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ICT competence, pedagogical strategies and methods in support of pedagogical innovation – studies involving in-service teacher participants of international development programs

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Introduction

Continuous production, organisation and transmission of knowledge are crucial in information society. The diffusion of information and communication technologies (ICT) and open learning environments has resulted in structural changes and the transformation of content in the field of education. Technology-supported education which eventually manifests itself in pedagogical innovation (Balanskat, Blamire & Kefala, 2006; Condie & Munro 2007; Józsa & Steklács, 2009; Kozma & Anderson, 2002; Pelgrum & Anderson, 1999; Pelgrum & Voogt, 2007; OECD, 2006; Westera, 2004), is reliant on new methodologies and pedagogical practices (Mioduser, Nachimias, Tubin & Forkosh-Barush, 2003; Pelgrum, Brummelhuis, Collis, Plomo & Janssen, 1997). In the last decade, educational experts have focused on defining competences, which are prerequisites of the successful usage of computer-supported learning environments (Lennon, M., Kirsch, I., Von Davier, M., Wagner, M. & Yamamoto, K., 2003; Hogenbirk, 2006; Kárpáti, 2007; Kárpáti & Hunya, 2009; Komenczi, 2001a; Rychen & Salganik, 2003; UNESCO, 2008).

In the present study, teachers' ICT competence, their pedagogical inventory and the characteristics of pedagogical innovation were investigated.

The aim was to examine and elucidate the effects of ICT-supported environments on teacher competences and pedagogical strategies, and also to describe the characteristics of the processes of transformation and innovation. The relevance of the study is that multimedia applications have created a new context in education; this enables the usage of new forms of teaching and learning. When analysing the effects of ICT on teachers both the perspective on applied competences and the functional aspects were included. The perspective on applied competences included teachers routines and skills adjusted to the requirements of the information society. Functional aspects referred to the role of ICT applied in learning environments in the process of pedagogical innovation (Komenczi, 2001b). Unique to our study is that we investigated the relations between innovation, ICT competence and pedagogical strategies in the context of teachers' daily practice.

In the first part of the chapter on theoretical background, the notion of 'competence' and the theories attached to it are being reviewed. We attempt to organise the various competence models based on their social and personal usability and describe suggestions and requirements concerning ICT competences relevant to the role of ICT in the pedagogical innovation process.

We considered it as important to deliver also a description of established theories of learning which are linked to the use of ICT-supported environments. We briefly introduce theories of linear knowledge acquisition – behaviourism, cognitivism and constructivism – later on, models that rely on social learning, and which serve as predecessors (activity theory), or are strongly tied to the possibilities offered by networked learning environments (expansive learning, trialogic learning), or they present a new theoretical approach (connectivism).

In the third block of the theoretical review, we describe the notion of innovation, characteristics and phases of the innovation process based on the well-known theories in social sciences. Further, we refer to international and national studies that focus on the innovative effects of ICT, and elaborate on the pedagogical relevance of the innovation process.

The thesis gives account of two empirical studies through which methodological characteristics of technology-supported learning environments, ICT competences and mechanisms of pedagogical innovation are investigated.

Theoretical background

Theories on "competence" and ICT competence

In our society, new learning cultures, the skills for life long learning and a competence-based education and training are needed. Educational researchers have investigated the notion of competence from various perspectives and as a result, they have created a number of theoretical frameworks. Seen from the social usability perspective, competence means valuable, valid and usable knowledge, which is created and maintained largely at school. In this understanding, competence is the result of an individual's activity, thus it is judged as usable knowledge adequate for certain types of performance. Seen from the personality perspective, the notion of competence is studied and defined in order to describe thoroughly the effects of pedagogical processes on the individual's personality, and to transform learning into a more personalised and effective process.

In the present study, we placed teachers' ICT competence in the group of special competences in Nagy's (2000) competence model. Our aim was to identify the components of ICT competence in the pedagogical practice within the groups of Hungarian participants of an international project focusing on ICT tool usage. We also investigated the complex application of interactive and new generational methods linked to the usage of ICT tools and digital resources. In the empirical study, from the numerous possible special competences, we divided the components of teachers' ICT competence into two groups: the competences of general ICT usage and the competences needed for the pedagogical application of digital contents. The former ones refer to those routines and skills that are linked to effective ICT tool use including the confident use of the computer (file management, word processing) and other ICT-related services (internet, email). The latter one means those routines and skills that are strongly related to the teacher profession.

The competences of general ICT usage involve routines and skills of ICT tool manipulation in general and in a given pedagogical context. The competences needed for the pedagogical application of digital contents encompass (according to our view) searching for digital information, filtering them in an annotated learning resources repository, analysis, evaluation, adaptation, grading, processing, organising, archiving of digital contents, creation of a personalised knowledge repository and interactive usage of digital content repositories.

Theories of learning concerning technology-supported learning environments

Theories of learning, which describe mechanisms and processes of learning, react to the changes of learning environments. Similarly to traditional learning environments, the study of teaching and learning strategies, educational contents and methods in the technology-supported learning can also be adjusted to respective theories of learning. Behaviourism and cognitivism relate learning processes to external mechanisms, whereas in constructivist learning theory, learning is the result of internal processes. Behaviourist strategy underlines the facts (what), cognitive theory focuses on the processes and mechanisms (how), constructivism stresses personal understandings related to real life experience. While behaviourist and cognitive theories of learning are teacher- and content-centred, constructivist theories are based on problem-solving learner activity occurring in real life contexts. Accordingly, constructivism is learner-, and problem-oriented. The activity theory (Vygotsky, 1971; Leont'ev, 1979; Engeström, 2001) underlines the object-orientedness of human activity, which is culturally defined and mediated by objects (tools, signs and symbols). It also stresses the mutuality and interdependence of individual and social activity. In this perspective, ICT tools are suitable for creating knowledge collectively that is indispensable in the process of problem-solving. Consequently, ICT tools may contribute to the creation of *innovative*

knowledge communities (Engeström, Y., Engeström, R. & Karkkainen*, *1995), which manipulate shared objects collectively. According to the expansive learning theory, collaboration and open activities that may be continued as creative activities are results of the social activities being transferred. The trialogical learning theory (Paavola & Hakkarainen, 2005) also underlines the importance of collaboration and knowledge construction through jointly created learning objects.

Related to the pedagogical usage of the Internet, a new learning paradigm has recently evolved. The connectivist approach is proposed by George Siemens (2005) whose studies have served as an inspiration of long-lasting and fruitful professional discussions among experts in the field. Central to these debates is the question whether connectivism should be considered as a new learning paradigm (Verhagen, 2006; Kerr, 2006) and a theory of learning that is related to complex changes in education. In the connectivits model, learning is an informal, networked, technology-supported information exchange, in which contextualizing information and evaluating their relevance are both done collectively (Downes, 2006; Siemens, 2005).

Pedagogical strategies and methods

In the present study, we relied on Falus' (1998) and Báthory's (1997) definitions on pedagogical strategies. Accordingly, pedagogical strategy is the collective of interrelated decisions, which provide for the characteristics and the approaches involved in teaching and learning processes, and they are manifested in a complex system of applied methods, tools, operational strategies, and work forms.

Innovation

Social scientists have been interested in the characteristics of introducing new ideas, practices, and technical innovations. Tarde (1903) focuses on the diffusion of cultural changes, Schumpeter (1939) refers to innovation in the context of productivity. In Rogers' (1995) diffusion theory, he defines innovation as an idea, practice or object, which is considered as new by an individual or another user. He differentiates between three types of the innovation process: *continuous innovation*, *dynamically continuous innovation*, and *discontinuous innovation*. The innovation chain includes according to Gáspár (2002) the recognition of the "new", testing it in practice, adapting it in a relatively wide circle, the analysis and generalisation of test and adaptation results, the identification of model characteristics with focus on necessary corrections, mass introduction, and the corrections based on user feedback.

The crucial effects of ICT tools on educational processes, their organisation, the educational contents and the methods were already acknowledged in the 80s. (Gibson*, *2002). In general, the notion of innovation has been referred to in the context of the diffusion of ICT and the reforms related to them (Balanskat et al.'s 2006; Pelgrum & Anderson, 1999; Pelgrum & Voogt, 2007; Westera, 2004).Studies on pedagogical innovation have showed that researchers investigate innovation at the micro level, since they are interested in the levels of innovation and the types of participants within the pedagogical practices (Law, Yuen, Chow & Lee, 2003; Law, 2003, 2004). At the macro level, innovation is examined from institutional, organisational, and strategic perspectives (Granger, Morbey, Lotherington, Owston & Wideman, 2002; Forkosh-Baruch, Mioduser, Nachmias & Tubin, 2005; Mioduser et al.'s 2003; Tubin, Mioduser, Nachmias & Forkosh-Baruch, 2003). International comparative studies revealed that the introduction, the implementation, the maintenance, and the application of innovation, due to cultural differences, internationally differ (Law, Chow & Yuen, 2005). In Hungary, research studies are of descriptive nature, they give a thorough description of innovation processes (Áts, Bondor & Kovács, 2000; Köpeczi-Bócz, Bükki &

Vinczéné, 2007), and they give account of school leaders' and teachers' ideas on innovation in a self-reflexive manner (Kőrösné, 2000, 2001).

Pilot study: Empirical study focusing on technology-supported pedagogical innovation in the framework of the European eTwinning program

The investigation focusing on the mechanisms of innovation in the eTwinning program was considered as a pilot study of the main empirical study. The eTwinning III. monitor aimed at studying ICT-supported international co-operations based on collaborative work and its pedagogical implications in the groups of participating teachers (n = 65).

In the eTwinning project, the precondition of pedagogical innovation was a speedy technical development (tool development) which either took place previously or was a result of the participation. According to the second step of the innovation process, the acquisition of the experience needed for the daily manipulation of ICT tools and their adjustment to the actual pedagogical scenario took place in the framework of the project (Gáspár, 2002). In our study, based on Forkosch-Baruch et al.'s (2005) work on the assimilation, transition and transformation levels of innovation, we identified assimilation level. This means that the conditions of the pedagogical processes changed, the infrastructure was provided – despite the difficulties as concerns space and availability of computer / Internet facilities – but the pedagogical innovation did not result in substantial changes of the content of the teaching and learning process. The aims and the organization of the teaching and learning process did not change, the content was slightly modified but exclusively in the extra-curricular activities. However, the participants' positive attitude concerning the ICT use implied potential changes in the future. Based on Rogers' (1995) user profiles, the teachers involved were identified as innovators. Analogously to previous studies (Law et al.'s 2003; Law et al.'s 2005), in these groups as well, traditional pedagogical methods and work forms prevailed, which indicated that activities co-ordinated and organised by the teacher are typical of the pedagogical scenarios. In the sample schools, the eTwinning program functioned as an "island of innovation" (Forkosh-Baruch et al.'s 2005), the number of participants (both teachers and learners) was rather low. International (Forkosh-Baruch et al.'s 2005; Granger et al.'s 2002; Mioduser et al.'s 2003; Tubin et al.'s 2003) and Hungarian studies (Hunya, 2007; Tót, 2007) have come to the same results: school leaders and decision-makers both at the local and the national level have an immense impact on the speed and the quality of the diffusion of pedagogical innovation.

The empirical study in the framework of the CALIBRATE project: Hypotheses, methods and tools

The CALIBRATE project (*Calibrating eLearning in Schools*) was launched in the framework of the EU Information Society Technologies (IST) program in October 2005. Teachers from 80 schools (equipped with high-quality ICT infrastructure) from 7 European countries (Austria, Belgium, Czech Republic, Estonia, Poland, Lithuania, and Hungary) participated in the CALIBRATE project between 2005-2008. Participants tested and developed materials for the European Digital Repository while collaborating in groups. The Mentored Innovation Model was used as an instructional design. Data collected in these groups were compared to the results of those communities of Hungarian teachers who did not participate in the mentored innovation process focusing on ICT use.

Hypotheses

Our research questions focused on teachers' ICT competence, their technology-supported pedagogical practices and approaches, and the characteristics of pedagogical innovation. We formulated our hypotheses accordingly:

H/1.   Competences of general ICT usage and competences needed for the pedagogical application of digital contents are prerequisites of the classroom application of ICT tools.

H/2.   The use of ICT tools does not necessarily result in the renewal of the methodological inventory, but it serves as a support of traditional methods.

H/3.   The use of interactive and new generational methods accompanies the regular application of ICT tools and resources.

H/4.   Teachers with previous innovatory experience are more likely to use ICT tools for pedagogical purposes as opposed to those who lack such experience.

H/5.   Those teachers, who did not participate in the development process focusing on the pedagogical use of ICT tools, differ from the Hungarian participants of the innovation process both in the pedagogical use of ICT tools and their pedagogical approach.

Methods and tools

The present study is based on survey methodology and document analysis. The 15-item Pedagogical Strategies questionnaire focuses on four issues (Lakatosné, 2010).

– Values, approaches and beliefs concerning "teacher profession",
– Pedagogical experience,
– Pedagogical experience in ICT-supported learning environments,
– Ideas on the use of educational tools in the future and the teachers' experience in innovation.

The second tool is the ICT competence test (Török, 2008), which was internationally piloted by the validation team led by Andrea Kárpáti. The ICT metrics focused on teachers' ICT competence and activity concerning their ICT use. Both tools are multiple-choice questionnaires with rating scales providing self-perceived values but they also include open questions.

The lesson plans prepared by the CALIBRATE teachers were the third data source. These *knowledge objects* (Priest & Komoski, 2007) are imprints of teachers' pedagogical activity. Firstly, we evaluated the lesson plans with the help of qualitative methodology. Secondly, based on the evaluations we grouped them into thematic units. Thirdly, we quantified the qualitative categories by creating a coding scheme.

The sample of the present study included those 142 teachers who participated continuously in the CALIBRATE project. The detailed analysis of the lesson plans relied on data from the Hungarian participants of the international community (n = 37). The Hungarian teachers of the CALIBRATE project were described as the *innovator group*, since this group participated in the mentored innovation model in the framework of the project. The survey was carried out in other similar Hungarian groups (n = 63) as well – similar with respect to the background variables (sex: $\chi^2 = 0.249$, p = .617; age: $\chi^2 = 4.253$, p = .373; years of professional experience: $\chi^2 = 5.281$, p = .152; subjects: $\chi^2 = .343$, p = .952, location: $\chi^2 = 2.220$, p = .330; type of school: $\chi^2 = 1.784$, p = .410). Our aim was to provide a reference framework for the results of the Hungarian innovator group. Thus, this other community was considered as the *reference group*. The members of the reference group, similarly to the majority of the innovator group, did not have experience in pedagogical innovation encouraging the use of ICT tools.

Results

Our first hypothesis claims that *general ICT competence and the competence of using digital contents are prerequisites of applying ICT tools in the classroom.* With the help of the ICT metrics survey, we collected data on teachers' self-perceived ICT competence. We investigated the ICT usage based on 40 variables in 8 thematic units (file management, word processing, internet usage, email, spreadsheets, preparing slides, photo editing, and other). In the listed competences, we consider file management (except for compressing files, more than 90% of the respondents was able to carry out this activity without any help), word processing (80% was able to do it without any help), internet usage (except for creating web pages, 85% of the respondents was able to use the internet without any help), using the email function (85% of the teachers used it without any help), and manipulating spreadsheets (65-75% of the respondents was able to carry out these activities alone) as part of the users' general ICT competence. We claim this because the majority of the referred competence components are judged as routine-like activities among those who use computers on a regular basis. These operations are part of the basic-level courses in computer use but they can also be acquired in an autodidactic manner. Nevertheless, they are all needed for the professional, pedagogical application of ICT tools. These five items include only rarely activities reliant on special skills, such as web page design. Results of the international sample and the reference group show similar results, also in their case, these competences constitute the majority of those operations they are able to carry out individually. The rest of the variable groups refer to more complex operations, which are not part of daily, routine exercises. The preparation of presentations (53% of the respondents was experienced), using the photo editing functions (60% was experienced), and computer hardware utilization (40% of the teachers was experienced) belong to this category. These operations needed special competences and skills, their acquisition was based on those skills that constituted the previous group of more general ICT competences. Special competences and routines needed for the pedagogical application of digital contents are necessary so that teachers do not use ICT tools as digital versions of traditional contents; instead they make the best out of their characteristics and advantages. Special competences are the prerequisites for the active use of digital contents and knowledge bases, which involves searching for digital information, filtering them in an annotated learning resources repository, analysis, evaluation, adaptation, grading, processing, organising, archiving of digital contents, creation of a personalised knowledge repository and interactive usage of digital content repositories. Consequently, we claim that our hypothesis is proved.

In the next phase, we used regression analysis in order to see which of the 40 items of the ICT metrics impact ICT tool use as mirrored in the lesson plans. The digital resource usage was considered as the dependent variable. We found that from the 40 independent variables the variance of the 3 variables impacted significantly the main variable (bookmarking websites; graphical presentation of data; saving data on pendrives). Forty percent of the variance of the main variable was explained by these 3 variables, which means that they were important elements (their importance however differs). The strongest variable was the one referring to bookmarking websites. Those respondents, who were experienced in manipulating web data, had various other ICT skills and competences. Those teachers who used digital resources more frequently, were able to present data graphically (by using the relevant functions), and to save data on pendrives. Based on this, we can claim that beyond the general ICT skills and competences, teachers need special skills in order to be able to use digital contents for pedagogical purposes.

If we consider the ICT tool usage mirrored in the lesson plans as the dependent variable, then there is only one independent variable (changing the file format of pictures) with

significant effect on the main variable. This variable only accounts for 25.4% of the variance of the main variable, thus it has only a modest effect on ICT tool use.

By using regression analysis, we intended to find out which of the 40 items of the ICT competence test impact the background variables. In the case of the target variables sex, taught subjects, and the years spent in-service, the independent variables (40 items) did not have explanatory power. As concerns age, only one variable – being on mailing lists – impacted significantly the variance of the target variable but this accounted for only a minority of the known effects ($R*\beta = 24\%$).

By taking the methods of lesson plans as dependent variable, we first investigated the traditional method. We found that the independent variables did not account for the variance, the reason most probably is that most participants use it, i.e. low deviation values. In the case of the interactive method as dependent variable, only one item – saving files from pendrives to computers – impacted significantly the target variable but it had only a low explanatory value ($R*\beta = 19,4\%$). When considering the new generational methods as dependent variables, we found two independent variables – formatting texts and using virus scan programs – which influenced significantly variance and accounted for 70% of the target variable. This means that those who are experienced in formatting texts, and are able to solve tasks related to the safe use of computers, are more likely to use new generational methods.

According to our second hypothesis, *the ICT tool use does not necessarily result in the renewal of the methodological inventory but it may support the use of traditional pedagogical methods*. From the analyses of the questionnaires, we found in the current groups that the traditional methods reliant on the teacher's leading role (teacher's explanation, individual work forms) are still the most common. In the case of teacher's presentation, we found different results in the Hungarian and the international teacher communities of the CALIBRATE project. Seventy-eight percent of the members of the international teacher community used the Power Point Presentation (PPT) tool weekly, whereas only 49% of the Hungarians applied this tool weekly. Nevertheless, the usage of the PPT tool did not reflect change in the methodological inventory or pedagogical approach since it was still a frontal way of teaching with the teacher as the main agent. However, the blackboard and the chalk were changed to a digital tool. Beyond the traditional techniques, there is only a modest occurrence of less traditional, cooperative, problem-based, self-regulatory type of pedagogical strategies. Only 29% of the innovators used the cooperative work form weekly and 26% organised classroom debate. Teachers in the current study, did not use the project method regularly but this is accounted by the rather special conditions (e.g. timing) project work implies.

The teaching and presentation tools themselves constituted parts of teachers' methodological inventory. With reference to this, we claim that resources and tools accessible through ICT tools were the digital versions of the traditional resources and tools in most cases. Those contents that were exclusively digitally accessible (e.g. online tests) or the softwares supporting collaborative learning and new methodologies were used weekly by a very few participants. Accordingly, in the current groups the use of ICT tools is not accompanied by the renewal of teachers' methodological inventory.

When analyzing lesson plans with respect to the applied methods, we found that interactive and new generational tools were present. However, the traditional methods more often occurred in most teachers' inventory. From the three types of methods, only one person utilised the new generational and three participants used the interactive methods. Only the total value of the frequency of both the interactive and new generational methods (51%) exceeded the value of traditional methods (49%) (the difference is minor). Twenty-three percent of the participants did not even mention new generational methods in the lessons plans. In the current groups, the ICT tool use was not accompanied by the renewal of the

methodological inventory. The analysis of lesson plans of the sample groups revealed that the traditional pedagogical approach and work forms based on the teacher's control and leadership (teacher explanation, individual work) still prevailed.

The traditional methods are in all age groups present – except for the youngest ones in the sample –, male teachers prefer them more as compared to female teachers. Twenty-three percent of the participants did not mention new generational tools in their lesson plans, which are more common among the participants younger than 25 years old. In the current study, we found that the "subjects taught by the teachers" does not influence the choice of methods. In the case of those teachers who use two types of new generational tools, we saw that different types of methods were also typical thus their methodological repertoire was richer. They used diverse types of methods and the classroom application of ICT resources was more varied. However, in the others' case, ICT-use did not necessarily result in methodological renewal.

Our third hypothesis refers to the users of interactive and new generational methods. We assume that *the use of interactive and new generational methods accompanies the regular application of ICT tools and resources*. Firstly, we investigated data concerning the ICT tools and then the digital resources. We divided teachers into two sub-groups based on the frequency of using interactive and new generational methods. With applying the F test, we found that there was not a significant difference between the standard deviation of the two sub-groups as concerns the ICT tool use (x_{rarely} = 32%; x_{often} = 58%; F = .609; p = .442). However, the mean value of those using interactive and new generational methods was significantly higher then that of the other sub-group (s_{rarely} = 19%p; s_{often} = 17%; t = -3.829; p = .001), which meant that they more frequently used ICT tools.

As concerns the digital resources, there was not a significant difference in the standard deviation (x_{rarely} = 32%; x_{often} = 55%; F = .141; p = .71). The mean value of the users of interactive and new generational methods was significantly different, the mean value of those applying new methods was higher than that of the other sub-group (s_{rarely} = 18%p; s_{often} = 14%p; t = -3.553; p = .001). There was also a difference in utilising the resources, depending on how rarely or often teachers used interactive or new generational tools. Based on the results of the present study, we claim that those teachers, who relied on a more up-to-date methodological inventory used ICT tools and digital resources more frequently.

Our fourth hypothesis referred to the relation between innovation and ICT tool use. We claimed that *the pedagogical use of ICT tools is more typical of those teachers who have previous experience in (pedagogical) innovation*.

Concerning the first hypothesis, we compared the experience in innovation and the ICT tool use of the members in the Hungarian innovator group and the reference group. We found that members of the innovator group have considerable experience in innovation (χ^2 = 44.274; p < .001). When considering the activities, which result in experiencing innovation, we identified significant difference between the two groups in the case of the pedagogical experiment (U = 656: HU[1]: 63; VCS: 42; p < .001), authoring books (U = 886.5; HU: 57; VCS: 46; p < .001), content development (U = 576; HU: 65; VCS: 41; p < .001), participation in international projects (U = 508; HU: 67; VCS: 40; p < .001) and the exchange trips (U = 824; HU: 59; VCS: 45; p < .001).

Results referring to the ICT tool use showed that members of the innovator group were more active users of ICT tools (U = 639.5; HU: 64; VCS: 42; p < .001). The number of classes where ICT use was part of the classroom activities did not differ in the two groups but the results on the type of tools revealed considerable differences. Members of the innovator group used both traditional tools and also resources exclusively accessible with the help of

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The Hungarian participants of the CALIBRATE project are indicated with the abbreviation HU, whereas the reference group is referred to as VCS.

ICT tools. Accordingly, the above results supported our first hypothesis, thus we claim that experience in innovation encourages further activities resulting in innovation.

As regards the fifth hypothesis, we again considered results of the innovator and the reference group. According to our hypothesis, *those teachers, who did not participate in the development process focusing on the pedagogical use of ICT tools, differ from the Hungarian participants of the innovation process in both the pedagogical use of ICT tools and their pedagogical approach.*

Based on the results, we claim that members of the innovator group spend more time on the pedagogical use of computers both at home and at school. When preparing for class, members of the two groups rely on "traditionally" accessible tools and resources, but the usage of simulations, web-based collaborative tools and softwares is significantly more frequent among the innovators (simulations: U = 652; HU: 60; VCS: 42; p < .001; video: U = 731; HU: 58; VCS: 43; p = .002; web-based collaborative tools: U = 829; HU: 55; VCS: 45; p = .006; software use: U = 681.5; HU: 58; VCS: 42; p = .001).

Self-perceived ICT competence values revealed considerable differences in the two groups. In the 40 competence components, in the case 36 items, we identified significant difference. The members of the innovator group had more routine. The regularly used pedagogical methods were connected to traditional work forms in both groups. From the pedagogical methods, teacher's explanation (U = 512; HU: 65; VCS: 39; p < .001), group work (U = 685; HU 59; VCS: 42; p = .001), pair work (U = 782; HU 60; VCS: 44; p = .005) and individual work (U = 522; HU 65; VCS: 40; p < .001) were more frequent in the innovator group. In the reference group, the weekly, monthly and semi-annual distribution was higher. As concerns the usage of cooperative techniques linked to new generational methods, we did not find any significant difference in the two groups (χ^2 = 3.640; p = .303). The beliefs regarding teaching and education were similar in both groups in various aspects: the importance of teachers' responsibility and the encouragement of personal development and self-fulfilment as a potential educational goal to reach. The reference group is more divided as concerns the type of pedagogical approach (authoritarian or facilitating approaches). In the innovator group, the traditional teacher roles (more control and leadership) and the elements of a supportive approach facilitating individual, creative thinking and self-development were both present. We found that the fifth hypothesis referring to the ICT competence and tool use was proved. However, results did not support our assumption regarding the pedagogical methods and approaches. Teachers' pedagogical approach – regardless of the group membership – was influenced by various views and methodological concepts at the same time. These concepts might eventually contradict each other. This however does not mean that teachers' pedagogical approaches are controversial and disharmonious, but it simply reflects the very many ideas, paradigms co-existence, among which teachers try to choose the best ones adjusted to their own personalities, conditions and the given context.

Relations among ICT competence, pedagogical strategies and innovation in teachers' practice

Based on the results of the study, we claim that beyond elements of general ICT competence, in order for the teachers to use ICT tools routinely, those special competences are also needed which enable the effective and safe pedagogical use of digital contents and resources.

The following skills which belong to the category of special competences were found to be of importance: handling web content, graphical presentation of data, handling digital contents by using data storage tools (pendrive), and using programs which enable the safety of contents (virus scan programs).

Similarly to other international research results (Hermans, Tondeur, van Braak & Valcke, 2008), also results of the current study showed that virtual environments most predominantly serve "traditional" teaching goals (presentation, motivation).Teachers' methodological inventory includes also innovative techniques, the methodology in general can be characterised as diverse but in their daily practice teachers most often rely on traditional methods. Student-centred approach which is based on cooperative and constructivist paradigms, and teacher-centred approach which is reliant on teacher's leading role and linear organisation of teaching and learning processes are both present in the classroom practice. Pedagogical activities based on collaboration and run on community platforms on the Internet, or informal, connectivist manner of learning are not characteristic of the current sample. The pedagogical usage of those tools exclusively accessible through ICT tools i.e. digital contents, simulations, animations, and so on, was not common even in the CALIBRATE project where facilitators supported teachers' work. As concerns digital resources, the majority of participants use the digital versions of traditional presentation tools (pictures and figures) regularly.

We also found that the traditional pedagogical methods and techniques can be enriched by applying technology-supported methods and resources. Consequently, results revealed that in the innovation process, participants of the present study are in the introductory (Fullan, 2001) or as Mioduser et al.'s (2003) put it, in the technology-adaptation phase. The fact that only a few changes were identified in the pedagogical practice also supported this. According to Forkosh-Baruch et al.'s (2005), this is described as the *assimilation* phase, where the conditions of the pedagogical process change but the curriculum, the content, the learning and teaching aims, the organisation of the teaching and learning process (class schedule), the learning environment (classroom), and the teaching resources (books and workbooks) remain unchanged. Only a few teachers are at the so-called *transition* level, they use both traditional and new pedagogical methods, contents and organisational strategies in ICT-supported learning environments.

The use of digital tools is adjusted to the processes based on both traditional and new pedagogical approaches. This indicates that the innovation process has already been started. Findings of the current study also confirmed this, since we found that participants' beliefs and their actual practice of teaching and education were diverse and related to various pedagogical paradigms. Similarly to the results of international research results (Forkosh-Baruch et al.'s 2005; Kozma & McGhee, 2003; Law et al.'s 2003; Mioduser et al.'s 2003), the majority of Hungarian teachers is characterised by the traditional methodological repertoire, which includes frontal work organised and led by the teacher. The new technological and pedagogical tools, the organisational methods are present in the classroom practice but their role within the innovation process is questionable. The ICT tool use rather generally contributes to evolving innovation but it is not specifically linked to respective educational fields and subject areas.

The complex relation between pedagogy and technology resembles the motion of a pendulum, since ICT tool use encourages the diffusion of new pedagogies but new pedagogical approaches impact positively technical developments. Thus, pedagogy and technology mutually impact each other. If the educational integration of ICT tools contributes to the renewal of pedagogical inventory and diffusion of learner-centred approach, we may claim that they represent added value in the pedagogical process. Nevertheless, technical innovation is not a sufficient condition of renewing the pedagogical inventory since the use of ICT tools depending on the way they are used may support but also set back teaching and learning processes (Lai, 2008; Lakatosné, 2008a). Our results also verified Greenagel's (2003) claim that infrastructure, ICT competence level (general, and based on this, the special ICT

competence needed for pedagogical application), and teachers' methodological inventory are all decisive factors in the efficient educational integration of ICT tools.

Based on the current research results, we cannot generalise our findings and draw the conclusions with respect to all Hungarian teachers' ICT competence and the innovativeness of the methodological inventory. Nevertheless, we collected data on participants' ICT use in real life pedagogical contexts and we did not exclusively rely on survey results, which provide self-perceived values. Our findings correspond to results of various other studies (some of them are large-scale studies), which relied only on survey methodology focusing on teachers' ICT use (Buda, 2007a, 2007b; Fehér, 2003, 2007; Hunya, 2006, 2007, 2008; Hunya, Dancsó & Tartsayné, 2006; Török, 2008, Lakatosné, 2007, 2008a, 2008b; Tót, 2000; 2007).

Pedagogical implications of the findings

The relevance and the importance of our study carried out in the framework of the CALIBRATE project and focusing on current pedagogical practices lie – beyond investigating ICT competence and pedagogical innovation – with the fact that it has shown the current value of training and professional training exercise in the field. In pre-service teacher training curricula, the pedagogical use of ICT tools does not occur as individual mandatory course, it is only included as part of courses focusing on other fields of training (Kárpáti, 2008). Freshly graduated teachers count as digital natives, which means that they use technologies without any difficulties but they have modest experience in acquiring methodological skills needed for the pedagogical application of ICT tools. Skills acquired while using digital tools for personal purposes can be transferred to teachers' professional skills in an autodidactic way but it would be professionally more effective if learnt as part of the methodological curriculum. Professional pedagogical competences attached to the computer-supported leaning environments should be acquired in the pre-service teacher training phase (Brouwer & Korthagen, 2005), since only this way will they become embedded (Lam, 1998; Veal & MaKinster, 1999).

Developing in-service teachers' ICT competence is also an important condition of the educational integration of ICT tools. This should focus on both general ICT competence (general knowledge on computers and informatics) enhancement and developing special competences needed for pedagogical application. The effective use of new generational (for some unusual) learning environments equipped with technology is reliant on special – subject-specific – methodological knowledge and expertise; this is best provided via *mentored* rather than *managed* innovation. In mentored competence enhancement, participants become active agents of collaborative learning processes, which may result in transferable knowledge provision.

In our study, we focused on the relations between three phenomena: ICT competence, pedagogical strategies and pedagogical innovation. We believe that in the process of developing an educational system that is competitive and adjustable to the constantly changing system of conditions the above-referred three areas must be further studied in relation to each other. Learner success and teachers' performance measure with respect to ICT tool use and digital resources must be considered as potential future research foci. The success of innovation is legitimized by its usability, usefulness, in other words the acceptance, embeddedness and diffusion of changes, transformations. In the informatised context of the school of the 21st century, it is worth examining the new characteristics of the innovation process such as the role of local and virtual (global) teacher networks as a factor in the potential transformations.

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