ICT-based environment for training: trends, opportunities and challenges

Amos DAVID - Lorraine University, Nancy – DICEN-IDF, Paris
Victor ODUMUYIWA - University of Lagos
Toyin OGUNTUNDE - University of Ibadan, CNAM, Paris, DICEN-IDF, Paris
Olubunmi AKERELE - University of Ibadan, Université Paris-Est Marne la Vallée, DICEN-IDF, Paris

ABSTRACT : *The impact of Information and Communication Technologies in everyday live is established. This is more pronounced particularly in the field of telecommunications such as mobile communications and Internet. This phenomenon is due to the possibility of dematerializing more and more real live objects as well as human activities.*
In this paper, we examine the trends, the opportunities and the challenges setting up an ICT-based environment for training.
After a brief overview of existing initiatives in computer aided education, we will examine the recent opportunities offered by the possibility of dematerializing objects and human activities in training. Of course our proposal transcends any particular domain of training.

I. OVERVIEW OF INITIATIVES IN COMPUTER AIDED EDUCATION

The technological advancement in recent years has witnessed a profound evolution in the field of miniaturization. High speed processing and high storage capacity have been achieved and have really influenced the evolution of the computer world.

Miniaturization has made it possible to produce laptops and smartphones. High speed processors have made the applications that used to run only on computers now ported unto smartphones. Coupled with cloud computing technologies and services, services on computers have gained the functional characteristic of ubiquity in which applications, users and devices can be located anywhere.

These evolutions have made it possible to implement the various activities in training using ICT. Some of these activities include the administration of training and the implementation of training scenarios.

I.1.Administration of training

Administration of training is traditionally handled by empowered organizations such as schools, universities and training centres. What is managed within the framework of training includes:

- Students' admission and registration
- Students' results
- Timetable

Before the advent of ICT, most of these activities were carried out manually and physically, such as travelling to the institutions to effect admission and registration; going to the institution to check examination results and consult the timetable. Presently, practically all these activities can be carried out electronically.

The current trend is that most of the activities that were carried out on personal computers or desktops are now available on smartphones. This is due to the fact that the gap between telecommunication and Internet services has been closed.

The evolution noted in the domain of mobile communication market is that millions of the population will switch to the use of smartphones from the normal classical mobile phones[9].

9. African mobile subscription to hit 930m in 2019 – Ericsson, http://www.vanguardngr.com/2013/11/african-mobile-subscription-hit-930m-2019-ericsson/, 15/11/2013

I.2. Implementation of teaching scenarios[10]

10. http://learningscenarios.org/the-scenario-methodology/

Trends, opportunities and challenges related to ICT based training cannot be fully comprehended without creating a teaching scenario. First, it is important to note that ICT based training embodies everything that has to do with the usage of education technology in training and learning. The technology in this regard includes, but not limited to, software, hardware and the internet. It is therefore necessary to mention some of the other nomenclatures used when referring to ICT based training. Such nomenclatures include: E-learning, computer-based instruction (CBI), multimedia learning (M-Learning), web-based training (WBT), computer-based training (CBT), online education, and technology enhanced learning (TEL) etc.

The Edinburg Scenarios developed in 2004 is a good starting point in illustrating teaching scenario. The Edinburg Scenarios (Bell, Martin and Clarke, 2004) were made up of four global scenarios for describing the future of e-learning. The scenarios were based on two major driving forces: technology acceptance and adoption, and control and ownership of content.

Some of these scenarios are realities of today's e-learning world. The four scenarios as shown in figure 1 include:

Virtual vanilla: describes a world where access to information and learning content are enhanced through advancement in technology. Established institutions are the key players and accesses to content are controlled by large corporations, governments and global universities. This forecasted scenario is a reality today as seen in the deployments of MOOCS e.g., Coursera, OCW, edx etc.

- Web of confidence: like virtual vanilla, this describes a world where technological advancement increases access to content. It also increases interactivity among e-learners. The main difference is that the key-players in this scenario are the learners. New ideas and contents come from various sources. The emergency of Web 2.0 has made it possible for this scenario to become a reality.

- Back to the future: describes a world where technological complexity is accompanied by frustration and loss of trust in online learning. Established institutions return to the traditional methods of teaching and learning. On a general note, this scenario has not become a reality.

- You choose: like "back to the future" scenario, this describes a world where people are frustrated by new technology and seek other ways of learning. Attention is shifted from technology and big institutions towards issues of local importance.

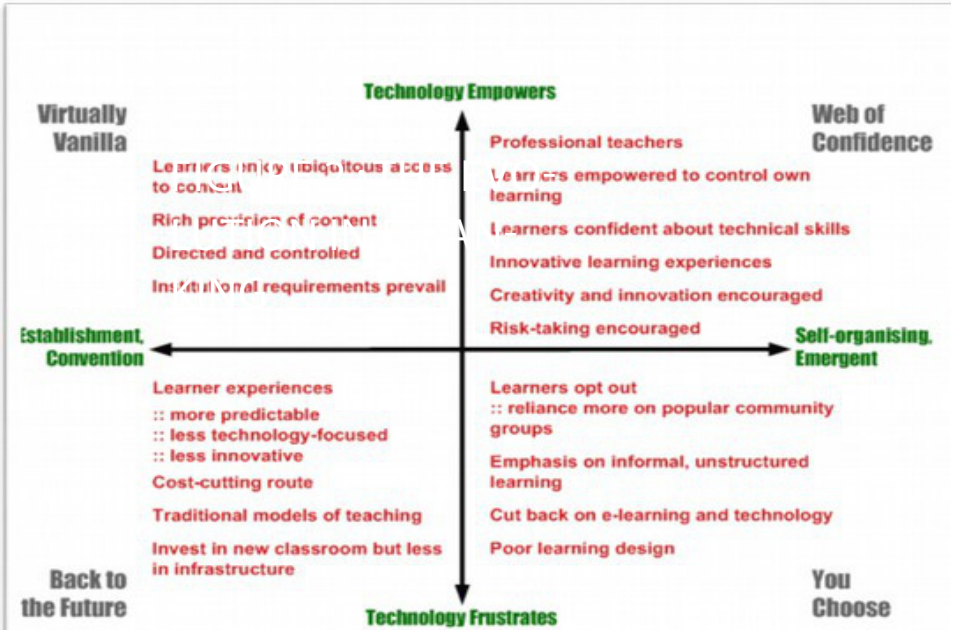

Figure 1 : The Edinburg Scenarios

In the past, ICT based teaching was based majorly on the intranet and users were geographically constrained. It was passive and more of just giving learners access to content. It was also institutionalized as content were produced and managed by institutions [Figure 4 :]. It was meant to supplement the traditional classroom teaching. The present state of ICT based training is reflected in two of the Edinburg scenarios: virtual vanilla and web of confidence.

ICT based education should be centred on the student(s) or the learner(s). They are the starting point. Everything revolves around them. Any educational content produced is aimed towards a learner or group of learners. The transactional environment that surrounds the learners and with which they interact comprises of the instructors, the content producers, the institutions and the provider of e-learning technologies used. The transactional environment is shaped by some factors (or driving forces) which constitute the contextual environment. Such factors include:

- Technology: as technology advances, online education becomes easier to deliver as regards to transmission and access. Technology does not determine the quality of the content but it can greatly affect the presentation of the content. The use of augmented reality and virtual reality can create a learning environment that is very close to the physical classrooms.

- Globalisation: distance is no more a barrier to quality training. The need for the under-developed and the developing countries to have access to quality education is greatly impacting the e-learning world. Many established western institutions now make some of their courses available online for free. The work force in different organisations is from the global market. The need to create a global platform for ensuring balanced education is a driving force influencing the growth of ICT based education.

- Cost reduction: the need to reduce training cost is also a determining factor in the progress of ICT based education. Developed content could be reused over and over with little running cost. Video lectures could be reused for many years as long as the content is valid without the need of continually paying the professor that produced the content.

- Time management: the increasing complexity of the world we leaves in and the increasing skills demand in work places calls for effective time management. Employees need to keep upgrading their skills in order to meet up with the challenges in the work place. It is becoming more difficult to combine work with traditional way of schooling. The need to provide alternative way of continuous education with personal time management as a priority is another important factor driving the future of e-learning.

II. TECHNOLOGICAL BREAKTHROUGH IN ICT

Two events have characterized the technological breakthrough in recent years: the closed bridge between telecommunications and Internet; and the possibility of dematerializing physical objects as well as human activities.

II.1. Dematerialization of objects and human activities

Various types of object can now be dematerialized. Dematerialization takes two forms:

a) An existing physical object is transformed into electronic form. This is generally the case for paper documents. The main technique is scanning.

b) A document can be directly produced in electronic form. However, in order to transport the content of the document, there is often need to attach the electronic document to a physical container. This is the case for e-passport, e-driving licence, etc.

Several types of human activity can now be dematerialized. The activities concern mainly services rendered by human beings, with some examples given in list of e-services below.

Some examples of the dematerialized objects and human activities are presented below.

E-cards:

- Various electronic cards in the banking sector
- National electronic identity card
- Electronic voting card
- Electronic student identity card
- Electronic professional identity card etc.

E-documents :

- Driving licence
- International passport

E-services :

- E-learning
- E-commerce
- E-banking
- E-governance
- E-voting
- E-farming
- Tele-medicine
- E-ticketing etc.

II.2. Bridge between telecommunication and the Internet

The bridge between telecommunication and Internet has been established. This technological development has made it possible to perform telephone services over the Internet and as well interact with information systems through telecommunication. The common characteristic of these E-services is that they are all built on a platform of information systems. The interface to these information systems can be developed on simple devices ranging from mobile handsets, smartphones, laptops, desktops, dedicated platforms, etc.

Figure 2 : The evolution in E-banking

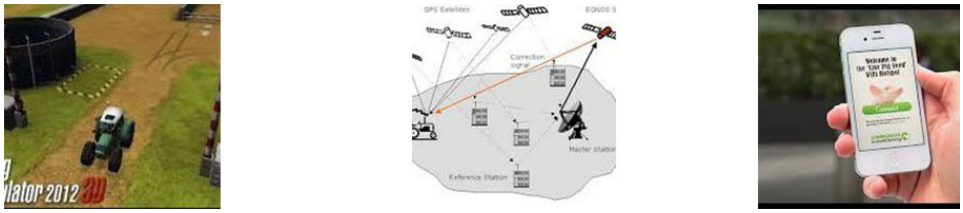

Figure 3 : The evolution in E-farming

Figure 4 : The evolution in E-learning

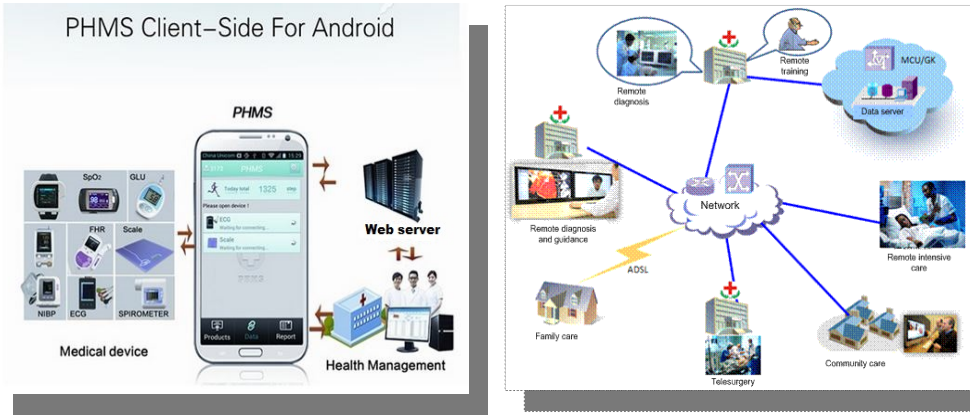

Figure 5 : The evolution in telemedecine

II.3. Web 2.0 technology

One of the new trends in computer aided training and research is the advent of Web 2.0 technology. It can simply be referred to as ever changing dynamic World Wide Web where people collaborate, share and communicate. Web 2.0 applications include blogs, wikis, RSS, social networks etc. The main difference between the traditional web and web 2.0 is the collaboration among the users and their input into the web in real time.

II.4. Video conferencing

Videoconferencing is the conduct of a videoconference[11] (also known as video teleconference) by a set of telecommunication technologies which allow two or more locations to communicate by simultaneous two-way video and audio transmissions. It has also been called 'visual collaboration' and is a type of groupware. It is an example of real-time integration.

11. http://en.wikipedia.org/wiki/Videoconferencing

With the introduction of relatively low cost, high capacity broadband telecommunication services in the late 1990s, coupled with powerful computing processors and video compression techniques, videoconferencing has made significant inroads in business, education, medicine and media.

Like all long distance communications technologies (such as phone and Internet), by reducing the need to travel to bring people together, the technology also contributes to reductions in carbon emissions, thereby helping to reduce global warming.

In the 2000s, video telephony was popularized via free Internet services such as Skype and iChat, web plugins and on-line telecommunication programs which promoted low cost, albeit low-quality, videoconferencing to virtually every location with an Internet connection.

Mobile collaboration systems now allow multiple people in previously unreachable locations, such as workers on an off-shore oil rig, the ability to view and discuss issues with colleagues thousands of miles away.

III. Knowledge representation, acquisition and reuse in E-learning

The available technologies allow the management and transport of contents. However, the efficiency of the associated services depends highly on how the objects and the activities are represented. The elements to represent takes the form of information, knowledge or intelligence.

III.1. Representing human activities and interactions

One of the most important aspects of ICT-based training is the management of the activities and interactions of the actors. In any learning environment, users interact synchronously or asynchronously and carry out different activities towards achieving the defined learning objectives. Users (learner, instructor, support) interact with one another and with generated contents. User's activities thus include creating content, reading content and annotating content. In carrying out these activities, users interact summarily in two modes: passive (observation mode) and participatory. In the passive mode, user acts as a receiver of information. S/he reads the contents and consults the resources available on the platform. In the participatory mode, user does not only consult resources and contents but also creates content. Therefore, to properly manage the human activities and interactions in an ICT-based training, there is a need to represent these activities based on the two modes of interaction.

Passive mode: user's activities in the passive mode are more of information consumption. The major attributes of concern in this mode include:

- User identity: any time a user is consulting a resource on the platform, his/her identity should be made known to the system and attached to the trace of the activities carried out on the resource.

- Resource identity: any resource being consulted should have an identity. Such identifier should be included in the activity profile of the user that consulted the resource.

- Consultation period: the consultation start time and end time are also necessary in describing the activity of a user. This enables the computation of the consultation period of a resource by a user.

- User's context: this includes the geographical location of the user at the point of access, the type of platform from which access is sought (operating system, device type: PC or smart phone), and the connection bandwidth.

- Use context: this captures the objective of the user i.e. the learning objective under which a resource was consulted.

Participatory mode: in this mode, users engage in both content production and consumption. All the attributes used in representing users in the passive mode also apply in the participatory mode with the addition of the time a content was created:

- Sending-User identity: the identity of the user creating the content

- Receiving-User identity: the identity of the user to whom the content is destined. It could be an individual user or a group of users

- Resource identity: as content is created, an identifier is attached to represent the content. Therefore, the created content identifier should be included in the representation of the activity of the creator.

- Time: the time the resource was created is also needed to add a temporal context to the activity of the user

- User's context: same as explained above

- Use context: describes the learning objective that necessitated the creation of the content.

Representing the human activities and interactions as stated above will foster activity awareness among the users.

In our research studies, we have chosen to represent in terms of three entities: the user who specifies the problem, the problem to be solved and the document used to solve the problem. Context is the set of suitable environmental states and settings concerning a user, which are relevant for a situation sensitive application in the process of adapting the services and information offered to a user [3]. It can also be seen as any information that can be used to characterize the solution of an entity. Our interest is on how we can adapt the system to the specificity of the user. User modelling is proposed to know the context of the user. The figure below represents the relationship among them.

Knowledge Acquisition

With the advent of web 2.0 technology, traditional web content is becoming a repository of experience, where user's contributions have made an impact within the web. In this work, Knowledge is acquired from the user's activities through the process of document usage where a document is linked to its usage. We proposed the process of document usage specification for knowledge acquisition. The process links document to its various usages and also specify the degree at which a particular document is relevant in solving a particular problem. The usage process is used to capture various usages of a document in solving problems. Each document usage can be distinguished by respective timestamp such that an existing use context of a document will not be replaced by the new use.

Knowledge Reuse

To aid strategic decision making, there is need for reuse of the acquired knowledge. The acquired knowledge can be reused through querying the system. The case-based reasoning techniques is employed as the cognitive process used in solving the problem.

IV. Enhancing E-learning

Integration of user model for adaptive ICT-based education systems

As presented in , ICT based education should be centred on the students or the learners. A success factor of an ICT-based education environment is its ability to adapt to the student's aptitude and preference.

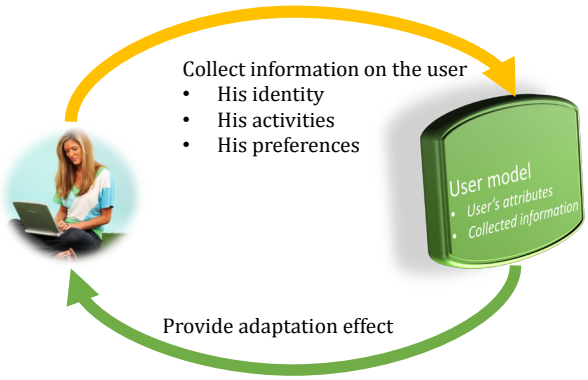

Figure 6 : Classic loop "user modelling – adaptation" in adaptive system [1]

Adaptive system is a system that adapts to various circumstances or conditions. A distinctive feature of an adaptive system is the creation of the user model that represents user's knowledge, goals, interest, context of work and other features that enable the system to distinguish among different users [1].

User model specifies the attributes used for representing information about an individual user that is essential for producing the adaptation effect of the system i.e. to behave differently for other users [2]. An adaptive educational system rely mostly on knowledge on the user and learning goals. Figure 6 : gives an overview of the functionality of an adaptive system.

IV.2. Application in collaborative information seeking

Information seeking is a socio-cognitive process. It is a learning process aimed at resolving anomalies in the knowledge state of an individual. An individual begins to seek for information when s/he discovers a lack of knowledge in either solving a problem or in becoming more enlightened on a subject/topic. Belkin (1978) describes this as an anomalous knowledge state. Seeking for information to resolve this anomaly involves interaction with knowledge resources either in a tangible form or in an intangible form. This could be done collaboratively.

Collaborative information seeking (CIS) is one of the areas in which we implemented some of our proposals mentioned above. CIS could be considered to be at the intersection of information search, communication, knowledge management and social networks. Search and communication are the major activities in CIS but during CIS activities, new knowledge is produced and such knowledge should be managed (organised, structure and stored). In CIS systems, networks of collaborators are being formed. CIS systems should be able to manage networks of collaborators and facilitate formation of new networks of users. Based on this background, our CIS system (named MECOCIR) was designed to support group formation. A user can work independently on an information search problem using MECOCIR. S/he could seek for recommendation of potential collaborators based on the similarity of their domain knowledge to his/her defined information search problem. S/he could then demand to engage in synchronous collaboration with such recommended users. MECOCIR imbibe the principle of using people to find content and using content to find people. MECOCIR also allows a predefined group of users to engage in CIS activities. Every member of the group signs up on MECOCIR and one of them defines the problem to be solved and they interact together on the problem.

The design of MECOCIR is based on a client-server architecture as shown in Figure 7:. The bulk of the work is done on the client while the server brokers information exchanges between communicating clients. The server also hosts the collaborative repository where captured activities and expressed knowledge during CIS sessions are stored. Each client has a personal repository where users could store documents.

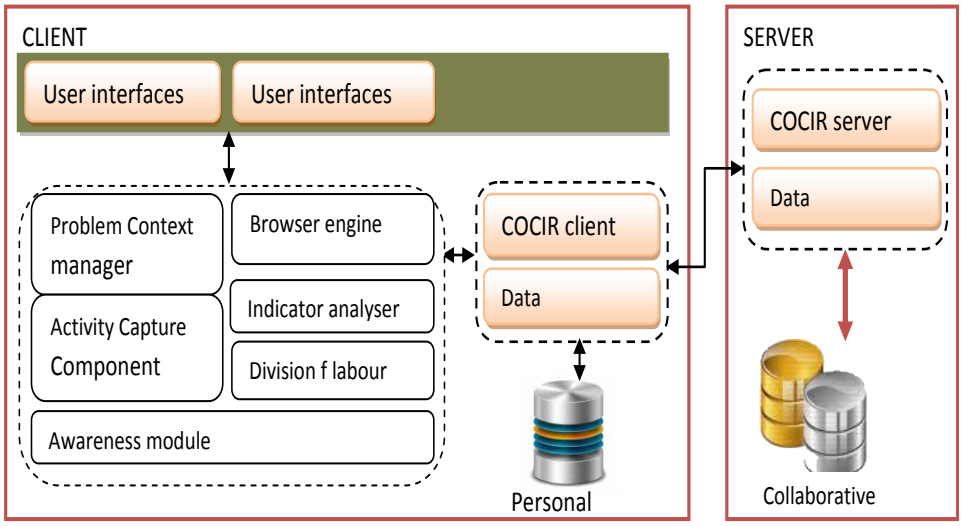

Figure 7 : MECOCIR architecture

When a user logs in to MECOCIR, a window opens with four tabs as shown in figure 4. The "Home" gives access to general information about the system. The "Problem definition" tab shows the problem definition interface which comprises of the defined problem and the clarifications made on the problem. The tab "Online search" provides access to an inbuilt browser which allows users to access any web page of their choice. The fourth tab is for accessing the collaborative repository. Before a user can start browsing for information using the online search, the system requires that an information search problem be defined or an existing search problem be selected as the current problem to work on. This is needed to create a problem context for every interaction on the system. Every visited url is attached to a context.

MECOCIR has a side bar which provides presence awareness and activity awareness for participants. It also has a bottom panel which is made up of three panes: the chat pane, the current document analysis pane and the message pane. The chat pane is for exchanging instantaneous messages during synchronous collaboration. The current document analysis pane contains three tabs: evaluation, indicators and inline annotation. Evaluation tab shows the numerical and textual evaluation made by participants on a currently displayed page. As a user browses and a page is loaded, if the same page has been visited by other members of the group, this tab displays immediately all the evaluations that have been made by the members of the group on the page. The message pane handles asynchronous communication.

MECOCIR provides a feature that allows participants to synchronize the pages being viewed. During a synchronous CIS session, a user can "take lead" and his partner "follows" (cf. Figure 8 :). The person taking lead does the navigation and controls what is displayed on the "Online search" interface of his/her partner.

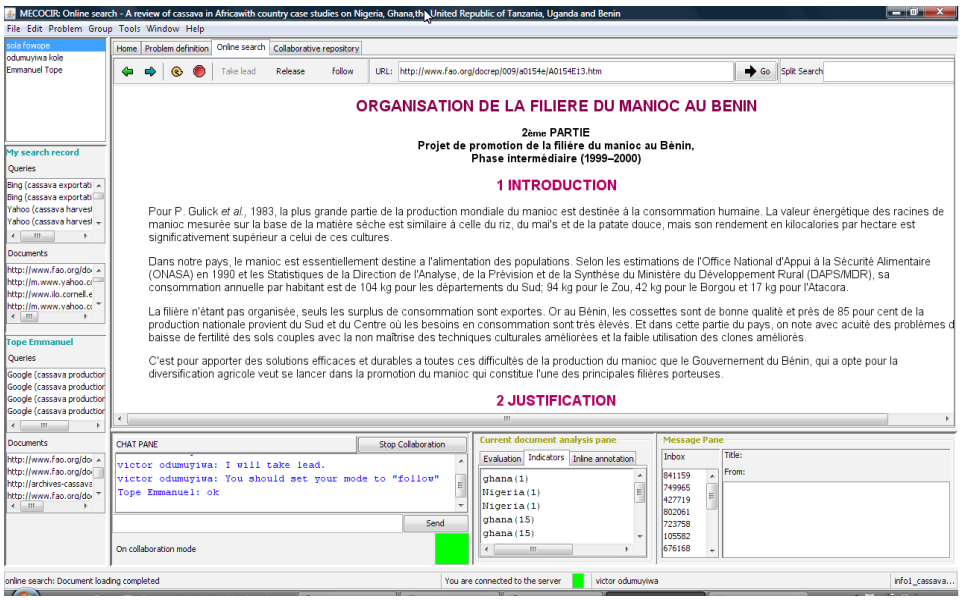

Figure 8 : MECOCIR main window

V. Conclusion

As presented in this paper, various technologies are currently available for building ICT-based learning environment since learning revolves around physical objects and human activities. The low cost trend of the technologies makes it possible for more people to have access to the facilities wherever they are located geographically.

The main challenge is now on how to build the contents in form of objects and human activities. The current trend in the field of mobile phones enlarges even more the opportunities. The development of apps (applications associated with mobile phones) are currently proposed to users to transform various forms of perception into objects, which can be stored in form of information, transformed into knowledge and then into intelligence.

Learning objective which focuses on the transfer of knowledge is a very suitable application platform for these various evolutions in the field of ICT.

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