ICT in education: facing a paradigm shift

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ABSTRACT. Major changes are characteristic to educational systems of different countries. Two issues are often noted with reference to them: ICT implementation and the change of educational paradigm, i.e. when the paradigm of teaching shifts into the paradigm of learning or the paradigm of teaching evolves into the paradigm of interaction which, in its turn, changes into the paradigm of learning. Researchers have noted that the depth of ICT implementation in education is related to the educational paradigm change. How and in which areas this interrelation is manifested in practice? What role in this change is played by ICT?

The above questions will be discussed in this presentation. Its aim is to analyse the potential of ICT in education in relation to the changing educational paradigm.

Introduction

This presentation consists of three parts. In the first part I will analyse the impact of ICT implementation in schools with reference to the educational paradigm change. I will present the results of theoretical and empirical research carried out together with my former doctoral student Vytautas Petkūnas. First of all, I will present the stages of ICT implementation in schools, highlight the evolution of the pedagogical system through the introduction of ICT in relation to the educational paradigm change. Then I will present the empirical results of the research which aimed to identify which stages of ICT implementation were characteristic to the schools and what educational paradigms in terms of their features were prevailing in these stages, also to reveal the influence of implementation stages on the paradigm change. I will present and discuss the data of questionnaire survey on 447 senior grade students and 413 teachers of Lithuanian schools.

In the second part I will present a dynamic model of teacher's competence developed together with my former doctoral student Vaino Brazdeikis. In the context of learning paradigm it is important

to provide conditions for a continuous development of teachers' competence, especially for teachers' self-directed learning. Of utmost importance is providing conditions for the accreditation of teachers' competence and, first of all, effective evaluation. But teachers need to be empowered for a successful presentation of their competence. Employing the method of competence portfolio is relevant at this point. What are potential strategies of evaluating teachers' ICT competence? What role is played by the e-portfolio? To respond to these questions, I will present empirical results obtained in the research on Lithuanian teachers.

In the third part I will analyse one more field of ICT application related to the educational paradigm development; this time I will refer to the university context. In the first section of this part I will raise the following question: is the university ready to effectively run a full distance learning programme in teacher education? What are the achievements and problems? I will present a case study of the distance learning programme in teacher education run by the Institute of Educational Studies at Kaunas University of Technology. In the second section of the third part I will raise the question: what is the relationship between a university teacher and researcher with ICT, a virtual library in particular? I will present the results of empirical research carries out with my former doctoral student Gintarė Tautkevičienė. The results may be compared to the results obtained in other countries, as the same research of a broader scope was carried out in the frame of a FP5 project. To sum up the results of all the above pieces of research, I will highlight the potential of ICT in education and its relation to the educational paradigm change.

Major changes are characteristic to the educational systems of different countries. Two issues are often noted with reference to them: ICT implementation and the change of educational paradigm, putting the emphasis on lifelong learning. There are attempts to switch from the paradigm of teaching ("people learn only when they are taught") into the paradigm of learning ("people learn everywhere and every time, not only when taught, but throughout all their life - from birth to death"). The researchers (Branson, 1990; Anderson, Van Weert, 2002; Brummelhuis, 2005) have noted that the depth of ICT implementation in education is related to the change in educational paradigm. How and in which areas is this

interrelation manifested in practice? What role in this change is played by the ICT?

These questions will be discussed in this presentation. Its aim is to analyse the potential of ICT in education in relation to the changing educational paradigm.

The context of my presentation is Lithuania that seeks to emphasise the lifelong learning and implement ICT while reforming its education system.

The basic conceptual position is that the shift in educational paradigm may occur not only as a revolutionary change from the paradigm of teaching to the paradigm of learning, but also as an evolutionary change, the essence of which is illustrated in Branson's chain of pedagogical system change (Branson, 1990). This change occurs from the paradigm of teaching to the paradigm of interaction (characterised by an interaction between the teacher and student, where student can choose active methods of teaching/learning while at the same time is obliged to learn according to the prescribed educational aim), and from the paradigm of interaction to the paradigm of learning where the self-directed learning prevails.

My presentation consists of three parts. In the first part, I will present the theory of ICT implementation and, on these premises, will overview the practice of ICT implementation at school. In the second part, I will present the model of teacher ICT competence and the related research carried out among the Lithuanian teachers. In the third part, I will discuss the implementation of ICT in the university studies. I will analyze the implementation of distance learning programme and the use of opportunities offered by contemporary library. Going deeper into the ICT implementation in Lithuanian education practice I will rely on the findings of the empirical research by three of my doctoral students (Vaino Brazdeikis, Vytautas Petkūnas and Gintarė Tautkevičienė).

ICT implementation in schools with reference to the educational paradigm change

The ICT implementation at school in the context of education progress is divided into four stages: *emerging, applying, infusing* and *transforming* (McCormick, Scrimshaw, 2001; Jucevičiene, 2002; Mioduser et al., 2002; Anderson, Van Weert, 2002; Petkūnas, 2007).

Emerging: schools are provided with computers and software necessary for work; teaching for computer literacy begins. The programmes of computer science include the education for students' computer literacy, the aims for teacher computer literacy are set. School principals and teachers start analyzing the possibilities of using ICT and the expected results of educational process.

Applying: the new understanding about the ICT support for learning is evident. The modern technologies are incorporated into the traditional pedagogical process and they make this process more diverse. Teachers start using ICT in their daily pedagogical activities. Computer based teaching aids are applied not only for teaching informatics, but also for other subjects.

Infusing: ICT is incorporated and integrated into the curriculum of all subjects taught. The application of simple technologies is replaced by the development and usage of web pages, Internet, Intranet and electronic networks; the distance education is applied, the interactive learning environments are developed, the competence of working with databases on Internet is fostered. School use the computer technologies in classes, laboratories and administration offices to a great extent. Teachers explore and experiment with new ways of working when ICT change their personal efficiency and professional practice. The boundaries between different subjects start vanishing in the curriculum and in that way the requirements of the real world are met.

Transforming: the fourth stage is achieved by the schools which use ICT for organization monitoring and for creative renewal. School organization and its culture experience deep changes: students and teachers join the learning partnership networks, schools become the centres of learning communities. The content of subject essentially or partly changes; the different disciplines are integrated into single course. ICT raise the personal efficiency of performance and become the integral and unseen part of the daily work.

The changes in the development of education system are related to the *educational paradigm* that dominates in the particular stage of educational process change. As mentioned above, the educational paradigm may be described as *teaching (traditional) paradigm;*

interaction paradigm; learning paradigm.

According to Branson (1990), also empirically proven by Petkūnas (2007), from the educational perspective ICT implementation has to be treated as related to the change of educational paradigm. The research by Petkūnas and myself (Jucevičiene, Petkūnas, 2006) led to a conclusion that, consequently, the ICT implementation stages in secondary education are related to the educational paradigm (Figure 1). This model discloses that the first stage (*emerging*) took place under the *teaching paradigm* the schools were following. In the second stage (*applying*) a computer expands the diversity of pedagogical practice, the importance of traditional teaching forms and methods is decreasing, and the educational process is influenced by the emerging *interaction paradigm*. In the third stage (*infusing*) where Internet, intranet and the databases are used with the educational purposes, the learning networks are developed, the distance education is applied, the conditions of learning to prevail are created and the *interaction paradigm* finally entrenches. The fourth stage (*transformation*) supplements the pedagogical system with the databases and expert systems which the students address directly without the assistance of a teacher. In this stage the conditions for developing learning communities, transforming subjects and curriculum, changing the school organization and its culture are created and related to *learning* paradigm.

We carried out empirical research to find what ICT implementation stage was achieved by schools in practice and what features of educational paradigm prevailed in these schools (Jucevičiene, Petkūnas, 2006). The questionnaire survey was carried out in 2007; 447 students of senior grade and 413 teachers selected in the 14 Lithuanian general education and vocational schools that carry out the secondary education programme participated in this research. The sample was representative on the scale of Lithuania. The findings have basically confirmed the above mentioned theoretical model (Figure 1). The empirical research has also revealed certain particularities of Lithuanian students and teachers as far as the use of ICT is concerned.
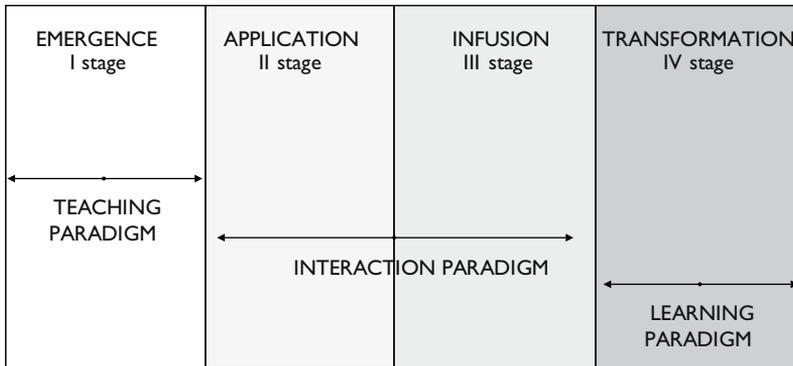
Figure 1.
The relationship of ICT implementation stages and educational paradigm (Petkūnas, 2007)

Most students confirmed that their usage of ICT for learning matches the second stage of ICT applying, and a bit more than a half of student respondents claimed they had reached the third and the fourth stages, while the first stage of emerging was favoured by less than one fifth of student respondents.

The students reject the importance of the teaching paradigm: only a small number of the respondents favoured it. Almost three quarters of the students evaluated most favourably the features of learning paradigm, and slightly smaller part of them stressed on the interaction paradigm. In this way they prove the obvious victory of learning paradigm prevailing in their minds.

The teachers' survey displayed a number of essential differences between their evaluations and the evaluations of their students. It was defined that teachers are behind their students in using the technologies in the educational process: almost half of teachers stated that they had reached the first stage of ICT application, a slightly bigger number of teachers had reached the second stage and the fourth stage of transforming was chosen by less than one fifth of respondents. The third stage of integration is reached by the number of teachers that makes 10 percent less than the students. While evaluating the educational paradigms, the teachers' bias was observed: almost three quarters of the teacher respondents favoured the features of learning and interaction paradigms proving their existence in the daily pedagogical practice. At the same time, however, more than a half of teachers indicated agreement with the statements of teaching paradigm that contradicts the above mentioned paradigms. Thus, a considerable part of the teachers still follow the traditional positions of the teaching paradigm, but declare

that they favour the learning paradigm. Because of this contradiction the data of teachers' survey could not be treated as reliable to use for the evaluation of relationship between ICT implementation and educational paradigm. The following problem was revealed: the students' progress in using ICT for learning exceeds the progress of the teachers in using ICT for teaching and this creates the tension between the students and the part of teachers who have lower level skill of ICT usage. This tension and the general tendencies of the change of education system towards the focus on learning create the situation when a part of the teachers strive to look modern and not behind with the rapid changes. They espouse the so called, new approach to education and a learner, but in reality they tend to maintain the usual pedagogical practice based on the teaching paradigm. This situation indicates the importance of support and assistance for a teacher as well as the development of their competence.

Teachers' ICT competence

There is still a lack of research regarding the teacher's ICT competence in different stages of ICT implementation (teacher's ICT competence is described as their knowledge, skills, attitudes, values and personal traits that determine the successful application of ICT in his pedagogical activity). The doctoral research of my former doctoral student Vainas Brazdeikis is particularly important in this respect (Brazdeikis, 2007a). As a result of this research, the dynamic model of teacher ICT competence in various stages of ICT implementation has been created (Figure 2) (Jucevičiene, Brazdeikis, 2006). Based on this model, four different strategies for identifying the teacher ICT competence have been prepared and tested. This empirical research enabled to identify the ICT competences of Lithuanian teachers.

Having analysed the works by different scholars (Coughlin, Lemke, 1999; Markauskaitė, 1999; Urbonaitė, 2000; Andresen, Van den Brink, 2002; Resta, Semenov, 2002; Knierzinger et al., 2002; Gjør, 2004; Šiaučiukėnienė et al., 2006) and different organizations (ISTE 2000; OECD, 2001; ETS, 2002; European Schoolnet, 2005) about the fragmentation of teacher' ICT competencies, it is observed that some of them relate these competencies to pedagogical work as a profession, while others highlight the transferable skills. Two

separate parts of teacher's ICT competence have been identified: ICT competencies related to the basic competence (ICT literacy) that is characteristic to all professions; and ICT competencies related to the specific activity of teacher (ICT as an integral part of educational competence). Both parts may be described by these characteristics:

ICT basic competence (ICT literacy)

1. Ability to use ICT and manage them by ICT (further - technological literacy).
2. Information skills and their application (further - information literacy).
3. Knowledge on the social, ethical, legal norms and ability to follow them in using ICT in fostering the skills (further - social literacy).

ICT integral educational competence

1. Ability to apply ICT in education and to develop students' computer literacy (further - pedagogical competence).
2. Ability to plan, manage and analyse ICT application processes (further - managerial competence).

The logic of teacher's ICT competence dynamic structure is based on the matrix idea. The parts and characteristics of teacher's ICT competence are displayed on the vertical axis of the matrix, while the horizontal axis contains the ICT implementation stages that correlate with the levels of educator's ICT competence. Depending on the level, the different requirements are attributed to the parts and characteristics of the teacher's ICT competence. Particular competence level is necessary for a teacher who is at the start of teaching the computer literacy, and different competence level is required when the virtual networks are applied in education and all the elements of pedagogical system are to be changed. Thus, the same part of the competence (basic, integral educational) has been changing according to the competence level. The attention, however, should be paid to the fact that the previous competence does not vanish; it is supplemented by new qualities.

This model reveals the significance of separate parts of ICT

competence and the characteristics in the concrete stages of ICT implementation.

While considering the peculiarities of ICT implementation stages and the descriptions of competence levels, the following aspects could be revealed:

- The *behavioural competence* level has been emphasized in the teacher's ICT competence model at the *emerging* stage of ICT implementation. This level is characterized by the elementary technological, information, social literacy and elementary skills (preparation of applied equipment, design of elementary documents, using the Internet).

- The *added competence* level has been emphasized in the educator's ICT competence model at the *application stage* of ICT implementation. In this stage an educator aims to enrich the traditional educational process. Therefore, the *performance improvement* that is related to educational competence is necessary, i.e. a teacher has to possess elementary knowledge on the ICT application possibilities and skills to use them (pedagogical competence). However, the efforts to apply ICT in educational process require deeper knowledge on ICT literacy.

- *The integral competence* level has been emphasized in the teacher's ICT competence model at the *infusion stage* of ICT implementation. The development of ICT literacy competence gains importance since one more element of performance networks emerges. The networks, integrated and project based teaching are related to managerial competence, because it helps a teacher to decide in what ways and when to use ICT in his subject taught, to analyse the existing ICT tools and to plan learning process.

- The *holistic competence* level has been emphasized in the teacher's ICT competence model at the *transformation stage* of ICT implementation. It is characterized by the holistic approach to competence and the sharing of work experience with colleagues, ability to act with the holistic view on the performance and with the insights for the future. A teacher

feels responsible for both the whole pedagogical system at school and the preparation of learning environment for teamwork based learning with the help of ICT.

The empirical research that proved the vitality of the theoretical model, as well as allowed to assess what ICT competence is most characteristic to the Lithuanian teachers was carried out among 1164 regular teachers and 242 expert teachers working at schools.

The analysis of group results revealed that the results of expert teachers' groups (ICT leaders, innovators, Comenius project participants) match the 2nd and the 3rd levels of ICT competence. The results of teachers working at schools show that they have the 1st and the 2nd levels of competence. It has generally confirmed the empirical data found by Petkūnas.

The 1st and the 2nd level competence of regular *teachers* (suitable for the first and the second stages of ICT implementation at school) are considered only partly sufficient, since Lithuanian schools have already achieved the second stage of ICT implementation. A big concern is felt because of the low educational competence (the 1st level) which level is basically determined by the poor provision with ICT learning resources, poor organization of competence development.

The 2nd and the 3rd level ICT competence of *expert teachers* (suitable for the second and the third stages of ICT implementation at school) is considered to be sufficient. It is worth to use this experience for developing other teachers' competence, to summarize the "best practice" and disseminate it.

Figure 2.
The dynamic model of educator's ICT
competence (Brazdeikis, 2007b)

Levels	I Level	II Level	III Level	IV Level
Parts	**Characteristics**			
2. ICT integral educational competence			**2.3.Managerial competence**	
			compound (network)	shared with colleagues
		2.1. Pedagogical Competence		
		elementary	compound (network)	shared with colleagues
1. ICT basic competence (ICT literacy)	**1.3. Social literacy**			
	elementary	compound	compound (network)	shared with colleagues
	1.2. Information literacy			
	elementary	compound	compound (network)	shared with colleagues
	1.1. Technological literacy			
	elementary	compound	compound (network)	shared with colleagues
ICT implementation stages	➡	➡	➡	➡
	Emerging	Applying	Infusing	Trasforming
Competence levels	Behavioral	Added	Integral	Holistic

Educator's ICT Competence

ICT and study process at university

Dynamic model of ICT implementation suits not only the specifics of the school, but also a modern university. The third stage of ICT implementation (*infusion*) is of a particular importance to the contemporary studies. Its opportunities and importance are particularly clear in the aspects of the use of distance studies and modern library for the studies.

I will provide a brief overview of the case of distance learning characterised by the one-year study programme at the Kaunas University of Technology for bachelors in various fields who already work as teachers and seek to certify their pedagogical competence by obtaining the teacher's diploma. It is a programme of 40 credits, based on *action research*. The latter concepts required not only teaching the modules in a distance way, but also an ongoing communication between the teachers and students, who start applying action research from very early on in their pedagogic activities. The result of this work is a final thesis, in which students describe the process of improving their activities based on action research and the results achieved. Whereas the action research is generally based on the team work at school, the teacher can observe this work from the distance and to consult on it, if it is based on the work in e-network. All this confirms once more the necessity of the third stage of ICT implementation. The results of student work and excellent feedback on the studies allow me to draw conclusion that in the analyzed academic unit of the university the ICT has been successfully implemented on the third stage, while the students and teachers have the necessary competence to act on this stage.

However, this is a case of a single study programme. It is easier to tell on which stage the ICT is implemented in a specific university as a whole if we analyze how students of this university use the learning environment of modern library in the study process.

My former doctoral student Gintarė Tautkevičienė in her doctoral dissertation has analyzed the learning environment of the Library of Kaunas University of Technology, which is one of the most modern in Lithuania (Tautkevičienė, 2005). In spite of the opportunities offered by this library, we have found out that the choice of learning environments depends on the type of students and their study stage. In different stages of studies and student groups (bachelor, master,

doctoral studies, non-traditional students), the differences in the manifestations of factors in study, library and personal environments have been reported.

Bachelor students are more interested in study information, but they spend quite a lot of time in the library with purposes unrelated to their studies: spend breaks during classes, communicate with friends, use computers, internet, etc. Still, the bachelors use the library learning environment to the extent it is meaningful for their studies. Although the bachelor students prefer the methods based on information transmission (these methods are usually linked with the paradigm of teaching), they also tend to emphasise the importance of learning paradigm. Such collision implies that the reality of undergraduate studies is characterized by the paradigm of teaching, although the vision of student activities is based on the paradigm of learning.

The graduate students possess greater needs for information, which are determined by active methods of teaching/learning used in the Master studies (stress on interaction paradigm). Master students tend to look for the sources on the internet by using the universal search engines rather than using databases accessible in the Library.

Non-traditional students rarely use the library, which is related to the fact that they are occupied and lack of time rather than their negative predispositions towards the library. Non-traditional students understand the importance of information and the role of library in its retrieval; they give good evaluations of the library learning environment, treat the librarians as assistants, who can help to achieve learning goals.

Doctoral students use a wide variety of learning environments, library environment among them (in particular, its virtual services, databases, electronic sources). They do not find the library particularly attractive as a physical environment of learning. Doctoral students highly (more than others) appreciate the information competence of teachers and librarians, which is treated as an opportunity to get advice or assistance searching for relevant information sources. With reference to using virtual services of the library, very effective are training sessions, database presentations given by the librarians and the related ability to use databases.

Conclusions

The ICT implementation into educational process is described as four stage process (*emerging, applying, infusing, transforming*), which is accompanied by the change in educational paradigm: from the *paradigm of teaching* (1st stage) to the *paradigm of interaction* (2nd and 3rd stages) to the *paradigm of learning* (4th stage). The ICT competence of teachers is dynamic and has to correspond to the specifics of work in the specific stage of ICT implementation.

The research of Lithuanian education has indicated that the ICT competence of teachers and ICT implementation are mainly focused on the second stage of ICT implementation, with rather strong characteristics of the third stage, which is particularly true in student activities.

The higher the stage of university studies, the more advanced stage of ICT implementation is expressed, although the existence of the fourth stage was not revealed.

The vision of student activities both at school and at this particular university described by themselves emphasises the paradigm of learning, which implies the hope that the fourth stage of ICT implementation is also likely to emerge.

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Sintesi

Il cambiamento del paradigma educativo a tutti i livelli di formazione, primaria, universitaria e di aggiornamento professionale, è analizzabile in relazione al grado di utilizzo e diffusione delle ICT nella formazione. L'armonizzazione tra il paradigma educativo e l'implementazione delle ICT favorisce, infatti, lo sviluppo della formazione continua.

I risultati di alcune ricerche empiriche sulle ICT nella scuola e nell'università lituane sono stati studiati in relazione a modelli teorici di riferimento didattico da un lato, e al processo di applicazione delle ICT dall'altro.

Il passaggio da un Teaching Paradigm (centrato sul docente) ad un Learning Paradigm, attraverso un Interaction Paradigm intermedio (modello di Branson), procede in parallelo all' applicazione delle ICT nella scuola. Questo processo si articola in diverse fasi: adeguamento tecnologico delle strutture scolastiche (Emerging); applicazione delle ICT nelle attività didattiche (Applying); loro incorporazione in tutti i corsi con sempre maggior enfasi sull'uso del Web (Infusing); trasformazione della scuola in una comunità di apprendimento che si avvale dello strumento informatico per gestire l'innovazione (Transformation).

Rispetto a tale modello, ricerche empiriche su studenti e docenti della scuola lituana hanno evidenziato la forte propensione degli studenti verso il Learning Paradigm, ma anche la poca familiarità dei docenti con le ICT e la conseguente loro tendenza a conservare il Teaching Paradigm, pur affermando di considerare il Learning paradigm desiderabile. In particolare, le competenze ICT dei docenti possono essere di tipo generico (ICT literacy) o mirate al processo educativo, e presentano gradi progressivi e dinamici di sviluppo, che si collegano a loro volta con il progresso dei paradigmi pedagogici. I dati empirici raccolti su oltre 1400 insegnanti con diversi livelli di

esperienza, hanno confermato che il grado di competenza informatica dei docenti corrisponde a quello necessario per i primi due livelli (Emerging e Application) di applicazione delle ICT nelle scuole. Dato il livello di diffusione delle ICT nelle scuole lituane (corrispondente alla fase Application), la competenza richiesta ai docenti dovrebbe essere tuttavia più elevata. E tale dato riconduce al tema della formazione continua dei docenti.

La Kaunas University of Technology ha attivato un diploma di aggiornamento a distanza per docenti basato sulla ricerca-azione. che evidenzia la necessità di raggiungere il massimo livello di competenza informatica da parte dei docenti. Una ricerca sull'utilizzo delle risorse didattiche offerte dalla Biblioteca della Kaunas University ha evidenziato inoltre che il grado di complessità dell'uso della struttura è proporzionale al grado di studio degli studenti (minore negli iscritti ai corsi di laurea e massimo tra quelli iscritti ai dottorati), senza tuttavia raggiungere il massimo livello di implementazione delle ICT.

Il completamento del processo di integrazione delle ICT nella didattica in Lituania ed il passaggio ad un paradigma pedagogico innovativo si fonda sul successo delle iniziative di aggiornamento docenti, incoraggiato anche dalla presenza di una nuova giovane generazione di studenti e ricercatori sempre più coinvolti nell'utilizzo delle ICT per la formazione.