



Doctoral School on Pedagogy Eszterházy Károly University
Digital pedagogy program

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**THE FOUNDATIONS OF DIGITAL TRANSFORMATION
COMPARATIVE ANALYSES**

Theses of PhD dissertation

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Main themes and structure of the dissertation

The term “digital transformation” has been used in a variety of contexts recently. Some view it as the fourth industrial revolution, while others emphasize the restructuring of mass communication and media technology and most people consider it as a business opportunity prioritising digitalization and the changes induced by the 3d platform. As Gerd Leonard in his lecture titled, “The digital transformation of society” stated, digital transformation, the latest phase of the industrial revolution can bring more changes in the next twenty years than humanity experienced until now.

Thus the question is how individuals or even countries react to the evolution of software and machine, the phenomenon of the on-demand availability of real time information and the related new challenges. The exploration of the digital transformation of the education sphere focuses on changes and modifications in the methodology of new learning environments. A recent tendency is the development of a multi-level and multi-actor educational system assigning important role to other segments of society as well. The respective units are connected to specific subsystems of the educational system and turn into complex, adaptive structures continuously accommodating the demands of their respective surroundings. As Halász (2014) considering this process further states: *educational systems are increasingly viewed as living organisms with unpredictable development and adaptation features. Consequently, we are only aware of the contemporary or given evolutionary process* (Halász 2014 p.9) Evolutions tend to accelerate, especially during the time of cultural paradigm shifts. Such complexity entails the total spectrum of educational management. If we consider the system on a meta level we encounter a dynamic process including the digital ecosystem. The given process, mostly due to the adaptive operation of the system facilitates digital transformation in education thereby generating a significant impact on the total pedagogical culture both on the macro and micro level. The multi-level and multi-actor aspect along with the abovementioned accelerated evolutionary process provide added legitimacy to strategic analyses. Consequently, the digital transformation process has to be considered from a methodological aspect since the given tests can influence the results of the evolutionary process and the particular time factor. My dissertation reflects these principles and considerations.

The imminent paradigm shift with a special impact on education is another consequence of the technological development. Accordingly, the focus will be on the definition and development of new 21st century basic skills which can significantly influence the total educational spectrum. Since industrial revolutions compel experts to construct new paradigms and models, the digital transformation process can substantially impact education in such areas as the conditions, process, and methodology of instruction, including the competence models of human resources (Kárpáti, 2002. p. 15).

My dissertation explores a narrower cross-section of the abovementioned model construction process focusing on the conceptual framework, condition system, the role and competences of human resources and the general resources of the new learning environments.

The main objective of the dissertation is the identification of the phases of the digital transformation process along with the definition of indicators, and characteristics facilitating the realization of its methodological objectives in public education.

The work at first provides an overview of the respective theoretical background with special emphasis on the educational role of information culture, the definition of the relevant key terms and concepts (technological determinism, learning environment, new media, digital ecosystem, electronic learning environment, and digital transformation). The chapter titled “The Significance of Human Resources in the Education Process,” explores the interaction of cultural paradigm shifts and new basic skills and competences, and the competences required for learning and teaching in electronic learning environments with special emphasis on information literacy models, complex measuring, evaluation, and developmental models, along with the new basic competence theories of the 21st century. I will also introduce the human performance support technology and the methodological models required for the elaboration of a personal learning environment via the triological learning theory, the BYOD model, the 1:1 accessibility model, and the R2D2 model analyzing the learner type based learning options.

After establishing the theoretical foundation of the research effort I will provide a description of the main attributes of the qualitative, comparative approach with special emphasis on the research

problem, the respective research issues, methods, sample taking strategies, qualitative data corpus, the research apparatus, the expected outcome of the content analysis process, and the phases and process of the data analysis. Furthermore, special attention will be paid to the description of the scientifically sound qualitative research theory along with meeting the requirements of objectivity, reliability and validity.

In the section titled “The scope of the inquiry,” I will provide a description of the three countries involved in the research along with the 5 dimensions of the respective digital economic and social index, introduce the relevant components of the specific national development strategies, and describe the main features and specific financing options of the given educational systems.

During the introduction of the results of the content analysis process the particular outcomes will be presented according to thematically organized research questions followed by a summary in each case. Consequently, I deploy the non-cross-sectional arrangement, that is I analyze the information communication strategy and the respective parts of the national core curricula in separate units. The analysis is concluded with a comprehensive summary complemented with the description of the respective technology-related experiences along with the professional conclusions. At the end of the treatise I will discuss the future perspectives of digital transformation.

The theoretical framework of the research program

The term digital transformation or digital conversion has appeared in numerous contexts in the past years. It emerged primarily on the field of business and marketing while it can play a role in mass communication, sociology, health care, IT technology, and the elimination of the gap between the developed and undeveloped world. In such cases the term digital transformation¹ refers to the impact of the application of digital technology, primarily the 3rd platform to these areas. While the term was not used in the context of education until 2016, the fusion of education and digital technology has been given significant scholarly attention. One such example is the Microsoft Innovative School program and its emphasis on the strategic management training of school principals promoting the digital transformation of schools.

In Hungary the term was popularised by the world of media and media technology as it started to gain widespread use after the recent conversion to digital broadcasting. The expression, “digital transformation,” is closer to the international trends.²

However, the phenomenon is described in a different sense focusing on digitalization or the preservation of cultural heritage.³ The concept of digital transformation in an educational context appeared first in a project titled “Digital transformation in education: TÁMOP-4.2.2.D-15/1/KONV-2015-0027 Eszterházy Károly College” resulting in numerous scholarly publications, school experiments and research and development programs.

The term can be used in two senses from an educational point of view. Digital transformation implies the application of digital technology in all areas and aspects of human society. The other interpretation is found in a research report published by the Educational Testing Service (ETS) in 2002. The document titled Digital Transformation: A Framework for ICT Literacy: A Report of International ICT Literacy Panel introduces and discusses the framework for ICT literacy. Consequently, the concept and its connection with cognitive skills is defined, along with the outlining of the role of the ICT framework and introduction of the digital divide. Furthermore, recommendations are made in the field of ICT literacy with special attention to diagnostic measuring and evaluation. It must be noted however, that in this case the digital transformation is only on the level of slogans, or buzzwords, as it appears only in the title and is not included in the text.

¹ The other term is the “digital switchover” describing the technological conversion of mass communication

² An EU project titled Digital Transformation primarily focuses on higher education and within the framework of the ERASMUS+ program promotes the respective changes, especially e-Learning via the inclusion of partners from France, Italy, Spain, the United Kingdom, and Hungary.

³ The study was produced by István Moldován and was published in 2014 in the periodical Science and Technology, the title of the treatise: “The digitalization of Hungarian periodicals, the options of harmonization, and the digital transformation phenomenon.”

According to other interpretations the digital transformation represents the third stage in the propagation of digital technology applications requiring digital competence and the high level use of digital devices paving the way to information or digital literacy. Consequently, the new skills entail SEL competences (Social and Emotional Learning) and the digital transformation gives rise to unprecedented innovation and creativity in a given area (*Lankshear és Knobel, 2008, p. 173.*). Moreover, as the 2015 research by Gartner suggests the digital revolution phase starting in 1980 is considered the most innovative.

Another interpretation, according to which the concept of digital transformation refers to the elimination of paper as a type of documentation is also gaining popularity. Consequently, the rising popularity of cloud-based computation can be described by the concept of digitalization⁴. This is primarily due to the increasing integration of digital technology in all aspects of society including business, government, mass communication, medicine, arts, other scholarly disciplines, especially education.

The scheduled process-oriented implementation of the digital transformation concept is justified by a frequently observable phenomenon, namely the uncertainty, or destabilizing impact of the educational application of technology. (*Koltay, 2010, p. 306.*) In order to increase the efficiency of the process and “[...] to surpass curricular constructs and pedagogical traditions restricting our perspective of the features of learning in digital environments strong professional support and highly sensitive development efforts are needed” (*Merchant qtd. in Koltay, 2010. p. 306.*)

Thus my research requires the definition of the concept of digital transformation in an educational context as well.

Consequently, digital transformation is defined as a process which can realize the potential of information literacy by the application of the apparatus of human performance support technology via the propagation and integration of the technological achievements (ICT) of the information-based society. Thus certain skills, competences, and devices and their digital environments (applications, Internet) promoting confident, critical, and problem-centred application in the learning-teaching process via the elaboration of non content-specific and relevant learning environments are given a special role.

The research objective and the research problem

In my research I explore the national development plans of three member states of the European Union: Estonia, Finland, and Hungary with special attention to the following components: the conceptual framework and the educational role of ICT in the info-communication strategy, the structure and alternatives of technological competences specified in the national curricula of the given countries with special attention to the components of ICT literacy and the embeddedness of 21st century expectations.

The research primarily focuses on electronic learning environments (henceforth: ELE, *Komenczi 2009*) gaining a greater role as a result of the digital transformation taking place in the education process. The scope of inquiry includes the. conceptual framework, components, the process of elaboration, condition criteria, and the respective human resource-related requirements. Furthermore, I explore how the ICT developmental strategy of a given country treats the issue of digital transformation in specific areas especially in education, and which key competence criteria are considered crucial along with the similarities and differences of the given countries.

The content analysis based on the comparison of the digital strategy and national curricula of Estonia, Finland, and Hungary is directed at the respective strategic, infrastructural and human resource requirements. Moreover, I analyse relevant data published in country reports prepared by the EU, the UNESCO, and OECD. I consider especially important to examine the competences expected in the 21st century and the perspectives and components of information and ICT literacy in the K-12 curricula of the given countries.

While the European Union had announced a *digital paradigm change* in 2010, this has not fully penetrated the educational system from a structural aspect and at a systemic level since “[...]

⁴ Estonia has achieved this level of digital transformation as it is considered a digital state in which virtually all aspects of life are conducted on a digital platform.

such innovations are usually realised via top-down initiatives. Thus the methodological development lags behind the improvement of educational equipment.” (Molnár, 2011)

Regarding the connection between technology and learning the issue of integration and the respective methodology is crucial: *“One priority related to the process-oriented integration of technology into the instruction and learning process is that technology should not determine the direction of the respective changes, and should function as the catalyst of the particular modifications. One of the biggest pitfalls of the educational use of technology is the very prioritisation of technology over the integration of the given device into the educational process. While infrastructure alone cannot solve the problem of education it can promote the necessary methodological changes increasing the efficiency of teaching and learning.” (Molnár, 2011 qtd. in Tóth, Molnár and Csapó, 2011).* Thus a series of measures aimed at handling the given problem is necessary. We are convinced that the methodology of digital transformation can be helpful in this regard.

The development and integration of information and communication technologies into education started in the 1980s as technological firms and businesses began to increase their market share in education. The ownership of mobile communication devices increased in the first decade of the 21st century due to the growing buying power of a wider segment of the population coupled with a higher level of investment in infrastructure enabling the education sphere to respond to the new demands.

Developmental and improvement efforts of the past years⁵ reveal that education-related innovations are substantially impacted by technological achievements in the business sphere. as firms tend to treat education as a test-laboratory. According to the Gartner, an American informatics and mass communication market research company 26,6 billion USD was spent worldwide for the improvement of educational technologies, while in 2015 the technology-related investments amounted to 67,8 billion USD (Gartner, 2015). Such huge investments cannot be carried out without a systematic and comprehensive national development strategy covering all areas of the country along with an info-communication plan.

After exploring the national developmental strategy of Estonia, Hungary, the Czech Republic, and Poland in 2013 Török concluded that due to the developmental strategies of the European Union and the current Europe 2020 developmental strategy ICT has been integrated into national development plans *“[...] promoting the improvement of employment rates and infrastructure development as well.” (Török, 2013. p. 29.)*

He also points out that the connection between the ICT sector and instruction has weakened and presently the preservation of the status quo, or the maintenance of the existing infrastructure is the dominant trend. The use of ICT in schools is mostly labour market oriented promoting entry and the improvement of employment figures. It has been proven that the top-down approach is not sufficient by itself as the implementation of electronic learning environments requires comprehensive reforms of the pedagogical sphere.⁶ The developmental plans emphasize another perspective of digital transformation, that is digitalization and archiving as crucial components of the digital ecosystem and the learning support environment. Török (2013) mentions that the *“[...] national developmental policies and the policies aimed at propagating ICT played an important role in the popularisation of technology.” (Bryderup et al, 2009 qtd. in Török, 2013. p.30.)* The education-related ICT strategies of the respective countries reflect the national goals of integrating ICT in education in light of the lifelong learning perspective (Scheuermann et al, 2009 qtd. in Török, 2013. p. 30). The realization of these goals required an adaptive attitude from education prioritising human resource development (instructor and learner) and methodological solutions on a strategic level.

What factors justify such a priority assigned to a trend almost treated as self-evident nowadays? I will introduce two phenomena supporting the scholarly inquiry into the analysis of developmental or info-communicational strategies. One one hand, the Europe 2020 strategy (European Commission 2015) highlights the necessity of innovative instruction and encourages eliminating the developmental differences in these fields. (Hunya, 2014. p. 1.)

⁵ I.e. the Samsung Smart School, Microsoft Essential, Intel-projects.

⁶ Among others the Horizon Report underscores the strategic significance of the training and preparation of teachers for meeting the requirements of new learning environments.

While several research programs (i.e. *Brecko*, *Kampylis* and *Punie*, 2014) introduced an increasing number of smaller scope yet innovative projects focusing on the educational integration of info-communication devices, the respective influence cannot be felt on the long run in a comprehensive and holistic manner. Even the European Commission admits that the impact of innovative methods cannot exceed the given field of relevance. The situation is even made worse by the fact that the more innovative is a given approach, the slower it gains popularity. (*Hunya*, 2014). Thus the sustainability of pilot projects and the respective project results is threatened and neither efficiency nor productivity can be explored without long term financing.

Several studies (*Lengyelne*, 2014) analyse and summarise the problems and issues the ICT sector is anticipated to face in the future. One of the most serious problems is the shortage of labor expected to reach 900,000 by 2020 along with the continuous decline of graduates, as since 2006 the number of those completing ICT programs decreased by 9,5% (*Lengyelne*, 2014).

The other challenges involve the present K-12 student generation studying in the formal education system. Recently different media (*MTI*, *444.hu*, *Koloknet 2015*) called attention to the connection between computer use at school (or at home) and student performance. The OECD has examined the knowledge level of students internationally since the end of the 1990s and the PISA 2009 and 2012 surveys explored the impact of educational technology on learning. Previous surveys confirmed that regular use of school-based computers and student academic performance in such areas as reading comprehension shows no positive interaction.

The results of the survey showed that information and communication technology related investment had no direct influence on student performance and competence tests, or in other words there was no discernable linear correlation between the time one spent on the computer and his or her digital reading comprehension. It was also revealed that mostly those students are successful who spend a limited time on computers at home⁷. All in all, home computer use has a positive impact on digital reading comprehension, while in case of school computers a negative trend⁸ can be seen.

How and in what form can recommendations issued by transnational organisations influence national info-communication strategies? My dissertation introduces cases studies from the European Union and OECD along with examining a positive example of Estonia successfully addressing the abovementioned obstacles. Furthermore, we cannot overlook the situation in Hungary, especially the National Info-communication Strategy 2014-2020 along with the current problems having a major impact on digital transformation and the determination of the role of ICT in education.

The main questions of the research effort

During qualitative research we are not working with pre-formed hypotheses as we utilise research questions. Research questions are open-ended inquiries starting with the following interrogative terms: "why, what kind, how, and how do you interpret it?" I have structured the research questions of the content analysis effort in thematic groups while naming the respective analysis unit. (Table 1)

⁷The PISA survey focuses on the reading comprehension, mathematics, and natural science knowledge of the 15 year old student population. Hungary has not achieved good results either 2 or 5 years ago. According to the PISA 2012 survey Hungary seriously lags behind not only in the abovementioned three areas, but in creative problem solving too. The gap between the well performing and poorly performing nations increased as the weak ones were weakened further. The surveys utilise the Robinsion effect facilitating the exploration of complex and creative problem solving modeled on real situations.

⁸The current situation in Hungary reinforces this trend as a large segment of the 15 year old age group has not yet developed digital literacy. At the same time researchers have confirmed a positive correlation between homework assignments requiring internet-based information search and digital reading comprehension.

Table 1
Thematic units of research questions and the system of the analysis units.

Identification.	Research questions	Analytical unit
General situation		
Q _{1 Q}	<i>What is the general objective of the strategies?</i>	info-communication strategy
Q ₂	<i>Which areas are considered important in the three countries under inquiry? Which areas are given priority? Which pillars can be identified?</i>	info-communication strategy
Q ₃	<i>What differences and similarities can be discerned in case of the prioritised areas?</i>	info-communication strategy
Q _{4A}	<i>What is the current level of digital transformation in the given country regarding infrastructure, the elimination of social divide and the promotion of education?</i>	info-communication strategy
Q _{4B}	<i>What are the latest developments in the public sphere and in education regarding digital transformation?</i>	info-communication strategy
The info-communication strategy and the resources of the educational context		
Q ₅	<i>What is the current role of ICT? What kind of objectives are connected with it?</i>	info-communication strategy
Q ₆	<i>Which are the components of the digital ecosystem? Are this expression and the respective components included in the text?</i>	info-communication strategy
Q ₇	<i>What is the definition and the main components of the concept of digital transformation?</i>	info-communication strategy
Q ₈	<i>In what form do support systems appear during digital transformation?</i>	info-communication strategy
Q ₁₃	<i>In what form does the conceptual framework of information and communication technology (ICT) appear in the curricula?</i>	national core curricula
Q ₁₄	<i>What is the definition of the term: learning environment?</i>	national core curricula
The role and required competences of human resources		
Q ₉	<i>What are the expectations regarding human resources?</i>	info-communication strategy
Q ₁₀	<i>How can the specific objectives and expectations be reconciled with the competence system of digital citizenship ?</i>	info-communication strategy
Q ₁₁	<i>What expectations do educators have to meet?</i>	info-communication strategy
Q ₁₂	<i>In what form do lifelong learning (LLL) concerns appear?</i>	info-communication strategy
Q ₁₅	<i>Which are the key competences scheduled to be developed?</i>	national core curricula
Q ₁₆	<i>How can the key competences expressed in the respective curricula be reconciled with the competence model of digital citizenship?</i>	national core curricula

The main aspects and methodology of the research program.

My research program focuses on the digital transformation of the educational context⁹, in other words the methodological background of the elaboration of electronic learning environments with added focus on the factors promoting implementation and the options and conditions of the formation of personal learning environments.

My research utilizes the methodology of comparative pedagogy since *“the emergence of information and communication technologies and the convergence of distance and traditional learning new methods, devices, and educational materials appeared whose impact should be thoroughly explored. Consequently, the scholarly examination of new learning environments is expected to be a principal field of comparative pedagogy”* (Altbach, 1997 qtd. in Kárpáti, 2002. p. 22.)

A mere comparison of the results of country studies themselves, however, cannot be considered comparative pedagogy. The requirements for such inquiry include *“[...] the exploration of mutually defined problems according to a unified research philosophy from the very outset of the given effort.”* (Kárpáti, 2002. p. 12.). Therefore, the respective comparisons are not based primarily on the results of international surveys, but on the content analysis of the given info-communication strategy and the national core curricula. The research carried out in the present context is a multilevel inquiry working with a number of variables leading to the establishment of a unified and complex criteria system (indicator system) facilitating coherent and objective comparison.¹⁰ In addition to introducing the latest international research results I aim at comparing the analysed documents with the situation in Hungary as well.

Regarding the methodology of comparative pedagogy and qualitative examinations content analysis appears to be the ideal method of inquiry. Comparative pedagogy is a discipline of pedagogy exploring educational phenomena and factors in context of the given educational environment, via comparing differences and similarities in two or more regions, countries, or continents in order to understand the unique aspect of the given phenomena of the specific educational system, along with identifying the general features facilitating the improvement of the education process.¹¹ (Fehér, 2007; Kozma, 2009).

From the wide methodological arsenal of comparative pedagogy I rely on the ideographic and evolutionary perspective implying the identification and description of unique attributes and the outlining of the direction of development along with the analysis of modernizing efforts respectively. The long-term objective of research can include the melioristic function aiming to find the best model via the comparison of the various educational problem solving models. Due to the complexity of digital transformation I will explore the given issue during a later phase of my research program. Following the guidelines of comparative pedagogy I use the systematic approach focusing on the specific problems and phenomena of the given systems.

As far as the qualitative methodology is concerned I employ non-reactive, non-interventional, or non-consequential methods¹² (Sántha, 2009) implying indirect observation and interpretation of the

⁹ The educational context includes the conditions, the given process, and methodology of the instruction effort (Kárpáti, 2002. p. 15.)

¹⁰ In the past decades several criteria systems facilitating comparative efforts have been developed. In the present case the following are explored or adapted: The Indicators of the Education System developed by UNESCO were summarised in such publications as Education at a Glance and Educational Policy Analysis, moreover, the European Union DigCompOrg evaluation framework system should be mentioned.

¹¹ The discipline emerging in the 1960s explores the dynamics and legitimacy of the development criteria related to educational systems and pedagogy of the given countries. The exploration focuses on the political, economic, and social correlations as well. (Illésné, 1980 qtd. in Benedek, 1985) As of the 1970s scholarly interest was assigned to the examination of the internal dynamics of school systems, the content of the instructional-educational effort, the issue of the unification and differentiated nature of instruction, extracurricular educational and research into youth issues along with the general comparatory approach (Benedek, 1985).

¹² *“The qualitative approach focuses on the surroundings of humans and the exploration of social reality. It bases its conclusions on the descriptive and exploratory inquiry pertaining to a limited amount of samples. It is an intensive research strategy deploying a variety of qualitative technologies and interviews via a*

situations and documents (Bortz and Döhring, 2003 qtd. in Sántha, 2009. p. 68.).¹³ In case of the present effort I use a qualitative content analysis method of the given texts.

My research strategy is two sided, inductive and deductive at the same time. It is deductive, or analytical as it helps to reach useful pedagogical conclusions and results via the analysis of available general principles, guidelines, international experiences and other scholarly achievements. Yet it is inductive as well since it involves the disclosure of correlations as at first I collect, and register then analyse the data obtained by domestic and international surveys.

The theoretical background of the research program and its implementation reflect the previously described scientifically justified methodological principles.

Sample identification and sample taking strategy

I choose the typical intensive strategy from the multitude of qualitative sample selection strategies (Helfferich, 2005 qtd. in Sántha, 2006. p. 88.), due to its suitability for the multidimensional consideration of the sample taking process. (Mason, 2005 qtd. in Sántha, 2006. p.55.) Consequently, I emphasize the period between 2000 (the time of the emergence of smart devices) until the present and in a spatial, geographic context I base my conclusions on results pertaining to the European Union and its member states. As for the organisational, administrative, and social scope I focus on public education, the total social background, and more specifically the K-12 age group and the two essential components of the learning environment, the teacher and the learner

The analytical units consist of the national curricula of the three countries along with the information communication strategies developed according to the recommendations of the European Digital Schedule (2014-2020). The temporal span of strategies starts either in 2011, or encompasses the 2014-2020 period, while the relevance and validity of national core curricula are measured in decades. In order to guarantee adequate international sampling country selection was governed by the following criteria shown in Table 2.

Table 2, Country selection criteria

Type of document	Title of document	Organisation	Time interval
Country report	Korte, W. B., Gareis, K. and Hüsing T. (2014). e -Skills for Jobs in Europe Measuring Progress and Moving Ahead. European Comission ¹⁴	European Commission	2014
	OECD Educational at Glance (2015)	OECD	2015
	Educational Policy Outlook (2013)	OECD	2013
Evaluation based on special indicators	DESI 2015 (Digital Economy and Society Index) results	European Union Digitally United Market	2015

The availability of the ICT strategy of the given EU member state in English or its accessibility on the worldwide web or in any other electronic or digital form was an important priority. According to the abovementioned criteria the following countries became the subject of the analysis.

multifaceted, detailed examination of a small size of samples. ” (Szabolcs, 2001; Szokolszky, 2004 qtd. in Sántha, 2009. p. 29..)

¹³ The content analysis of texts can be performed from a quantitative and a qualitative aspect. In case of the former the frequency of the given research categories is established, while the latter implies interpretation, construction, focusing on the thoughts, messages conveyed by the respective research subject. (Sántha, 2009. p. 74.)

¹⁴ A country report sponsored by the European commission with a partial focus on ICT innovation capability and professional policy making intensity in the EU member states.

Table 3 Evaluation based upon country reports sponsored by the European Commission on the ICT innovation capability and professional policy making activism broken down into 4 clusters (Source: Korte, Gareis and Hüsing, 2014, p. 12.)

I. Low ICT innovation capability + Low professional policy activism	II. High ICT innovation capability + low professional policy activism
Romania, Greece, Slovakia, Czech Republic, Slovenia, Portugal, Spain, Cyprus, Lithuania, Bulgaria, Italy, <i>Hungary</i> , Latvia	Luxemburg, <i>Finland</i>
III. Low ICT innovation capability + high professional policy activism	IV. High ICT innovation capability + high professional policy activism
Poland	United Kingdom, Ireland, Sweden, Netherlands, Denmark, Germany, Belgium, France, Malta, Austria, <i>Estonia</i>

The reason I chose Estonia, Finland, and Hungary was the availability of the respective documents in English. Moreover, the chosen three countries display a significant dispersal regarding the other indicators thereby promoting the realization of the diagnostic function of comparative pedagogy.

The main features of the qualitative data and the observation units

The qualitative data corpus of the analysis is formed by the national strategies of Estonia, Finland, and Hungary along with the national core curricula of the respective countries. whose raw data form the observation units of the comparative content analysis. The data corpus including six documents allows a gradual or step-based analysis as core curricula and strategies compose a separate unit facilitating the production of analytical patterns and theory formation (Szokolszky, 2014). Special care was taken to assure that documents with similar content and aggregate character number were analysed. However, the latter requirement was not always met.

The description of the research apparatus

The research effort utilizes the MaxQda content analysis software, a program developed in knowledge based programming language. (Mayring, 2002 and 2003 qtd in Sántha, 2007).

The MaxQda¹⁵ is the product of the German Verbi firm and it facilitates computer-supported analysis of qualitative and mixed methods data in addition to that of texts and multimedia.

While the MaxQda 12, a version I personally favour, facilitates qualitative, quantitative and mixed methods research, qualitative data analysis methods have gained priority due their capability to analyse pictures along with texts. Moreover, they are suitable for the examination of previously recorded texts and data corpus created during the entry process. Said software not only facilitates the coding of documents, charts, tables, sounds, videos, images, twitter entries, and survey data, but promotes the grouped or collective storing of data in a form of a project file with an *.mx12 extension.

In case of audio and video files the program provides an option of rewriting and viewing with the in-built media play feature, while the texts can be saved in excel, html, and xml formats.

Furthermore, the software facilitates inductive and deductive coding along with supporting open coding based on sound theoretical support. The given codes can be made more illustrative with memos, notes, and colours, and even emoticons can be used as well. The program facilitates group work as well, since persons can be allocated to the given codes, a feature helping the quantification of reliability. There is an option of writing remarks or memos to the textual parts and the codes, which can be later exported and presented as parts of the given graphs.

¹⁵ The detailed introduction of the software is found in *Qualitative Analysis of Multi-coded Data* by Kálmán Sántha. (2013) Eötvös József Könyvkiadó, Budapest.

The coded text units and segments can be exported in an editable format according to codes and subcodes, which facilitates subsequent research via the resulting quote collection and contributes to the refinement of the given code system.

The program facilitates the comparison of graphs via several visual solutions and codes as the distribution of the latter is depicted in spectacular drawings.

The number of the codes and the coded units facilitate the generation of a code frequency chart and frequency matrices exportable in Excel and SPSS format. Moreover, the software provides an option for the analysis of statistical data.

It must be noted however, that the program has a certain level of difficulty with static data, such as PDF, because the given paragraph units considered the basic components of the latter cannot be handled in such a format. Consequently, the pages will become the basic units, which will prevent the operation of several visual functions. The program has an English language control surface.

Summary of the content analysis

I explored the info-communication strategy and national core curricula of three countries, Estonia, Finland, and Hungary along the line of 16 research questions arranged into three thematic categories. The summary is divided into two sections, one is concerning the respective professional materials, to be complemented with correlations¹⁶ revealed via the comparative examination of the strategic documents of EU member states, the other part introduces the experiences, options and limits of the respective software in light of the conclusion of the content analysis.

The summary of the research results concerning the methodological foundation for digital transformation takes the current situation, the information and communication strategy, the resources of the educational context, and the role and competences of human resources into consideration.

The examination of the **general background** focused on the information and communication strategies. Accordingly I aimed at identifying the general objectives of the three countries' strategic perspective in the period lasting until 2020. Special attention was paid to the respective priorities, the similarities and differences in the various pillars. Furthermore, I wished to evaluate the progress achieved in digital transformation along with the respective developments in the general, the public and the education sphere.

The inquiry revealed that the Hungarian and Estonian info-communication strategy is more comprehensive and contained detailed descriptions of the specific measures to be taken in the 2014-2020 period. The Finnish strategy for 2011-2020, however, had a broader, survey-oriented perspective both in the aspect of planning and implementation and lacked statistical data.

The structure of the Estonian and Hungarian plans was similar as both contained a general background analysis, the introduction of overall objectives substantiated with indicators prior to the detailed description of the respective thematic areas. Country performance was frequently compared with the EU average along with identifying the relevant objectives and action plans. The examination of Hungarian strategies contained a SWOT analysis performed in each thematic area in addition to the assessment of the consistence and coherence of a given strategy according to the domestic and international (primarily EU) indicators.

As for the objectives and the identified priorities the improvement of digital competence is crucial as it can substantially impact other areas as well. Two goals can be discerned, the elimination of the digital divide between those literate and less proficient in the given field, and at a higher stage of development, the avoidance of the second level of the digital divide via improving the competitive edge of the given country along with promoting employability and alleviating the labour shortage in the information technology sphere resulting in added values and innovations. Essentially this is the area which can have an overall impact on all the other as with the exception of infrastructure it determines the level of efficiency. It must also be noted that both Finland and Estonia assign priority to ICT related national image and the preservation of its high international reputation.

¹⁶ The comparative examination refers to the 2012 study sponsored by the European Commission, with special attention paid to the changes in Finland due to the 2014 reform of the national core curriculum. My research, however utilizes the previous documents (*European Commission/EACEA/Eurydice*, 2012).

Finland proved to be exceptionally successful in the area of digital transformation similarly to the level of success achieved by Estonia regarding digital infrastructure. Estonia's digital state facilitating accessibility to most aspects of public administration and governmental functions via digital platform displayed the greatest level of improvement, while in the category of the digital economy Finland performed in an outstanding manner. It must also be noted that in the field of ICT innovations Estonia was ranked high and Hungary showed good results regarding start-up initiatives. Yet, we are lagging behind both countries concerning the digitalization of the business sphere. Digital competence places a special priority on education, the elimination of social divide in the context of attitude formation, the provision of accessibility, and life long learning efforts. Furthermore, general accessibility to educational materials and the cultural heritage are equally important strategic considerations.

The section titled **The resources behind the information and communication strategy and the educational context** highlight the role and function of ICT, the forms of digital ecosystem facilitated by digital transformation and the support systems provided by the education sphere. I also explored the respective curricula according to the level and sites of ICT penetration with special attention to the definition of the learning environment.

It can be concluded that ICT has a central role in all countries and strategic areas either as a supportive environment or device in such fields as employability, competitiveness, competence development, and equal opportunities. Furthermore, the components of the digital ecosystem are implied in separate objectives addressing the area of infrastructure and human resources.

While in all three countries the support systems are digitalized, the educational support role of public archives and collections is less important, as it mostly applies to the digitalization of the given cultural heritages.

The info-communication strategy and the curricula specify the digital support of learning while the recommendations include the reconsideration and reform of info-communication instruction along with increasing the rate of employment in the ICT sphere.

ICT is prioritised not from a device-oriented or technological perspective, but as a methodology of application facilitating sustainability via a crucial paradigm shift. Hungarian curricula do not contain a definition of the concept of the learning environment, while the virtual dimensions of the learning environment are highlighted to a lesser and greater extent in Estonia and Finland respectively. One of the reasons is the recent curricular reform in Finland assigning a special role to modern technology and the relevant competences.

The third thematic unit focuses on the role of human resources and the attendant competences regarding digital transformation. Consequently, I explored the strategic expectations and requirements regarding students and educators along with the correlation of the competence criteria of digital citizenship and the form and extent of life long learning.

A 2012 research project titled: "The improvement of key competences in European schools: challenges and options for professional policy making," (*European Commission/EACEA/Eurydice*, 2012) proved the prevalence of digital competence compared to other key competences. Digital competence, unlike other competences appears in all national developmental strategy perspectives to be applied in such areas as e-government, infrastructure, broadband connections, ICT security, the improvement of e-skills and ICT in schools. The comparative analysis also revealed that the integration of ICT in education is coupled with the existence of a general informatics (info-communication) strategy as well.

Another important concern is the integration of transversal skills into education and the incorporation of the expected ICT, entrepreneurial, and citizenship competences into the learning and instruction process. The third point of intervention is increasing student recruitment in the field of natural science including mathematics and technology as a way of improving competitiveness and innovation.

My research confirms the presence of the abovementioned human resource requirements and the greater role of transversal skills and competences. In Finland the latter term is used, while in Estonia the expression "interdisciplinary, or cross-curricular" gained acceptance.

Continuous development focusing on digital competence is crucial for educators as well, while continuous lifelong learning integrating digital competence development objectives has a strategic significance for all people.

The application of theories and complex models to the content analysis of strategies and curricula reveals the following conclusions.

Technological determinism appears to have the greatest impact on the Estonian strategy reflecting the concept of the network-based government and economy and the related developments. In Finland the strategic objectives assign a special role to technology, but the hardware-related developments are coupled with calls for the improvement of general ICT competences. While Hungarian strategies also emphasize the importance of the technologically defined economy and public services, several indicators (DESI empirica research, innovation capability and professional policy making activism) reveal a significant lag behind the other two countries.

In the next section I summarise the exploration of the educational aspects of the digital ecosystem, especially the 8 dimensions of a school providing a creative environment.¹⁷

As for the **content and curriculum dimension** the most important roles are given to the cross curricular or interdisciplinary contents and the open sources. The cultural paradigm shift emphasized by McLuhan, Bruner, and Z. Karvalics is a central component of the digital transformation addressing the issue of basic skills in Finland. The Finnish national curriculum follows an uptodate, modern perspective in dealing with the key competences or as they call it the transversal competences. At the same time in Estonia non-subject dependent competences appear in the form of cross curricular components. The comparative examination of the key competence systems of the three countries confirms the importance of meeting the new expectations.

Regarding the role and position of Informatics as a subject all three countries underline that digital competence cannot be developed by only one subject, as the teaching of information literacy should be integrated in all subjects on the level of educational devices, educational materials and methods. A similar attitude can be discerned in case of educational reform as it is considered a strategic component in Estonia and Hungary, and in Finland the first phase of this objective was realised by the implementation of the new national core curriculum in 2016.

As far as content is concerned all three strategies focus on the issue of digital heritage and the digitalization of the respective cultural heritage, moreover in Estonia a comprehensive attempt is made at the effective propagation of this approach. Digital accessibility of learning contents is a clearly defined objective for all three countries under inquiry, while both in Estonia and Hungary plans are made for the arrangement of reusable contents into a repository. In Finland network-supported learning and e-learning schemes are given priority as the respective improvement of ICT competence promotes active digital citizenship as well.

The **dimensions of learning and teaching** are closely connected to the above concerns. In Finland priority is assigned to soft skills and individual strengths in teaching practice, while the promotion of critical thinking and a variety of learning styles is applicable to all three curricula.¹⁸

Regarding the **practice of learning** category in Finland playful and cooperative learning methods are preferred. Such learning approaches are not only relevant in a formal educational environment. In all three cases self-directed, self-regulating learning, and creative, productive learning via ICT devices are applicable as well.

Furthermore, personalized learning and the elaboration of the necessary environment on a digital foundation is a shared priority among all three countries.

The **network dimension** pertains to learning events, social networks, and the maintenance of connection with the real world, While all strategies contain such components, the level of priority differs. In Finland the promotion of networks facilitates the assessment of citizen demands and the meeting of the respective needs via the development of applications, the maintenance of digitally accessible connections and equality of opportunity along with the building of a competitive and productive country. Due to the strong e-Learning background and the wide spread availability of on-line environments the learning events are the most prioritised among the three countries.

Estonians prioritise the network-based approach in order to support the digital state as the maintenance of connections and social media events serve that purpose. Estonians place a high priority on social media, and web-based communication as their Facebook page and web site are available in

¹⁷ The examination focuses on education, but in some cases due to the larger scope of info-communication strategies I take a broader look.

¹⁸ This was not a prioritised research objective, and was not explored directly.

two languages, in Estonian and English. While the role of learning events is smaller and the term “virtual environment” is used in various texts, the principal goal is the improvement of ICT competences facilitating access to and more sophisticated use of digital public services.

Although the Hungarian info-communication strategy and national core curriculum places a lesser emphasis on network orientedness, the supporting knowledge bases as learning areas and events can be considered rather significant. A related goal is the provision of accessibility and the achievement of appropriate level ICT competence.

The physical and ICT-environment related components of the **infrastructure dimension**¹⁹ mostly appear in the Finnish and Estonian practice. In Finland the application of the latest information and devices is a basic expectation. Both countries’ documents confirm the importance of ICT infrastructure in learning environments in addition to the physical aspects of the latter. The national core curriculum of Hungary does not emphasize the question of ICT and does not define the concept of learning environment either. The info-communication strategies underline that ICT-related improvements in education, primarily the public education sphere are significant strategic goals. The definition of learning environment in Finland and Estonia includes the library, the enterprise context, and public archives as scenes of learning.

As for the types of instructional environment (*Ollé*, 2013) the virtual is applicable to Estonia and the on-line one is present in Finland, while in Hungary contact-based and network-supported versions, characteristics of the other two countries, are preferred.

The management and values, organising and organisation, and the evaluation dimension is optimally connected to the concept of human performance support technology as the achievement of a better performance is regulated by the currently available conditions in all three cases.

The **organising and organisation dimension** entails the innovative services, innovative class scheduling, and the monitoring of quality parameters. The most characteristic is the innovative approach not only relevant to the education sphere but to state-provided and digital public services as seen in Estonia. Learning plays a more defining role in Finland, and Hungary is primarily characterised by quality control manifested in the submission of portfolios and the educator career model.

The **dimension of evaluation** prioritises evaluation methods with a motivating capability including the formative or developmental evaluation and the acknowledgment of the results of informal or non-formal learning. As the respective learning environment definitions confirm the latter concern is considered crucial both in Estonia and Finland. The evaluation process is considered essential by all three countries as the re-consideration of evaluation methods is urged in Estonia and Finland, and as part of the educational reform, in Hungary as well.

The **management and values dimension** includes such concerns as social inclusion, fairness, entrepreneurial competence, and innovation management. In Finland all three factors are considered important as a significant amount of attention is paid to the aging of society and the integration of the elderly into the digital society. The promotion of entrepreneurial competence is a central component of national core curricula and innovation is manifested in the increasing role of competence centres and e-research efforts. Estonians emphasize innovation and entrepreneurial competence as social inclusion is not as prioritised. Hungarian policy makers promote the digital integration of social groups lagging behind and the formation of the respective attitudes. Furthermore, the high number of start-ups indicate the significant role of innovation.

If the issue of dealing with labor shortage in the ICT field, a concern shared by all three countries is listed in this category we can confirm that all participating countries pay a great attention to this question similarly to the promotion of the competitiveness on the labour market. The content analysis confirms that all three factors are integrated into the respective curricula as well.

¹⁹ The exploration of the frameworks of learning environments is crucial as I examine the core curricula of the three countries concerning the prevalence of the given perspective, the outlining of learning environments and the identification of the respective dimensions of the instructional environment.

The technological aspects of content analysis

During the MaxQdA software-assisted analysis I encountered several phenomena adding a further dimension to the work performed and facilitating subsequent research in similar topics.

The first challenge was the selection of the official documents of the two foreign countries. In order to eliminate language barriers I preferred the English language version. A great care was taken for acquiring the latest documents and assuring the equivalence of the respective time intervals. However, this goal could not have been fully realized as the info-communication strategy of Finland applies to the 2011-2020 interval. An even greater problem was that as a result of the 2014 curricular reform the national core curriculum was introduced in 2016. The given text, however, could not have been obtained free of charge on the Internet. The MaxQda software can handle texts, along with the static, non-editable PDF. (the software can handle picture formats as well, but that is not relevant in our case). The PDF, however has its limits, as its components cannot be edited, thus the MaxQda can only handle the textual units page by page unlike the paragraphs preferred by the word processing formats. (.doc, .docx, .rtf etc.), which prevents the deployment of some functions. One of these is the Document Portrait, a visual device facilitating the observation of the distribution of codes in a given segment, or in case of the full document a specific code or series of codes can be identified. The other similar feature, the Document Comparison Chart can only be used for paragraphs.

The other important issue is the lay out of the PDF documents. The Finnish strategy arranged in dual columns helped better navigation, but the highlighting and retrieval of segments and textual parts for coding was made harder.

Memo and note features and the option of the adjustment of alias codes helping to find the equivalent of one term in the other language provided significant help in dealing with the multilanguage data corpus.

Furthermore, while the use of colours facilitated code identification, this practice could not have been called colour coding since colours could only be assigned to a code and the respective subcodes.

Lexical search in some cases could prove very useful (however, not during open coding) facilitating the search for texts and text units in a given document.

It can be concluded that the software provided significant help. The respective visual elements, the collection of the codes and quotes including the appropriate textual segments are a great advancement providing the foundation for future research. This task could not have been performed in this form with the traditional cut and paste method.

Mapping further research

In this thesis I identified the phases of the digital transformation of a given country along with the ICT-defined competence areas required in the 21st century. The respective competences cannot be restricted to ICT alone as they have an overall importance. The digital transformation of education is a process whose perspective differs according to the current phase of progression.

I plan to continue the research program focusing both on the available data corpus and analysing newly collected data.

Surpassing the ideographic and evolutionary function of comparative pedagogy I would like to perform an analysis from a meloristic aspect striving for the optimal model of the various phases of digital transformation. The analysis will utilize the previously mentioned strategies and features of 21st century schools.

As far as the curricula are concerned I will provide a deeper analysis of the role and application areas of ICT in the given fields of culture and education with special attention to the methodology of the practical aspects of the learning and teaching process. While this area cannot be omitted from the methodological analysis, due to spatial and temporal restrictions it was not included in the present dissertation. I would like to explore the measurement and evaluation methods both on the institutional and individual level from the point of view of the student and the teacher. My findings would be integrated into an indicator system. The research would pertain to the concept of human performance support technology and its evaluation models, the evaluation methods used during strategic planning, the self-evaluation methods used domestically and internationally, along with

systems facilitating individual self-evaluation. Such inquiry can be performed via content analysis with deductive coding observing the indicators of a given evaluatory method.

The present research can be further developed by a chronological, retrospective examination of the given curricula with a special focus on the evolution of the learning environment concept in the respective different versions along with the modification of key competence perspectives in the past 20 years.

Furthermore, besides the national info-communication strategies I will include the national developmental strategies in my research. While this task was completed by *Török* in 2013, he did not use a content analysis software and no comparison was made with other countries either.

I plan to extend the research focus to Poland²⁰ where low ICT innovation capability is coupled with high educational policy making intensity. I also intend to include countries allocated to other clusters due to their DESI Index. This would be especially important because it would also mean examination of the effectiveness of the implementation of a code system based on the principles of comparative pedagogy and scientifically justified open coding efforts. Such program could lead to the development of a criteria system pattern.

In order to assure the reliability of the results I recommend the use of research groups facilitating the calculation of the Cohen-kappa indicator, the generally agreed upon indicator in case of qualitative research programs.

The significance and limits of the dissertation

Although I planned to conclude the dissertation with outlining a future perspective, the actually unearthed research materials and the work-shop based discussions motivated me to continue the work. The completion of this treatise is a significant step in my career and I intend to widen my scope of research. Currently, I can view the given problems from an elevated vantage point in a more comprehensive manner. In this conclusion I make an attempt to outline the problems impacting the meta level and to express the respective dilemmas and pose new questions. This is my long term objective, but I haven't elaborated the know-how for its realization. While such aspirations cannot be fulfilled with the present thesis I hope further research will help in finding the answers for the respective questions.

My principal research objective was to analyse the educational context of digital transformation and (1) identifying the respective phases, (2) the specific indicators, and (3) the assessment of their relation to other social actors, (4) evaluation of their interaction, (5) assessment of the respective expectations toward human resources, and societal actors and (6) toward the total pedagogical profession.

The inquiry provides a cross-sectional scholarly look at the respective phases in the digital transformation process in the educational sphere. Yet it takes into consideration that the dynamic system will have many actors and many levels. (*Halász, 2014*). The conclusions of my analysis have a temporary validity since the given process is taking place currently, and due to the dynamism and complexity of the system its outcome is still not definite. The changes are permanent and fast, and cannot be predictable at the present stage. Consequently, I believe that my work is only an introductory phase of the process analysis aiming to integrate the issue into pedagogical science, and to compose the basic questions and search for the respective answers.

Consequently, I could not reach the meta level whose lack was pointed out in the preliminary opposing review of *László Z. Karvalics*. At the same time the given opinion helped me to reach a higher context of analysis. The discussion and exploration at the meta level is necessary and rightfully expected for many reasons. In the Introduction (vid. *Halász 2014*) I made an attempt by establishing a correlation between the multiple factors of the education system and the process of the digital transformation. The exploration of the meta level cannot be condensed into a few sentences as it should function as a certain umbrella, frame or guiding principle leading towards the deeper layers. Thus such an analysis requires a different analytical logic surpassing the limits of the present

²⁰ The realization of this objective requires international cooperation, as the Polish strategy is presently inaccessible in English, but in case the coding is done in that language, then a research group can carry out this task, The mutual equivalence of codes can be assisted by an alias code table.

dissertation while outlining the next developmental stage of the given inquiry. In order to analyze the digital transformation from a meta level we have to understand and restructure our current perspectives concerning the evolutionary phases and periods of digital culture.

The terminology currently used in various strategies and curricula along with the discipline of pedagogy as a whole has a conserving or preserving effect. This is supported by the strong influential role of the business sector and its ability to govern all subsystems of society. “*The designing of technology and services should be based upon an action and intervention-centred image of society and children which has a logos, or a specified, normative, internally motivated perspective concerning the reason and direction of shaping the respective determinative relations.*” (Z. Karvalics, 2016. p.76.) If we followed this direction the changes would be more effective while innovations would be correlated, not dispersed like islands. At the beginning of the dissertation I dealt with this issue by pointing out that good practices and educational innovations are also negatively impacted by this phenomenon characteristic of this state of digital transformation as they cannot realise their full potential and can achieve only smaller scope results (Hunya, 2014). Via a more thorough understanding of the related issues one can get a clearer image of the digitally initiated generation (Z. Karvalics, 2016) and their integration in all fields of the digital ecosystem.

I hope my work will provide further justification for the methodological examination of digital transformation in the education sphere along with understanding that the crucial component of digital transformation is not the device, but the persons involved. Thus the digital transformation can lead to fulfilling the demands of future generations treated “*not as a source of problems, but opportunities and resources.*” (Z. Karvalics, 2013. p. 76.)

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