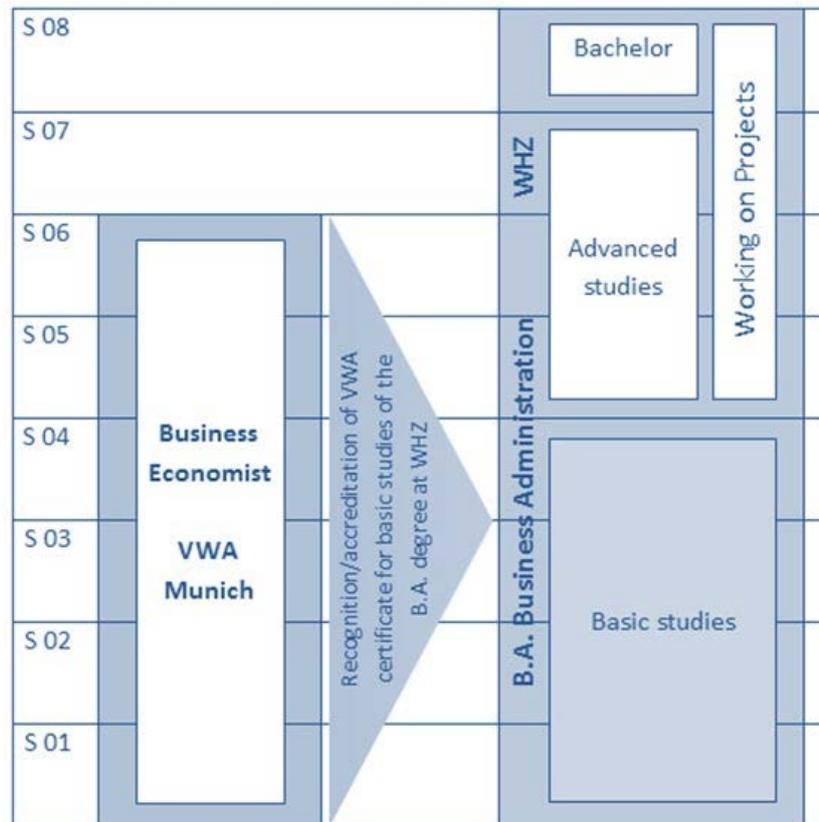


Figure 2. Full-integrated distance education program of a non-academic provider and a university

Now, the key question will be how interoperability can be used directly at the point of contact to the customer for open learning and training programs. The chance will be opened to intensify the cooperation with different educational providers by flexible interconnection of educational components using interoperable facilities. The results are the increase of the reusability, the improvement of the openness of the knowledge, the better independence from single providers, etc.

### **Interoperable platform development and application for learning and training**

The development of interoperability was pushed by the experts for integration mainly from the software engineering dealing with application as well as information integration in a heterogeneous system environment. Instead of the integrated attempt to build a monolithic solution, the interoperability- based approach is focused on the exchange of meaningful, content-oriented data between autonomous systems. The view on the interfaces has to be changed because they have to support source and target systems by cross-system exchange in a smart way applying graph theory and ontology (Pollock, 2001). The main characteristic of interoperability is the ability of independency and heterogeneity of several systems for generating seamless cooperation, applicable interaction and efficient exchange of information (Schleipen, 2013). Levels of information systems interoperability were derived for a general view of enterprises. (Figure 3)



Figure 3. Stage model for the development of interoperability in an application environment

The development of interoperability as philosophy, strategy, concept and model is going on for the different applications especially in business and industry (Kassel, Schumann, et al., 2009) as well as in further consequence in education and training with a focus on information systems as well as platform convergence (Paulsen, 2007) and a slightly tendency to content-driven services. The state of the art is that ICT based stakeholders for training and education, especially in the field of e- and m-learning, are able to provide the demanders with interoperable tools, platforms and concepts as well as the knowhow for the application of interoperable systems in training and teaching. Sometimes, the unsatisfying user-friendliness and practicability of the systems prove to be a hurdle for the further application.

But, the issues for developing interoperable applications for knowledge transfer as cognitive processes are the complexity and transdisciplinarity of the task, the dynamic development of the existing knowledge, the growing scarcity of qualified specialists and last but not least non-transparency of operational effects with perhaps skyrocketing costs. One of the latest ICDE reports on quality models reflects the topic only in the content of media design (Ossiannilsson, Williams, Camilleri, & Brown, 2015) because serious statements are so difficult by the current unavailability of enough information on the subject.

### **Evolution of open programs by using advanced knowledge**

Interoperable systems are a prerequisite for interoperable applications. There are a lot of skills and experiences coming from the knowledge management or software engineering referring to the use of interoperability and already applied in the context of open and flexible learning. Especially, the increase of methodological knowledge was accelerated by re-design of monolithic contents into multivalent knowledge components which are cross-linked for special target groups of learners on demand. The learning objects are put into relations by semantic networks as a kind of knowledge representation (Figure 4) (Baier, 2008; Götze et al., 2013).

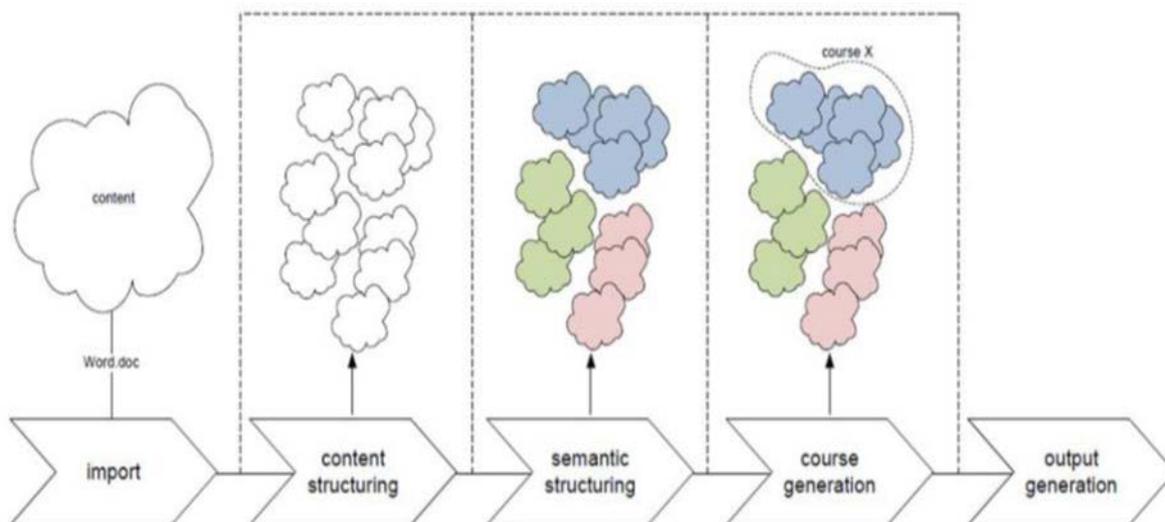


Figure 4. Interoperable re-engineering of holistic courses and contents by semantic technology (Presant, 2015)

The future applications of interoperability in open learning and training programs could be oriented towards the concept of open badges and portfolios (Presant, 2015). The principles should be similar. The participants are able to collect fixed and validated forms of recognition. The worldwide credit point system in higher education especially the unified European one will be used for adding completed learning and training activities rewarded and by credit points to a recognized body of individual knowledge (Buchem, 2015). The existing knowledge will be divided into knowledge units transferred by learning and training modules. The modules could be part of different programs fixing the general structure and content which is needed to come step by step to an academic degree. This method will guarantee consistency of the different educational programs and systems, the individualization of learning and knowledge transfer, the evaluation of the acquired knowledge as well as a reasonable combination of individual learning pathways with the requirements of useful degrees.

Recently, the first wave of applications is advancing including the use of system interoperability as well as semantic technology. The experiences by using autonomous and mobile logistic devices without central control based on interoperability and collective intelligence prove that simple rules for the interaction already lead to a first stage of functioning systems. The same results can be obtained for interoperable open education programs. (Figure 5)

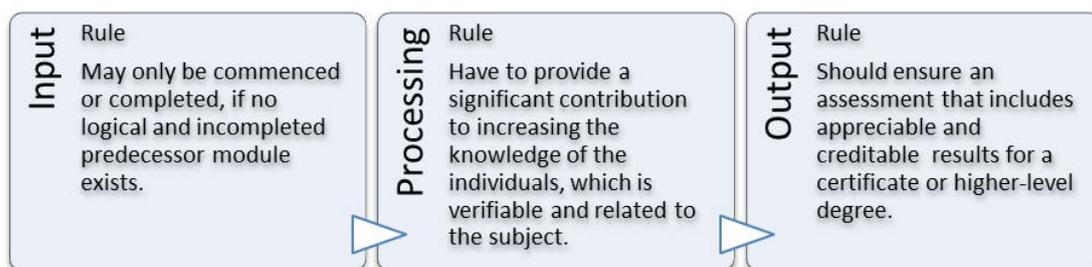


Figure 5. Input, processing and output rule for learning units of an interoperable educational program

The approach can be matched with the principles of the more technology-enhanced learning based on Advanced Distributed Learning Initiative (ADL) including accessibility, adaptability, affordability, durability and interoperability (Vernadat, 2010) without central control system. The concepts was used for developing several study programs provided by an network of educational organizations in the national context and rolled out in different international programs supported by a global network of universities.

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