

Influence of ICT Development on Education

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The progress of information technology has a major impact on education process as computers represent the main support for most of educational activities. Although investments in ICT in Romania are 10-15 times smaller than in developed European countries, it seems that they are not related to the use of mobile devices. As mobile devices are becoming increasingly more popular, their role in education should not be neglected. This paper presents the transition towards mobile learning, complementary to e-Learning.

Keywords: HCI, ICT, GDP, m-Learning, MBT, MBW, MBL

1 Introduction

The progress of information technology over the past years had a major impact over the society mainly by determining the use of personal computers in almost all domains of activity. At the same time, software applications were developed in order to provide solutions for the design, development, maintenance and optimization of different tasks, personalized for each domain.

The objective of this paper is to identify the benefits and emphasize the importance of using mobile learning solutions in education. The paper is structured as follows. In section *Human Computer Interaction* is presented the evolution in time of HCI and Computer Based Training. The section *Investments in Information and Communication Technology in European Union Countries* presents the IT&C investments between 2006 and 2010 in European countries along with the development of ICT in Romania. The section *M-Learning* highlights the main characteristics of mobile learning. *From HCI to m-Learning* section focuses on transition toward mobile learning. The paper ends with conclusions and future work.

2 Human Computer Interactions

The starting period of the use of personal computers in current activities is known as HCI - *Human-Computer Interaction*. Once people familiarized with them, personal computers evolved from representing a study object to being a tool used for teaching and

studying more efficiently. We can speak of a new stage in the evolution of using personal computers, known as CBT - *Computer-Based Training*. The instruction may be seen as a process of educational domain inside a school or a university, or as a process of other domains of activity.

The use of personal computers for accomplishing instruction in vary domains was based, as a natural requirement, on transmitting information between two or more computers very fast, in order to accomplish current activities. For personal computers located in the same area, the problem was initially solved by using floppy-disks, optical units and local computer networks.

On the other hand, for computers located geographically at distance, the problem of fast transmission of information was accomplished through the development of Internet and of World Wide Web, subsequently. This led to reducing both the costs and the time spent for the instruction process based on the use of personal computers through *Web-Based Training* which relied on educational platforms and videoconferencing systems.

Beside the fast transmission of information between computers, another natural requirement of the development of human-personal computer interaction was *facilitation of communication between computer users even through the use of computers*. Such a communication fostered the collaboration between the users of

personal computers in order to accomplish tasks at work *Computer-Supported Cooperative Work*, between students or participants at different courses in order to learn and accomplish home works *Computer-Supported Collaborative Learning* or research projects *Computer-Supported Collaborative Research* [1].

Today, when we speak about the process of Computer-Based Training through the use of computers, we mean more than it was meant when used for the first time. The definition of the word *computer* currently incorporates also the connection to Internet, Web, or videoconferencing systems and the access to software applications that simplify the instruction process and the accomplishment of collaborative activities. Initially, this type of instruction assumed strictly the instruction based on the use of a computer, without any external connections, the access to information requested for the instruction process and its transmission being done through floppy disk or CD-ROM.

Over time, the instruction process evolved and adapted to new discoveries in information technology.

Starting from the first human-computer interaction, the use of computers in the instruction process was also characterized by a parallel development of computer based collaborative activities, instruction and research, besides evolving from computer based instruction to Web based instruction.

3 Investments in Information and Communication Technology in European Union Countries

The concept of information technology has been firstly used in 1958 by Harold J. Leavitt and Thomas L. Whisler when describing its impact on top and middle-level management [2]. According to their definition, information technology includes three parts:

- quick processing of large quantity of

information achieved by using high processing speed computers;

- applying statistical and mathematical models in decision making problems through the use of mathematical programming and operational research;
- simulating high level thinking through computer programs.

According to [3], information technology is associated with informatics, the science about information processing through automated calculus systems.

Nowadays, the concept of information technology, substituted by the acronym IT, implies the use of computers and telecommunication systems in order to process, store, extract and transmit the information [4]. The development of communication means led to the extension of the concept in ICT, **I**nformation and **C**ommunication **T**echnology.

The weakness of information technology is that devices become obsolete before they get out of order. Thus, in future, the main analyzed indices will refer to obsolescence and to the capability of the population to replace old components that are obsolete or out of order with new ones.

Nowadays, the information technology is an important pillar underpinning the evolution of the society. Investments in everything that deals with information technology – research computerization, activity automation – sustain the development of all sectors of activity: education, health, public administration, defense, production etc.

In the European Union, between 2006 and 2010, large amounts of money have been allocated in order to support information technology. Based on the per cent of GDP allocated by each country for investments in information and communication technology and on GDP per capita of each country, we computed the Euro per capita invested by each country in ICT, Fig. 1.

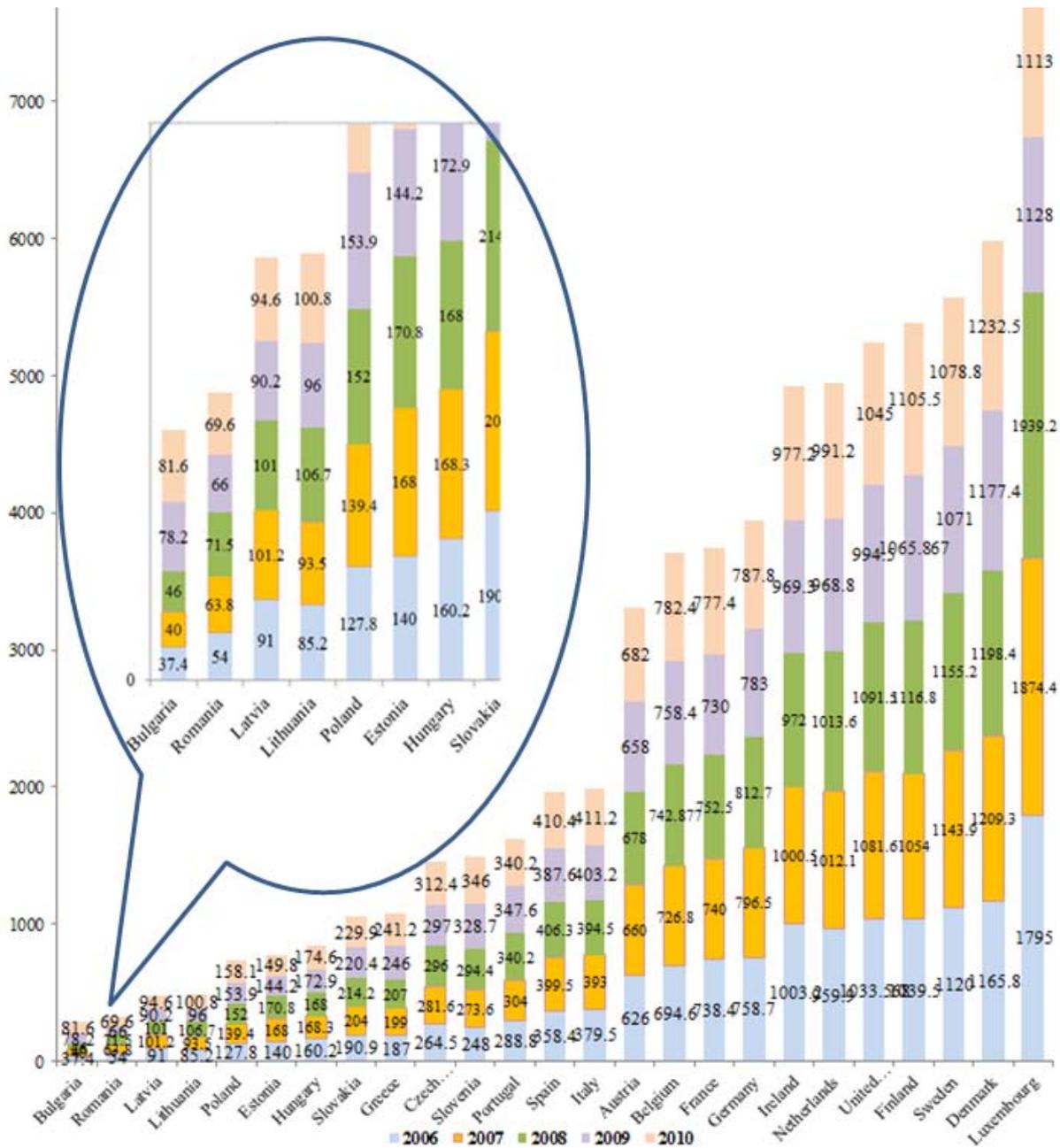


Fig. 1 Euro per capita invested in information and communication technology in European Union countries (data from [5])

The greatest investment in information technology during 2006 and 2010 is done by Luxembourg, with almost 8000 Euro per capita, followed by Northern European countries, United Kingdom and Netherlands which invested between 5000 and 6000 Euro. At the opposite pole, investments done by Romania in information technology do not exceed a total amount of 325 Euro per capita in the last 5 years. The results of the investments in information technology have a

considerably impact on the quality of services provided in developed countries as they have high quality social, medical and educational services.

According to the statistics of European Commission (EUROSTAT 2012), the percent of people using computers in daily activities reported to the total population of Romania increased from 33% in 2006 to 48% in 2011, Fig. 2.

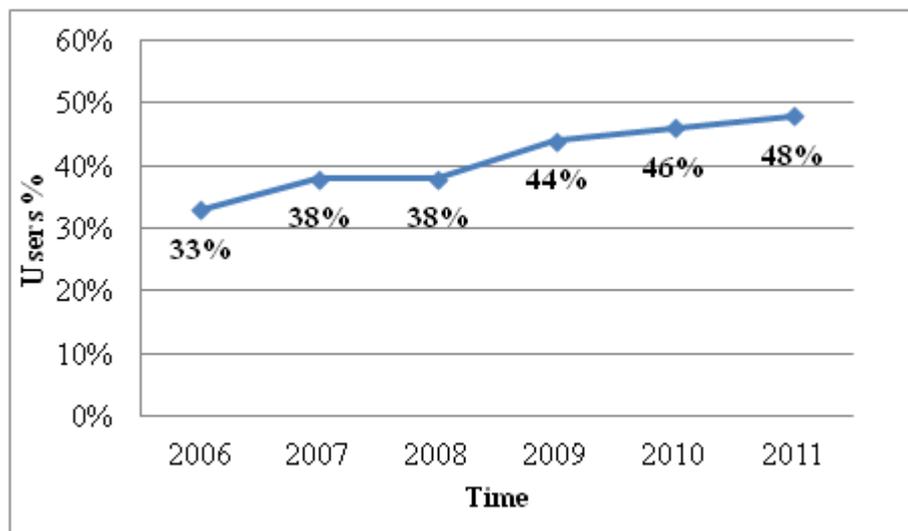


Fig. 2 People using computers in Romania as percent of total population [5]

The constant per cent between 2007 and 2008 is an effect of the economic crisis that started to directly affect Romania. The growth that follows for the next years can be explained both by the growth in investments done in the ICT sector (Fig. 1) and by the

fact that part of the active population started to use computers intensively in order to search for new or better jobs.

Among the total population of Romania, people using computers most frequently in daily activities are aged 16 to 24, Fig. 3 [5].

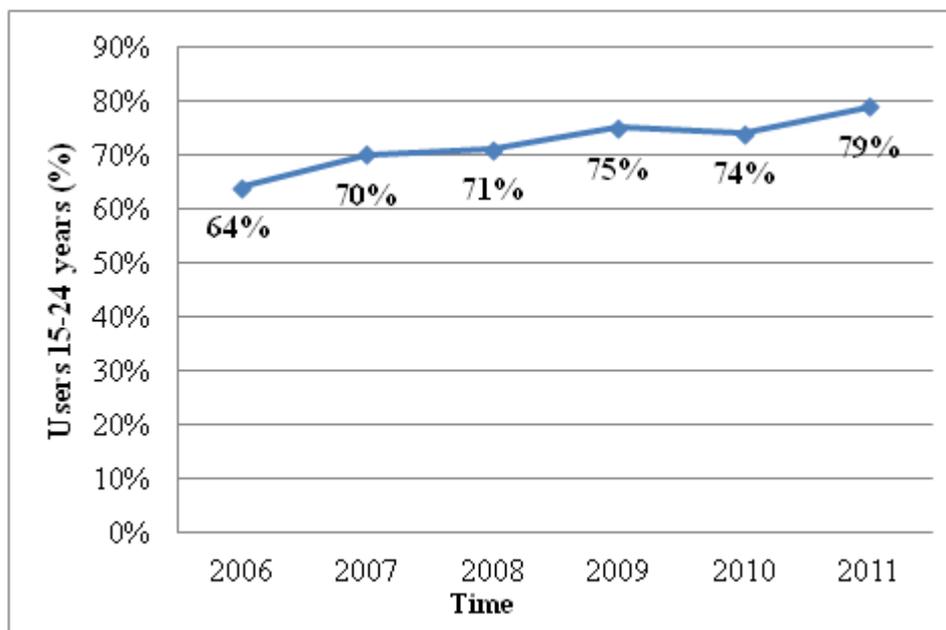


Fig. 3. Dynamics of computer use by persons aged between 16 and 24 in Romania [5]

The intensive use of computers by peoples aged 16 to 24 is also explained by the fact that most of them are either pupils or students, enrolled in the learning system, or fresh employees. These types of people are involved in sustained activities of research

and documentation that imply the use of computers.

Developments in the information and communication technology field led to the use of landline telephony, mobile telephony

and of the internet together with the use of personal computers.

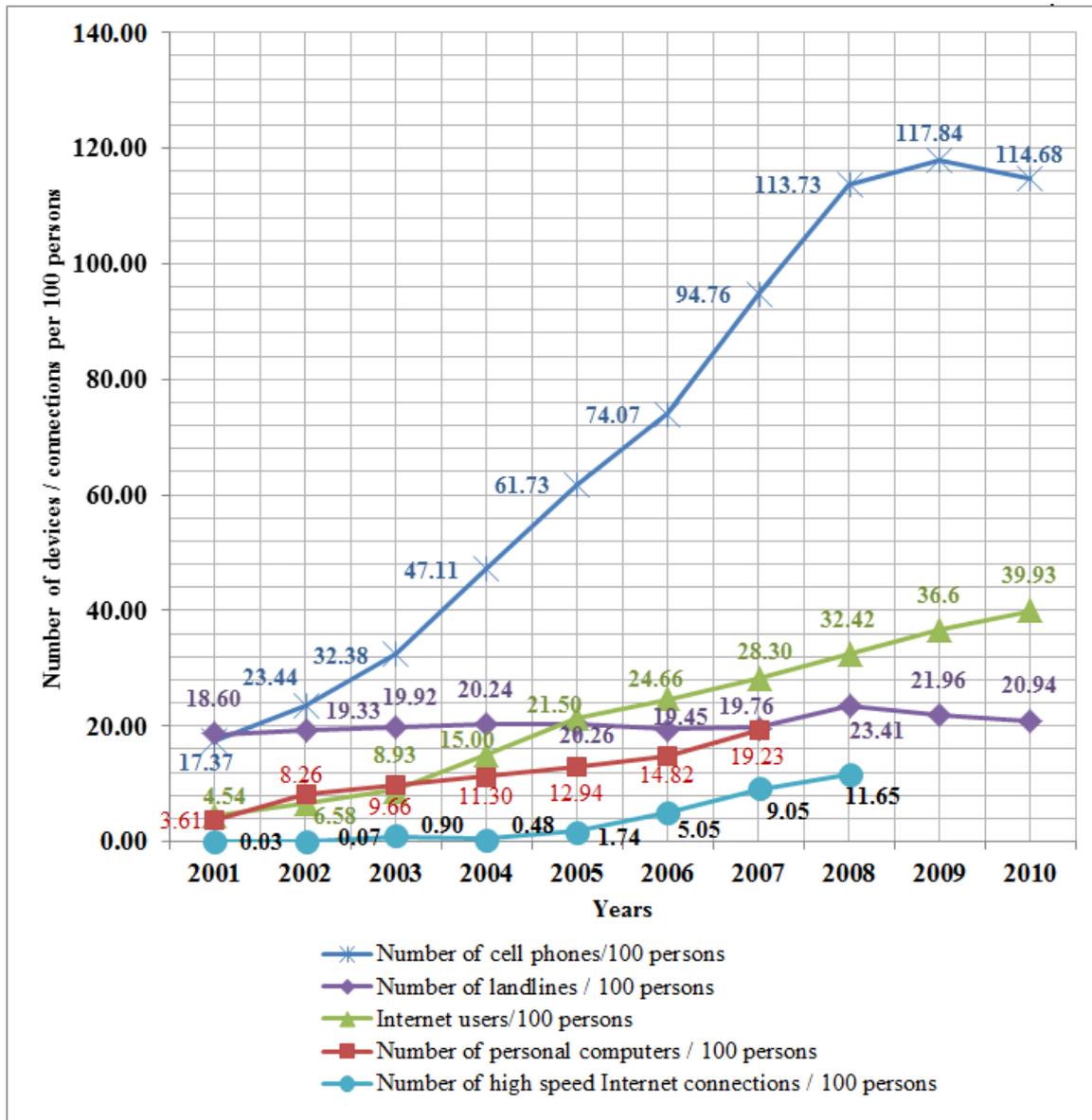


Fig. 4 - Use of Information & Communication Technology in Romania ([6], [7])

The evolution in the use of mobile telephony led to the stagnation in the use of fixed telephony between 2001 and 2010. The current and future research and development in mobile telephony will have as effect the involution of fixed telephony towards its complete disappearance.

The second component of information technology as speed of growth is the access to Internet. If in 2001 there were only 4-5 internet users per 100 persons, their number increased up to 40 users per 100 persons in 2010. Practically, 40% of Romania population used Internet in 2010 which is an

important figure as it refers both urban population and rural population.

High speed Internet connections, represented by cable and fiber connections, increased by 388 times between 2001 and 2008, as reported to 100 persons. Still the number of cable and fiber Internet connections per 100 persons is reduced as this type of infrastructure is implemented mainly in urban environment.

Among ICT devices, the greatest impact on Romanian society was, by far, made by cell phones. The number of cell phones increased by 6.78 times between 2001 and 2009, from

about 17 cell phones per 100 persons to approximately 117 mobile cells per 100 persons, Fig. 4.

The decrease of the number of cell phones per 100 persons between 2009 and 2010 is due to the global economic crisis. The poor economic situation determined the mobile operators to provide better offers in terms of costs and services. This fact, together with the diminishing of population income also led a small decrease of the number of cell phones per 100 persons.

As the use of mobile phones had the largest growth in ICT sector, the impact on the education cannot be neglected and the providers of educational services have to consider mobile devices as a very important option.

3 M-Learning

Along with the development, the diversification and the increase of the use of mobile devices, the instruction process may be extended by activities supported by mobile devices.

Modern technologies in informatics simplified the process of implementing student oriented instruction methods [8]. Distance instruction through means of computer and, sequentially, of Internet redefined the educational process. Students have access to education anywhere, anytime and any time they want to get involved into an educational process.

Courseware educational supports provide students with more chances to study at distance by means of computers. This type of educational materials loses the utility when the student gets out of the digital scope. Mobile devices represent a solution for solving this issue due to wireless communication and technological development [9].

Mobile phones and related technologies started to be used since the end of 60's. Nowadays, mobile phones became devices which are indispensable to daily tasks of any person, regardless of the group age he belongs to: teenagers, adults, and older people.

Using mobile devices in the educational process including mobile phones, PDAs and tablets, led to the raise of the concept of Mobile Learning, known also as m-Learning. Complex m-learning applications include courses, test and quizzes, homework and projects, marks, personal profile administration, payment, history, communication and feedback [10]. This approach in education is relatively recent but it presents a lot of interest for software developers, instructors and students. Mobile devices and, particularly, mobile phones, are no longer technologies that intimidate the users. M-Learning provides a new mean of study for students that are geographically dispersed which can learn using mobile devices.

If distance learning through computers is often considered to be an instruction itself, the instruction through mobile devices should be considered as a method which is complementary to the classical education process and, more, complementary also to distant learning.

Due to their reduced dimensions, mobile devices are discrete and then can always be used by those interested in getting knowledge in different domains. If they have an available Internet connection, full battery and available time, users may study regardless their location in a class room, transportation mean or at home. The main function of these devices is represented by the communication through short messages, information retrieval or by displaying or playing content. Writing large size texts is discouraged due to the small dimension of the screen. Thus, educational supports dedicated to m-Learning instruction must be designed to be optimally displayed on the screen of the device. Also, educational supports should not stress too long the attention of the user, in order to avoid the loss of interest.

Mobile technologies promote, facilitate and improve collaboration, communication and interaction between students. They communicate one with another; ask each other questions and share points of view

regarding common interests in studied domains.

Through features as communication by text messages, dialogue and chat, collaborative tasks among those studying through this method are encouraged. Based on these arguments, [11] states that mobile devices represent a mean of collaborative learning.

Printed educational materials provide students with the possibility of underlining or highlighting paragraphs they consider to be important, of annotating various ideas when they study. The educational process based on computer or mobile devices has the advantage of using mouse, light pen or touch screen.

Although nowadays the accent is on technology, most of the students prefer to print educational materials in order to take advantage of making manual marks and annotations. They feel a greater implication in the educational process if they use a regular pen to mark printed documents.

A similar implication in the educational process is provided to the students by mobile devices used for learning. Because of their reduced dimensions, mobile devices provide a personal nature to the educational process the student is involved in. By instance, the student may make various markups on the documents he studies using his finger or the touch pen or even the tip of a regular pen.

Practically, mobile devices combine the personal nature provided by printed educational materials with the technological advantages provided by a computer: touch screen, Internet, software applications etc.

Because the mobile phone is a daily usage device and the performance of the new models is rising continuously, incorporating more and more useful services, this type of device may be considered an example of device that supports lifelong learning [11].

In the instruction process, the use of mobile devices must be seen as an activity that is complementary to the computer based training. Although mobile devices have continuously increased performances and provide mainly the same advantages as a computer from the point of view of

information technology, the reduced dimensions of the screen prevents the deployment of complex educational activities.

One of the main advantages of mobile devices is the rapid communication of information, which facilitates collaborative activities. Also, mobile devices maintain the user in a permanent contact with education or work activities he is performing, encouraging this way the long-life learning process.

Although most of the mobile devices allow full display of websites on their screen, browsing the websites such displayed may be an inconvenient process due to the poor readability of the content and to repeated zoom in / zoom out operations required for accessing and reading the content. This kind of problems may be solved by using CSS3 technology in order to adapt the website to the actual resolution of mobile devices screens.

Using the media queries (@media) allows the detection of the resolution used by the mobile devices for displaying the websites so that the elements on the pages may be reorganized depending on the displaying space. In order to optimize the access to the information on the website, an option is to load a simplified version of the images when the mobile device is in landscape mode or to completely eliminate the images when the device is in portrait mode. The advantage of using CSS3 for creating websites adaptive interfaces is given both by the easier and more organized access of the information on the website and by the faster load of the pages as the graphic content is no longer being displayed. This is especially important and useful as the access to Internet resources from mobile devices is regularly done through mobile networks at speeds that are far lower than the speeds of Wi-Fi and LAN networks

4 From HCI to m-Learning

In the context of society today, a natural evolution is the accomplishment of activities using mobile devices, as m-Working or m-Learning. Because the main function of a

mobile device, like a mobile phone, is communication, which directly implies collaboration also, we can speak of *Mobile-Supported Cooperative Work* – MSCW and

Mobile-Supported Collaborative Learning – MSCL (Fig. 5, A), which may be developed into *Mobile-Supported Collaborative Research* - MSCR.

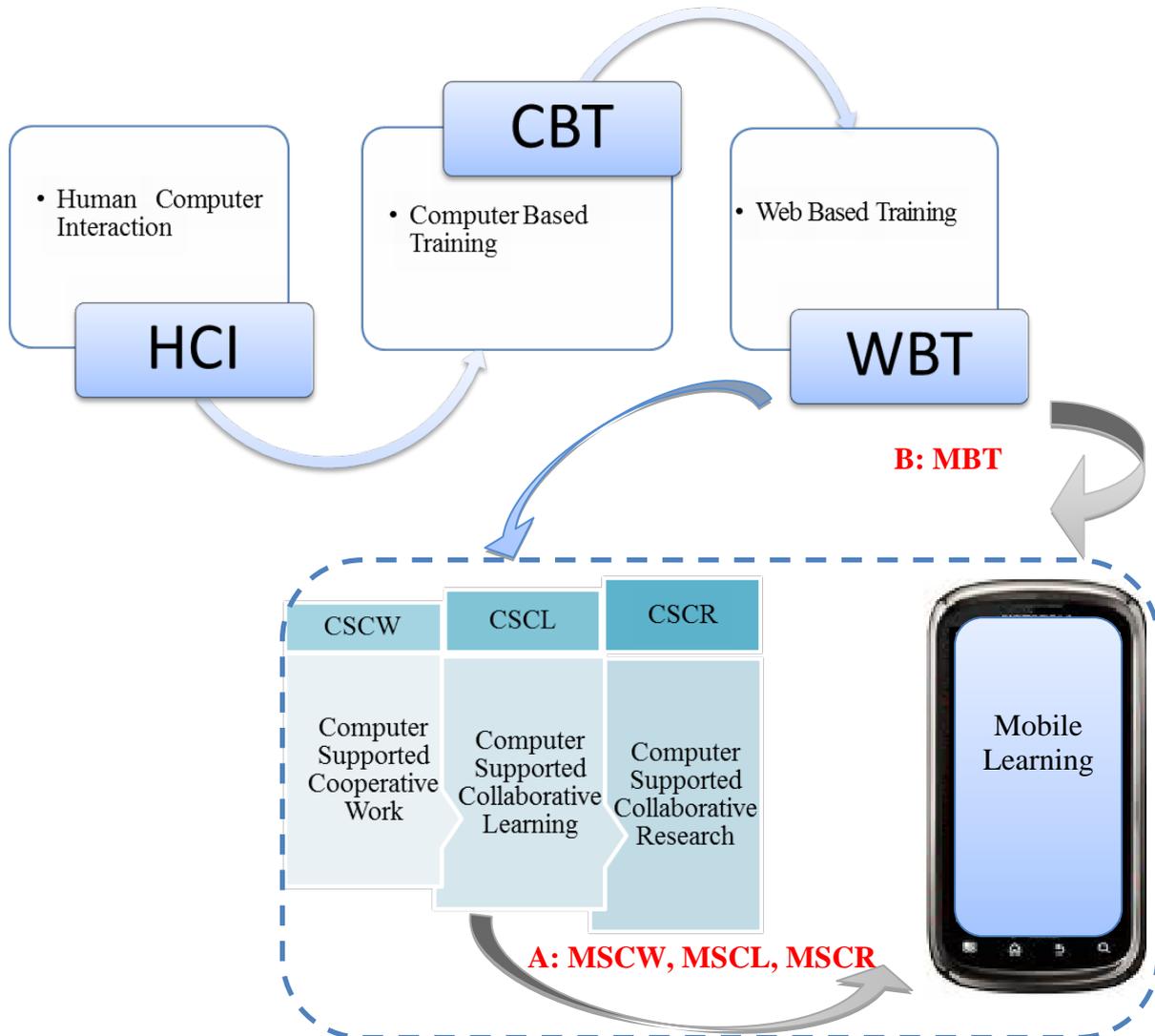


Fig. 5. Instruction process, from Human Computer Interaction to Mobile Based Training

CSCW reflected the dramatic change in the role of personal computer in society, from a personal tool towards a mean of human communication [1]. In the same manner, MCSW reflects the change in the role of mobile devices in society, from tools used for communication towards means of deploying collaborative work. The main role of MSCW is to support collaborative work in order to increase productivity.

The main purpose of mobile devices is to facilitate synchronous and asynchronous communication between users. Thus, they

sustain the development of the social nature of users. We may say that social activities are the result of communication between two or more persons and that they support the deployment of collaborative work.

MSCL is education oriented. The use of mobile devices as support for educational process should not replace CSCL but it should represent an extension of the assisted instruction process based on computers.

MSCL provide learners the freedom to study at their own pace, no matter their location or the moment of time. All the features of m-

Learning are provided by MSCL to the actors involved in the educational process.

Future developments in mobile-supported activities include Mobile-Supported Collaborative Research, MSCR.

We can also look forward to evolving from using computers to using mobile devices in the instruction process, as an evolution from *Web (Computer) – Based Training – WBT* to *Mobile-Based Training – MBT* (Fig. 5, B).

MBT represents a complex process where information is transferred to learners through mobile devices. Learners can access this information using software applications specific to mobile devices.

The activities accomplished through mobile devices are sustained by the development of communication technologies, by the extension the infrastructure of mobile operators and by the dramatic decrease of costs related to data transfer services.

5 Conclusions

The instruction assisted by mobile devices may represent the next generation in the evolution of the instruction process.

The attention of those implied in educational activities which desire the instruction process to be as more attractive as possible for the new generation of students already familiarized with using personal computers, navigating on the Internet and using mobile devices, is guided towards social network, virtual 3D platforms and micro blogging. Their popularity also emphasizes the importance and the influence they have on students' life. Educational domain may take advantage of this influence by using new technologies in order to create educational activities.

Blended Learning integrates different teaching and learning methods and techniques and uses alternatively sessions of face-to-face traditional instruction and distance instruction through computers or through other mobile devices. The purpose of blended learning is to provide instructors and students with the proper environment where the instruction process is more and more efficient [12].

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