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Digital competence assessment and teaching strategies in the knowledge society

Antonio Cartelli

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Antonio Cartelli
cartan@unicas.it
University of Cassino, Italy

Abstract

The paper first shows the features of the InnovaScuola project, which aims at introducing new technologies and teaching innovation in Italian Primary School and Junior High School; the analysis of the sample of the teachers involved in the project and the description of the activities planned and carried out in cooperation with the Laboratory of teaching and learning technologies follow. Soon after the problems evidenced from students while approaching discipline structured knowledge are reported, the need for digital literacy is discussed, a framework for digital competence assessment is described and the results from a survey on digital competence assessment are analyzed. At last the discussion on the instruments and strategies used during the teachers' training activity is reported. Among other things the importance of the problem solving strategies for the improvement of everyday teaching are highlighted and the functions of problem searching, problem finding and problem building are proposed for teachers.

Keywords: digital competence, interactive whiteboard, knowledge society, learning object, teaching-learning strategies

Introduction

The Internet, and all the services on it, are changing mankind and human society for the effects they have on the acquisition of information and on communication strategies; they are also influencing individuals' learning, knowledge development and, more generally, interpersonal and intrapersonal relationships.

The phenomenon has been widely analyzed since its origins, and many studies have shown that the IT/ICT provided deep changes on learning environments, either formal, non formal or informal (Conner, 2004; 1997-2007); it is important to recall here, that also the relevance of the above environments on the different stages of human development is changed, and the effects of digital technologies on intentional and unexpected learning have been widely modified.

Furthermore, the same Internet is often considered responsible for the differences letting people access information and manage it. More specifically, the digital divide, once identified with the lack of communication equipment in the underdeveloped countries, is today considered a growing problem in developed countries (Bindé *et al.* 2005; Guidolin, 2005), where it is identified with:

- the gap in the pre-existing personal differences between people who can use technologies (are able in the use of), and people who cannot
- the gap in the content management between people who master it (i.e., subjects who are able in the use of ICT to manage information, knowledge, know how etc.), and those who cannot.

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In this context it has a special relevance Baumann analysis of today society (2006), due to his definition of "liquid modernity"; for Bauman the destruction of the certainties in the liquid life forces the subjects to adapt to group behaviour to avoid exclusion.

As a result of the above issues the following questions arise:

- how much theories and models from educational research are used from public institutions and governments to produce innovation in everyday teaching?
- what role has the School in today society to help students in developing self-learning skills, meta-cognition abilities and lifelong learning strategies?
- what role have digital technologies in everyday teaching-learning processes to improve the quality of teaching and help students in overcoming their difficulties?

A first answer to some of the above questions has been given from Galliani (2004), who proposed an integrated model for the use of e-learning strategies at school. In his model, web based learning and computer mediated communication (CMC), both determine the development of students' knowledge, skills and competences.

Due to the features of the web the most relevant elements proposed for students' learning are information retrieval (IR), knowledge management (KM) and the use of learning objects (LOs). The CMC induces and improves social actions, like computer supported collaborative learning (CSCL), computer supported collaborative work (CSCW) and action research (AR).

Figure 1 synthesizes the structure of the model described above.

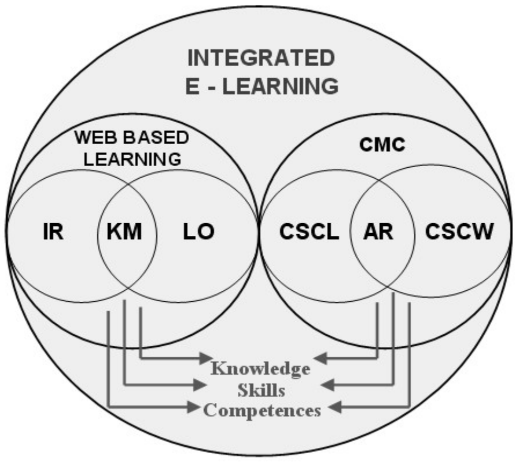

Figure 1. Model for integrated e-learning strategies (by L. Galliani)

In this paper the above model is used as a framework for the analysis of an experience the author made while supporting some schools involved in a national project for teaching innovation (the "Innovascuola" project, described below).

The main aspects of the experience have been based on the following issues:

- teachers backgrounds, the planning of the training activities to be carried out and the instruments and strategies to be used in the teachers' training and in the proposal of learning units to the students
- the use of the results from an inquiry on digital competence assessment to obtain new teaching units of learning in everyday school work.

The InnovaScuola project and the teachers involved in it

The work the author made with the teachers is the result of the agreement between the Laboratory he manages and the schools aiming at participating in the *Innovascuola* national project; its features are described in this section.

The Laboratory had to support the schools in the choice of the instruments to be used for teaching and to help them in the planning of the teaching strategies to be adopted in everyday school work.

The constraints the author was submitted to during his work were as follows:

- the introduction of new instruments and processes in the schools had to respect the commitment of the approved projects, as stated by Italian Ministries and Agencies
- teachers' training had to be based on the knowledge and skills the teachers involved in the project already had.

The InnovaScuola Project and the introduction of IWB and LOs at school

Since 2006 the Italian Ministry of Education has proposed the introduction of Interactive Whiteboards (IWBs) in the school, to produce direct and effective changes in teaching-learning processes. This idea came after more than 20 years of different projects for the introduction of informatics, computer programming and more generally multimedia, IT/ICT and new technologies in education (Cartelli, 2002). The main differences with past experiences are as follows:

- No specific computing topics (i.e., algorithm development, computer programming etc.) had to be introduced in study curricula
- Teachers were directly involved in the digital revolution, which had the students at its core attention; they had to actively and collaboratively involve students in the construction of their knowledge and skills and had to use the strategies of web 2.0 for hitting this target (DIT, 2010).

The project started in 2008, when the Ministry of Education guaranteed the distribution of equipment and funds to the schools. The Department for Innovation and Technology, the agency of the Presidency of the Italian Council of the Ministers, which was entrusted of the management of the project, started in that year a national competition for the assignment of the IWBs, of the funds and other equipment to the schools. The main obligations for the competitor schools were:

- They had to propose biennial educational projects centred on the production and use of learning objects (LOs)
- They could subscribe agreements with firms, corporate, associations and universities to carry out their projects; the agreements had to guarantee the support for the choice of the more suitable equipment and the training of the teachers involved in the projects
- School's projects could provide teachers with incentives for the extra work needed for the creation of the LOs
- A given number of LOs had to be made up before the end of the project, and they had to be available on a national virtual space from every teacher in any school (i.e., on a platform for LOs distribution)
- The LOs created by the teachers had to be Scorm 1.2 compatible and based on the use of Open Source software.

The schools and the teachers involved in the project

As soon as the call for participation in the competition ended and the projects of the schools were evaluated, it was clear that 4 networks of schools (i.e., groups of schools made of at least one public institution), three in Southern Latium and one in Molise, could start their projects in cooperation with the Laboratory of the author.

In the first meeting with the teachers of the different schools a survey was made to analyze the context; the following data were collected:

- There were 36 teachers working on the different projects, they were from Primary Schools and Junior High Schools (i.e., most part of the networks included both kinds of schools, or were made of schools including both kind of students)
- The answers to a questionnaire and an interview to those teachers show that almost all among them had the basic computing skills and knowledge, but only a little minority had the pre-requisites for the immediate start of the projects. The result of the inquiry (i.e., the answers to the questionnaire) is synthesized in table 1, where the percentage of positive answers to the various questions is reported.

Table 1. Basic computing knowledge and skills held by teachers

N.	Description	%
1.	Basic structure and operation of a computing system (creating folders, copying files, saving information etc.)	100
2.	Advanced operation on a computing system (back-up and restore of data, clearing and defragmenting the system, connecting and managing devices etc.)	9
3.	Using a word processor (at home and at school)	100
4.	Using a spreadsheet (at home and at school)	31
5.	Using a presentation manager (at home and at school)	56
6.	Browsing the web frequently	75
7.	Communicating by e-mail periodically (at least once or twice a week)	53
8.	Editing of images	12
9.	Web editing	3

The interviews produced a supplement of information which is reported in the remarks below:

- Only three teachers (9%) knew Open Source software, and only one really used it (e.g., the suite of office automation Open Office)
- The image editor used from the teachers who positively answered question 8 was MS Paint (included in the MS Windows operating system), which is very limited and does not manage the image formats needed on the web
- No teacher had former experiences with e-learning platforms
- Almost all the teachers had preconceptions on the use of IWBs: they thought in fact that IWBs could be used only like traditional projectors connected to a PC (i.e., to show multimedia materials to the class).

As a result of the above survey it emerged that the first need of the teachers was to know the instruments to be used and what teaching processes could be activated with them.

On the side of the instruments, the following Open Source tools complying to the requests of the project were suggested:

- Open Office as the tool for office automation (at least word processing, spreadsheet, presentation management)
- Gimp and/or Paint.net for image editing
- Exe-learning for the editing of learning objects (it creates LOs SCORM 1.2 compliant)

- Moodle has been the e-learning platform suggested to teachers for online activities.

To let teachers experience the features of the e-learning platform they have been allowed access to a Moodle platform, and all the materials used both in the kickoff meeting and during the different lectures have been put online on that environment.

A few meetings on the features of the software followed, and gave to the teachers the basic instructions for its use. Two lectures were made up soon after, with the main aim of soliciting the teachers interest on the following topics:

- the didactical use of learning objects depending on the involvement of the different actors (i.e., students and teachers)
- the proposal of some topics to focus on, during the second and last part of the projects, so that suitable disciple and cross-discipline units of learning could be developed in the classes, based on the creation of LOs and the use of IWBs.

In the first case the scheme reported in Figure 2, where the planning and carrying out of LOs is connected to the different psycho-pedagogical paradigms, has been used to discuss with the teachers and let them see how LOs could intervene in everyday teaching.

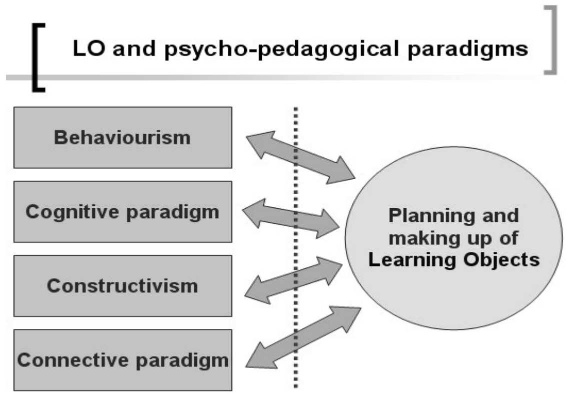

Figure 2. Psycho-pedagogical paradigms and LOs

This approach made easier for teachers to understand that:

- The equipments and the LOs could be used in different ways in their classes
- The correspondence of one paradigm with the activity to be held in the class did not depend on the structure of a given LO, it was more properly the result of the teaching-learning processes activated by the LO
- The choice of a given psycho-pedagogical approach in a teaching-learning activity did not exclude other approaches (i.e., other paradigms).

In the second case a list of different LOs was made on the topics proposed from the teachers, they mostly depended on the disciplines they taught; before passing to their creation the following themes were proposed to teachers for discussion:

- The results from the OECD-PISA surveys, which showed how difficult is for Italian students (at all school levels, from primary to high school) to solve verbal-linguistic and logical-mathematical problems
- The results of an international competition called “Beaver” used for the assessment of students’ digital competences. The choice of this last topic was the consequence of the discussion the author had with the teachers on the features of the net generation and

on the differences existing between digital natives and digital immigrants (Prensky, 2001; Mantovani & Ferri, 2006).

In the next section the last two arguments are widely analyzed and at last a few examples of learning objects to be created collaboratively in the classes are discussed.

Students' learning and digital competence assessment

The discussion on the OECD-PISA surveys, and the low level of Italian students performances, have been very useful to introduce the more general question of students' learning difficulties. This problem is analyzed in the current section and is compared with the results from a survey on students' digital competence assessment, which was made in conjunction with the international competition "Beaver".

The main result of the above issues has been the proposal of some learning objects which have been discussed with the teachers and built collaboratively.

Knowledge construction, meaningful learning and students' problems

When looking at knowledge construction, two main positions must be considered. On a first hand, individuals' learning is compared with the structure of scientific disciplines and evaluation/assessment strategies are used to express the compliance of the subject's personal knowledge with the scientific knowledge. On another hand, when knowledge development is mainly analyzed from the social constructivist and cultural viewpoint, the comparison with scientific knowledge is on the background and self-consistency, activity, support and scaffolding elements are paramount. Otherwise stated, knowledge phenomena are the main object of analysis. As a consequence of the above issues it makes sense to ask the following question: what does it mean "meaningful learning" in students' knowledge development?

There is no general agreement on the meaning of the term "meaningful learning" and the main definitions on this topic are due to Ausubel (1990) and Jonassen (1994). The former looks at meaningful learning as the result of the interaction of the subject with the environment, when three main factors occur: motivation to learn, self-consistency of the topic to be learnt and presence of specific sub-sumers (pre-knowledge elements) letting new topics insert in the subject's knowledge-tree in the right way. The latter reports that meaningful learning lays on three main factors: the construction of knowledge, a meaningful context and the interaction between learner and teacher; as a consequence meaningful learning is: active, constructive, collaborative, intentional, conversational, contextualized and reflexive.

The above approaches have their counterpart in the definitions used to describe the problems that students meet in explaining natural phenomena, especially when there is a comparison with the right scientific explanations.

By adopting the first viewpoint Driver and Erickson (1983) defined nomothetic the studies which evaluate the correctness of people's ideas with respect to the scientifically accepted paradigms; on another hand they called ideographic the studies on the ideas that people show when they explain phenomena with no dependence from scientific paradigms (i.e., only the internal coherence of the people's concepts and ideas is evaluated).

As it can be easily deduced from the theoretical work of Driver and Erickson, many investigations and researches have been made all over the world in the '70s and in the '80s, to find instruments and strategies to help people overcome the difficulties they meet in the study of scientific disciplines and in learning new topics (i.e., most recent investigations have shown that misconceptions and mental schemes do not affect only natural sciences and/or technical knowledge like IT and ICT, they are also present in history, literature and other humanity's cross disciplines fields).

Despite the lack of a unique approach to the solution of the students' learning problems many situated analyses and *ad hoc* instruments and strategies have been proposed during last decades (i.e., they were mostly based on interactive and social constructivist experiences, often based on the use of special equipments, and produced very good effects on the classes involved in the experiments). The traces of the fragmentation of the interventions can be found in the educational chapters and special interest groups of the different scientific associations (like those of mathematicians, physicians, biologists, computer scientists etc.). The most successful experience in the creation of a cross discipline studying people's learning has been made by the Meaningful Learning Research Group (MLRG, http://www.mlrg.org); within it four international conferences were organized, many hundreds of papers on the above topics were published, and Novak ideas on knowledge maps were developed ad proposed to teachers (Novak & Gowin, 1984).

At last it must be noted that no final answer could be given to students' learning problems, because it has been shown that the preconceptions and misconceptions usually defeated with the help of highly technology and constructivist strategies have reappeared in some special cases (Cartelli, 2003).

Digital Literacy, Digital Competence and Beaver competition

On the basis of the issues reported above, the different meanings of digital divide proposed in the introduction assume now the features of special learning difficulties that people may have. With respect to other knowledge fields, different proposals of literacy have been developed with the help of computer science and information technology being supposed that they could prevent people's difficulties.

Computing literacy, information literacy, IT/ICT literacy and media literacy are the most famous ones, and they are also those compared by Tornero (2004), who proposed the definition of digital literacy as the literacy for the knowledge society.

The most recent and comprehensive definition for this literacy is as follows: "Digital Literacy is the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesize digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, in order to enable constructive social action; and to reflect upon this process" (Martin, 2005).

Very recently the attention of researchers and institutions has focussed on how people use digital resources and processes, more than on the things they must know and be able to do with technologies. This new approach to the analysis of the impact of new technologies on mankind led to concentrate on the concept of competence and on the active involvement of subjects in the interaction with digital equipments, without forgetting the representations of reality, knowledge and skills that people had (Le Boterf, 1990).

On this side the European Commission issued in 2005 the "Recommendation on key competences for lifelong learning" and stated the features of the digital competence, the fourth among them (Commission of the European Parliament, 2005). For the European Commission the development of digital competence is based on the confident and critical use of Information Society Technology (IST) for work, leisure and communication and is underpinned by basic skills in ICT: that is the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet.

The above issues led to the definition of work plans for the creation of suitable frameworks for digital competence assessment and the development of strategies helping students build sound digital competence. The most recent proposal on this side is reported in Figure 1 (Cartelli et al., 2010).

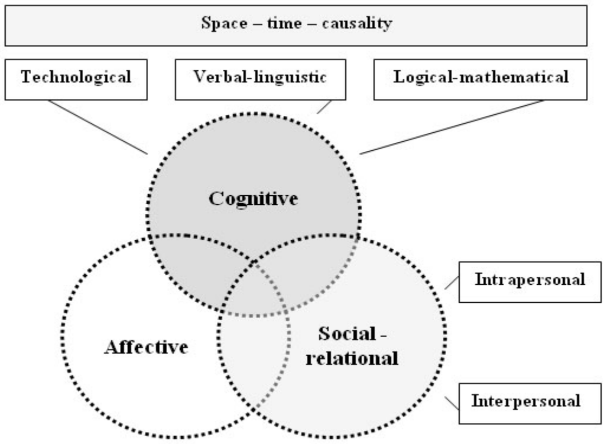

Figure 3. The digital competence assessment framework

The framework in Figure 3 is based on three dimensions: cognitive, affective and socio-relational. The cognitive dimension among them is the better analyzed until now and has three main sections: technological, verbal-linguistic and logical-mathematical (the last two due to Gardner, 1993), all under the umbrella of the following categories: space, time and causality (Piaget, 1970).

It is behind the aims of this paper the detailed discussion of all the features of the framework, but it has to be remarked here that cognitive dimension is very important in the analysis of people's ways of thinking and knowing. It can suggest hypotheses for the mistakes and the errors people make in interpreting natural and scientific phenomena.

The Beaver competition, the international contest for the assessment of computing, logic and mathematical skills in the students of the 15 countries taking part in it, has been used in 2009 from the author to verify, by means of the answers to its questions, the structure of the model, and especially the correctness of the structure of the cognitive dimension.

Two different categories of students have been investigated during the Beaver competition: the Benjamins (10-12 years old) and the Juniors (13-15 years old). From their answers emerged very similar behaviors, because in both cases there was a relevant number of positive answers to single questions, but only 3 - 5% of the students gave the right answers to all the questions. More specifically it could be shown that in both categories of students, less than 50% of them succeed in managing the same information through different languages (i.e., the verbal and iconic languages), and may be the 50% among them did not use space, time and causality categories of the cognitive dimension in the right way.

The above data led to the following conclusions:

- The structure in sections and categories of the cognitive dimension looked good enough and, what is more important, it could be deduced that the students are differently skilled in each of them
- The less developed sections and categories in cognitive dimension are the possible reason of students' problems in knowledge development and in the acquisition of meaningful knowledge
- Sound teaching-learning activities can be planned and carried out to help students recover the gap in the underdeveloped dimensions and build the digital competences needed in the knowledge society.

The main consequence of the above issues for the InnovaScuola project has been the proposal to the teachers involved in it of the collaborative creation of two learning objects:

- The first one is centred on binary logic and its use in the research and affordability of information
- The second one focuses on the representation of reality by means of different languages (especially verbal and iconic) and on the use of instruments and strategies for the hitting of this target.

Both of them have been developed in the second part of the project and the corresponding LOs have been made publicly available on the Internet (http://elf.let.unicas.it).

Conclusion and future work

From what has been reported until now the following remarks can be deduced, with a special attention to two sections: the former devoted to the instruments proposed for the InnovaScuola project, the latter concerning the strategies to be adopted for introducing teaching innovation in everyday school work.

As regards the instruments adopted all the teachers agreed on what follows:

- The framework centred on the integrated e-learning environment, having as its main components web based learning and CMC, has proven very successful for the proposal of materials and the development of the activities in the project,
- The Open Source instruments suggested for the management of documents and processes were considered very useful and would have been adopted for everyday work in next school year,
- The framework for digital competence assessment, and especially its cognitive dimension, has been considered very useful to discover undeveloped or less developed languages and skills in the students.
- On the side of the processes activated during the project the following issues emerged:
- The use of the integrated e-learning environment was considered useful for introducing deeper innovation in the class work, but adequate help was needed from teachers for the management of the e-learning platforms and for the use of social networking instruments,
- The lack of instruments involving students and families in the continuous monitoring of school processes and in the updating of students learning and educational data, could have negative effects on the evolution of teaching-learning activities,
- The planning of teaching activities based on problem finding, problem searching and problem building, has been considered essential for students' successful learning, due to the development of problem solving features; the hypothesis underlying this issue is that contextual and situated learning can be reconciled with scientific/discipline

learning and, what's more, students can be helped in such a way to overcome the problems they usually show when approaching scientific knowledge.

At least the following issues need further research work:

- the analysis of the features of the framework for digital competence assessment and their evaluation,
- the evaluation of the results obtained from the use of the integrated e-learning environment in everyday teaching and the effects of the introduction of LOs on students' learning.

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