Exploring the Micro, Meso and Macro
Proceedings of the European Distance and E-Learning Network 2018 Annual Conference
Genova, 17-20 June, 2018
ISBN 978-615-5511-23-3
ISSN: 2707-2819
doi: https://doi.org/10.38069/edenconf-2018-ac-0047

MODEL-BASED APPROACH FOR PENETRATING EDUCATION SYSTEMS BY DIGITAL TRANSFORMATION KNOWLEDGE

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Model-Based Approach

Digitization penetrates all areas of social life and is one of the defining phenomena for the future development in science, business and politics. Digital transformations are characterized by high dynamics and high complexity. One of the biggest challenges for knowledge transfer in society is the near-term transfer of the latest knowledge on complex system developments from research, development and application in elementary, primary, secondary and tertiary education. Despite the variety of well-known research methods, the challenge of mastering complexity is growing (Epple, 2016).

Based on the theory of competence cells for the transfer of knowledge in industrial and economic networks (Müller & Riedel, 2003), including the related knowledge and competence networks, a theory of knowledge networks with the knowledge carriers as nodes and the knowledge flows as edges was developed, whereby new insights and applications were generated by exploration of the processes within the nodes and edges (Schumann & Tittmann, 2009). Similar considerations in educational research led to the design of the theory of connectivism (Siemens, 2004) as a counterpart to the prevailing constructivism. Common to all theories of this cluster is that networks can be scaled arbitrarily. Thus approaches can be used in particular for very complex problems.

Due to the pace and variety of the changes, it is difficult to examine individual areas empirically, normatively or formally in order to come to empirical or rational knowledge about the entire system. Therefore, the different methods of research are also networked. Therefore, quite different research methods are combined in a holistic approach. In addition, there is the danger to follow the real developments with the theoretically founded research results only with a time delay. That is why; the combination with the theory of action is

Holistic challenge of the exploration area

Of course, the transfer of new knowledge and competence potentials from the field of digital transformation into the education systems is also characterized by individual sciences and special topics, but due to the complexity of the real world, it has to be traced back to a holistic approach of interdisciplinary nature, whereby the interconnection of humanities and social sciences, medical and health sciences, natural sciences, engineering and technology as well as agricultural sciences (OECD, 2006) are explored in complex, interrelated fields of action. The whole is more than the sum of the parts, which is why, starting from the wholeness, individual parts of the system have to be identified, analysed, described and interpreted. The design should be done in the sense of an overall optimum.

The holistic approach also requires complex consideration from the macro level as a contextual level at the overall system level through the meso level as transactional level at the group and community level to the micro level as individual-organizational level at the intra- and interpersonal level (STEEP edition, 2015; Eco-Social Work, 2015).

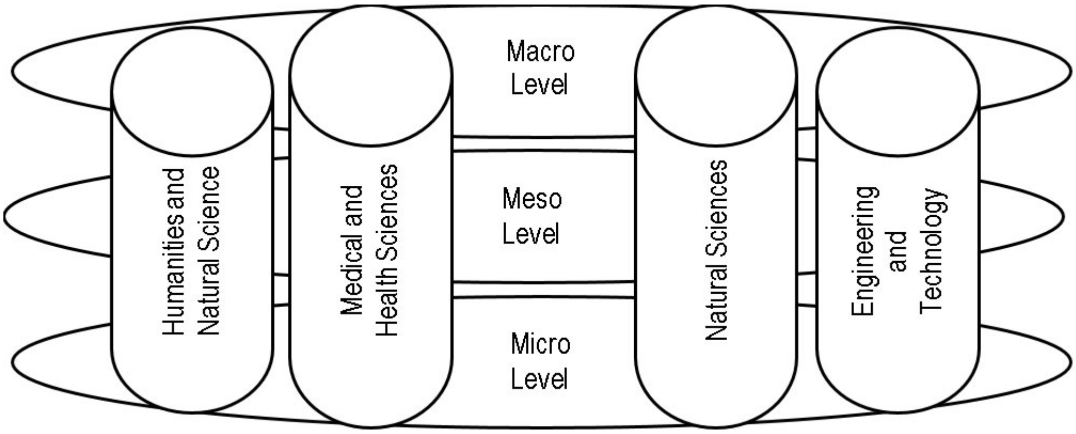

Figure 1. Holistic view of social levels and sciences

If knowledge and experience from transformations in general and digital transformations in particular are to be transferred into education, then the field of investigation has to be considered holistically, otherwise inadmissible simplifications and errors in the interpretation of the models may occur.

Variety and diversity of views and concepts

The present state of analysis, description and interpretation of such complex processes as the digitization of social processes and functions as well as digital transformations of different systems require different disciplinary perspectives which in turn lead to a high variety and diversity of different concepts. If a two-dimensional clustering with the characteristics System, Model, Technology and Application in the first dimension and with the characteristics Business / Management, ICT, Production / Logistics, Safety and Engineering in the second dimension would be chosen, then even the matrix would have the complexity of 4*5, which would still lead to a comparatively clear semantic representation.

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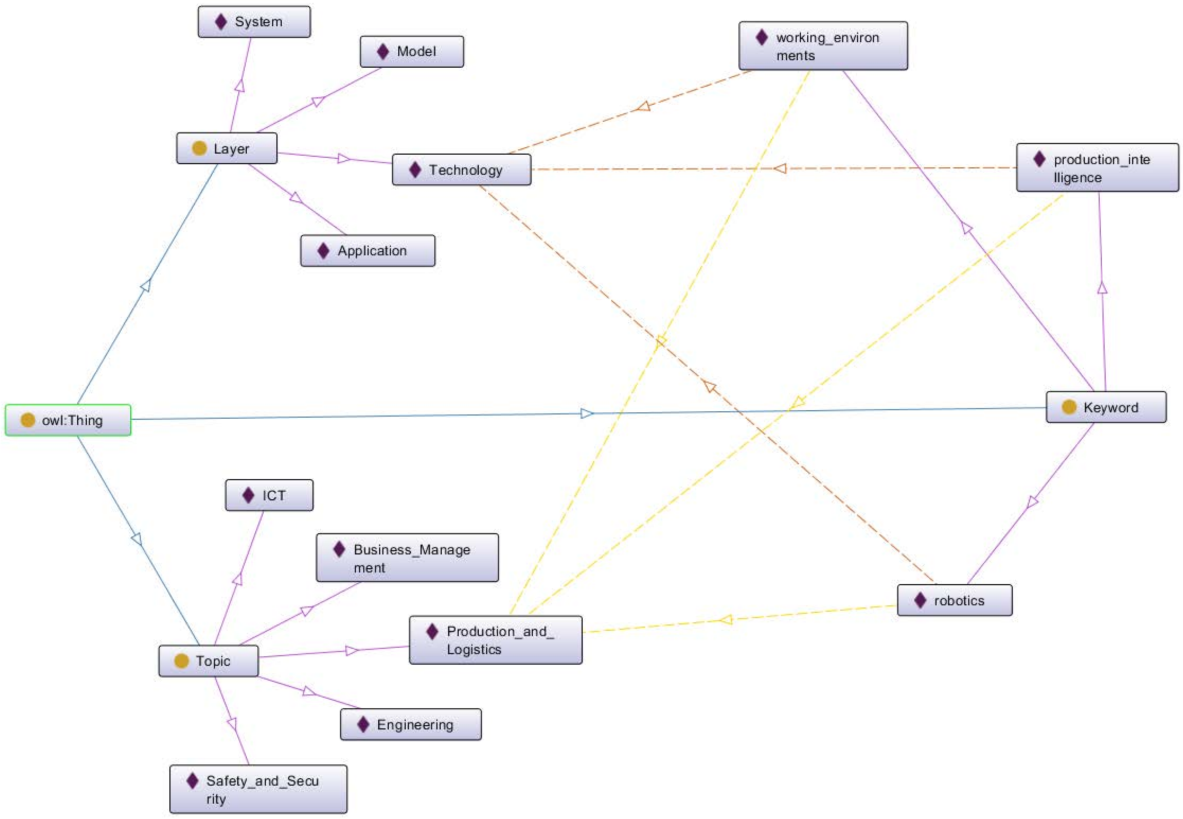

Figure 2. Semantic presentation of the holistic clustering for digital transformation (Gallenkämper et al., 2018)

Depending on which singular or multivalent perspective digital transformations are observed, described and interpreted, very different model variations arise for one and the same research subject.

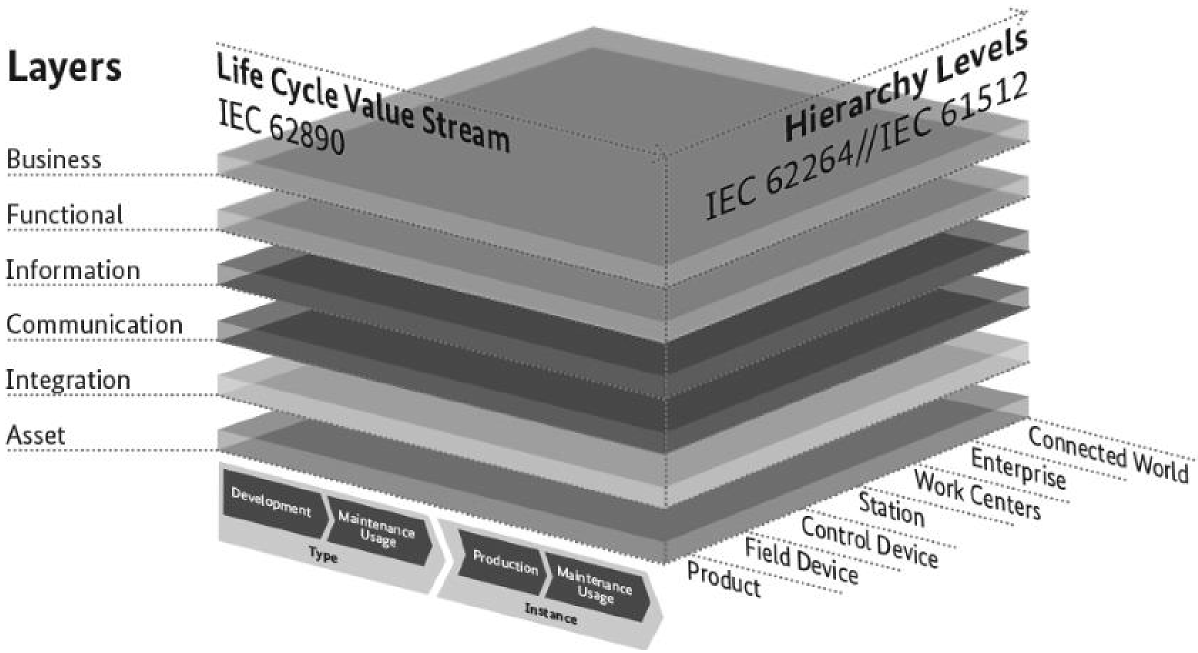

Figure 3. Reference Architectural Model Industry 4.0 (RAMI 4.0) (Adolphs & Epple, 2015)

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If the same area of investigation is viewed from the viewpoint "World of Work" rather than from the viewpoint of industrial systems, different model approaches occur.

Table 1:Multi-layer model Working World 4.0

Incentives	Payment
	Flexibilisation
	Appreciativeness
Organisation	Project orientation
	Network organisation
	Lean organisation
Leadership	Collectiveness
	Self management
	Implicit leadership
Technology	Digital transformation
	Big data
	Smart system
Cooperation	Agile methods
	Inter- and transdisciplinarity
	Interculturality
Environment	Creative labs
	Smart working spaces
	Virtuality

Impact of system engineering models

Systems are sets of objects between which relations exist. Systems theory is used for interdisciplinary explanations. System engineering offers models and tools for the research and design of complex tasks and applications. The goal is the successful planning, design, development, implementation and operation of systems. Systems engineering is closely related to software engineering. Engineering systematic was transferred to software development. New methods of software development are shared interdisciplinary, in particular through project management. One of the most recent examples is the dissemination of agile methods and procedures that were first applied to software development (Schumann et al., 2014). System and software development have verifiably influenced the design of new learning systems in the categories development philosophy, development process and lifecycle management.

Table 2:Impact of system theory and engineering modelling on educational design

	Selected Models of Software Engineering	Use cases of (digitalised) Learning Systems
Development philosophy	Prototyping	Design of frame degree programs
	Agility / Scrum	Developing of new curricula in education networks
	Rational Unified Process	Automated generating of tutorials
Development process	Waterfall model	Creating of multimedia sequences
	Spiral model	Developing of Content Management Systems
	V-Modell	Knowledge transfer based on structured knowledge bases

ISBN 978-615-5511-23-3

Lifecycle management	Product Lifecycle Management	Development, application and reengineering of certification tracking
	Capability Maturity Model	Defining of degree of digitalisation of education programmes
	Control Objectives for Information and Technology	Controlling of the use of e-learning in educational organisations

The V-Modell (2006) was explicitly selected for further consideration, because it includes not only the analysis and decomposition of the task, but also the subsequent synthesis and composition of the educational application including the corresponding quality assurance. In addition, the design of knowledge transfer in teaching and learning systems was successfully established in this way and is used in particular for tasks of the public sector on development standards.

Approach by using V-model in curricula development

The multi-phased approach from requirements analysis to module design in a top-down process is described on the left side of the model. Equivalently, there is one phase each on the right-hand side for reviewing previously developed concepts and solutions. This results in different views at different levels of detail, which ensures the direct involvement of all stakeholders in the development process, depending on their role.

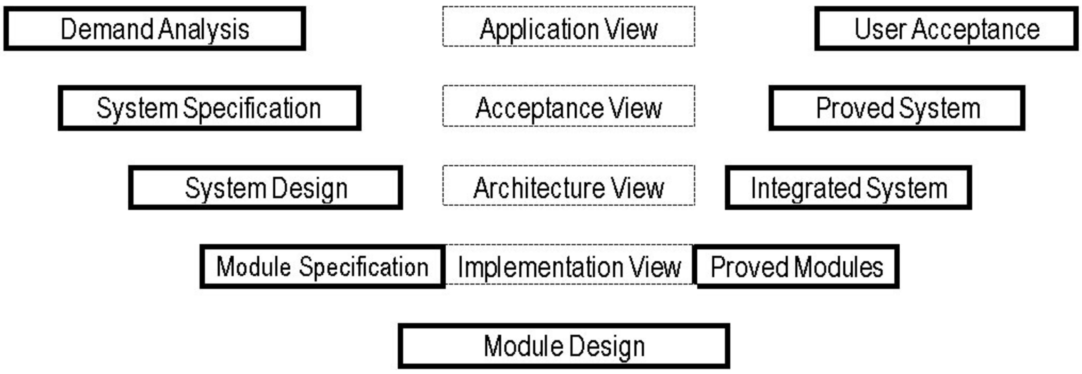

Figure 4. Architecture of the general V-Model

If this general development perspective is applied to the course design, especially of the curriculum, a specification of the contents is done, while preserving the basic idea of development and the better mastering of the complexity.

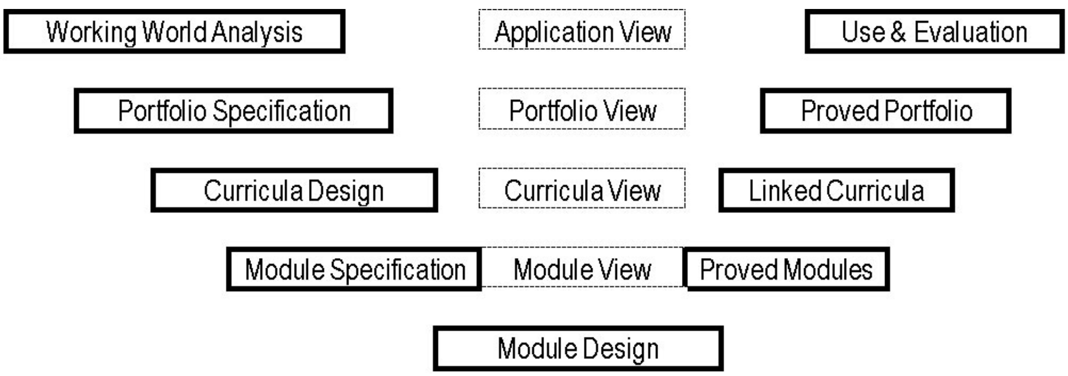

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Figure 5. Architecture of the V-Model in course design

Thus, even in more complex educational networks, new study programs can be professionally designed in a short time and in high quality, while respecting the individual needs and stakeholder demands.

Case study and results

The process model was successfully used in the development of new double degree programs in national and international educational cooperations, for example in China and Mexico, in combination with other methods of system and project development. The interdisciplinary program for Business Administration and Engineering (BizEng) was designed in a basic version, subsequently built up by four different profiles, and then additionally expanded to include "Digital Transformation / Industry 4.0 (DT I40)" profile.

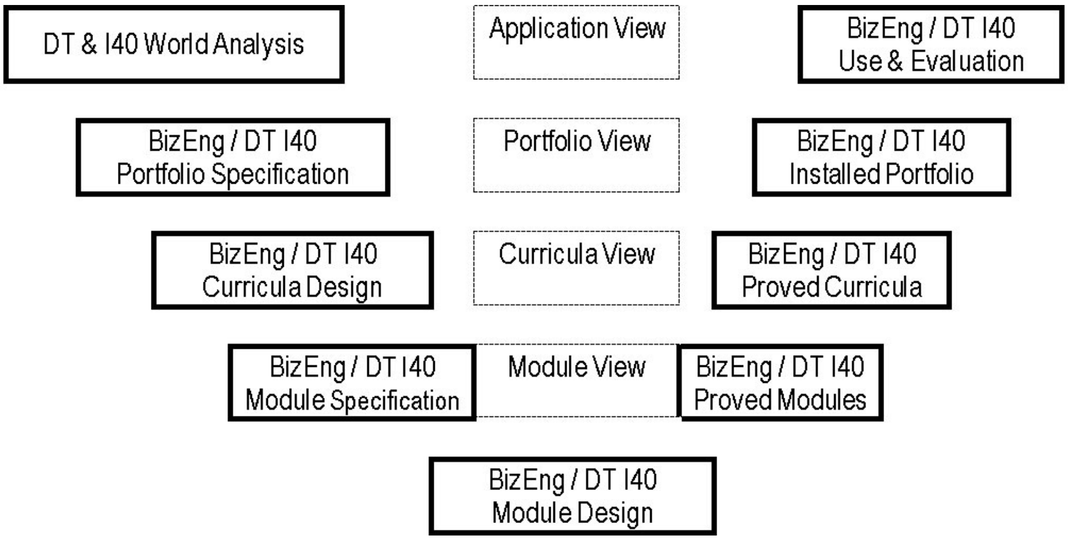

Figure 6. Architecture of the V-Model in course design for Digital Transformation & Industry 4.0

Once the standardized procedure has been introduced procedurally, contextually and organisationally, it can be ensured even for complex applications that derivatives can be derived in a target group-specific and output-oriented manner in a short time and in high quality. Hitherto, several variants of distance learning with different partners have been developed for the entire program as part of PPP models. Thus, a significant contribution is made to transfer the latest research results in the field of digital transformation into teaching as quickly as possible.

Perspectives

Content and form, purposes and objects, methodology and didactics of knowledge transfer concerning digital transformations are subjected to a constant change, which simply results from the dynamics of the development of the real world. From a strategic point of view, this means for 2018 and the following time (Evans, 2017):

- Digital insight – from platitudes to actionable perspectives.
- Digital frameworks – from DIY to off-the-shelf platforms and accelerators.

ISBN 978-615-5511-23-3

- Digital intrinsic agility – from destination focus to continuous journey focus.
- Digital balance – from gregarious disruption to ethical disruption.

The changes are extremely fast. The major trends in 2018 will be: The IoT will push as to the edge, blockchain finds its way; AI goes from newbie to mainstream, VR goes from hero to zero, failure as a service, culture remains hurdle, and digital transformation becomes a must (Newman, 2017).

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