Chapter 1
ICT as a Catalyst of Innovation

Opportunities and Critical Issues in Italy's Strategy for Digital Schools

Rosa Maria Bottino

Abstract Research in educational technology has revealed that technology can be an important resource for the quality of teaching and learning processes both for the learning of disciplinary contents and for the acquisition of transversal cognitive competencies. However, many research studies have also demonstrated that new technologies only have an impact on teaching and learning processes if there is co-evolution of ICT and schooling. This co-evolution should entail novel educational strategies, pedagogical activities, and roles in which teachers and students are both actively involved, as well as development of educational institutions' general organization and policies. Change at this level is extremely challenging; it involves numerous changes in educational practices and resources, as well as in educational policies. Countries throughout the world have established different national strategies for integrating ICT in their schools. This paper examines the situation in Italy, focussing in particular on the national plan for digital schools and on some of the different projects that have been launched under this umbrella. The paper reports some of the initial outcomes of the plan, which is presently underway, and looks at some of its strengths and weaknesses taking into account a review of this plan made recently by OECD. A few exemplary experiences carried out in recent years are also discussed with the aim of identifying positive indications and possible interesting developments.

Keywords School innovation · Digital schools · ICT policies in education · Technology-enhanced learning · Learning environments

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1.1 Introduction

Research in the field of educational technology (generally known in Europe as Technology-Enhanced Learning or TEL) has revealed that technology can be an important resource for enhancing the quality of teaching and learning processes. This is true both for the learning of disciplinary concepts, e.g. in science or maths, and for the acquisition of transversal cognitive competencies. However, many research studies have demonstrated that an effective impact on education can only be obtained if technological innovation develops together with pedagogical innovation (Guzman and Nussbaum 2009, Bottino et al. 2009).

Notwithstanding the considerable public funds invested to equip schools with hardware and software and the positive experimental results produced in research projects, the high expectations about technology potential to drive change and innovation in schools appear to have remained largely unfulfilled at the level of mainstream school practice (Venezky and Davis 2002; Sutherland 2004).

The possible reasons for this outcome are various, ranging from traditional resistance to change by school systems and teachers alike, to reasons more deeply related to the fact that technology has often been introduced as an addition to an existing, unchanged classroom setting (De Corte 1996; Grasha and Yangarber-Hicks 2000) and that large implementation gap remains (Eurydice 2011). Of course, national policies and the general guidance provided by national governments on the introduction of Information and Communication Technologies (ICT) in schools have had a key role in this regard.

At the beginning, many countries invested considerable funds in the provision of ICT infrastructures (PCs, internet connections, etc.) to schools and in providing teachers with basic ICT knowledge and skills.

However, this investment did not lead to wide-scale take-up of ICT for enhancing teaching and learning processes. In cases where ICT did enter teaching practice, it generally led to superficial changes that brought little real innovation to the foundations of schooling: syllabuses, methodological approaches, content knowledge, relational dynamics, organisational aspects, etc. (Bottino and Furinghetti 1999; Bingimlas 2009). Indeed, only when ICT adoption is accompanied by a parallel evolution in education as a whole it can have a real impact on teaching and learning processes and act as a catalyst of innovation (Collins and Halverson 2009).

Co-evolution of ICT and schooling leads to increased organisational and management complexity (Davis et al. 2011) and is extremely challenging, requiring numerous changes to educational practices and resources, as well as to educational policies. If these changes do not happen, even innovative schools may drop back from effectively embedding ICT (Eickelmann 2011; Law et al. 2010).

Consequently, there is a strong case for analysing specific instances in which ICT in education is concretely supported by national policies. These cases should prove useful both for investigating emerging trends and for identifying critical issues.

In this paper, the specific case of Italy will be considered and discussed. In particular, reference will be made to the Italian national plan for digital schools

(MIUR 2012) and to two specific projects that have been launched under this umbrella. Some strengths and weaknesses of these projects are briefly considered and analyzed, along with the discussion of some aspects put forward in a recent review of the plan carried out by the OECD (Avvisati et al. 2013).

1.2 The Italian Strategy for Introducing Ict in Schools

1.2.1 The Past

Italy's first national initiative for ICT in education was the 'National Plan for Informatics' launched in 1985. It was devoted to the professional development of mathematics and science teachers in upper secondary schools, aiming to update their content knowledge to include elements of informatics. This training plan was enacted through courses for teachers in which traditional face-to-face lessons alternated with computer practice. The method used was 'pull-down', i.e. the training programme was operated through trainers who are in-service teachers specifically trained for the purpose.

In the early 1990s, the 'Programme for the Development of Educational Technologies' offered funding support to schools for acquiring technological equipment and for the professional development of teachers. The schools were granted autonomy in both their equipment choices and teacher training initiatives. A total of 13,300 schools were involved between 1997 and 2001.

In 2000, a large-scale national programme for teachers' professional development was launched, targeting not only the development of ICT knowledge, but also its educational use (Schietroma 2011). This programme ('ForTIC') targeted 180,000 teachers of all disciplines, involving more than 20 % of the entire teacher population. A blended methodology was adopted, with each participant receiving approximately 12 h of training (six face-to-face plus six online).

An analysis of these initiatives (Bottino 2003) highlighted some general trends: (a) significant results were obtained in providing a considerable number of schools with a basic technological infrastructure (e.g. on average one computer for every ten students in secondary school, about 1/5 in technical schools to 1/25 in lyceums); (b) ICT equipment was mainly located in laboratories and access was seldom available from classrooms; (c) approximately half of the primary and secondary school teacher population was involved in ICT training initiatives, even if the quality and depth of that training varied widely; (d) the impact on teaching and learning methods and on teaching practice was limited; (e) a direct relationship could not be established between provision of infrastructure and ICT training on the one hand and effective pedagogical use of technology in schools on the other; (f) even when ICT use entered teaching practice, though with differing modes and characteristics, only superficial changes were observed that did not lead to innovation in syllabuses and methods.

It became more and more clear that the critical issues mentioned above called for careful consideration of the related difficulties and possible interventions, and for a clear support policy. In response, some national projects were launched to

provide teachers with examples of practice in which technology had been used to support the teaching of disciplinary topics. The main mission of these projects (e.g. 'Science and Technology—SET' projects, see: http://www.indire.it/set/) was to provide web-based repositories of primary and secondary school level teaching units that addressed curricular topics and integrated ICT. These projects had some positive outcomes: they generated direct collaboration between teachers and educational researchers in the implementation of the teaching units and provided interesting experiences for the teachers directly involved in the work. However, they failed to make a significant impact on a wider basis, due in part to their limited scope and budget.

1.2.2 The Current Situation

In 2007, a new national programme for large-scale introduction of ICT in schools, the 'The National Plan for Digital Schools' (Piano Nazionale Scuola Digitale) was launched with the aim of introducing ICT use directly into mainstream classroom activities; in this sense it represented a break from previous national efforts. The idea of isolated computer laboratories has been abandoned, and ICT adoption is considered equally relevant at all levels of education and for all subject areas (the STEM bias was dropped).

The national plan includes four main initiatives: a fund to equip classrooms with interactive whiteboards (Piano LIM), and three test-bed programmes in which pilot schools, selected through open competitions, are testing different ICT solutions (Cl@sse 2.0, Scuol@ 2.0, Editoria digitale scolastica (digital books for schools).

This paper looks in detail at two of these, Cl@sse 2.0 and Scuol@ 2.0, since in principle they have the greatest potential for introducing new teaching practices and new models of school organization. These initiatives are still in progress and are being carried out in successive implementation rounds. Consequently, the analysis and considerations reported in this paper are based on partial results and accomplishments.

The Cl@sse 2.0 programme started in 2009 for lower secondary schools and in 2010 for primary and upper secondary schools. It aims to support the creation of ICT-based learning environments that become a central part of daily school activities. Table 1.1 provides an overview of the budget invested by the central government in this initiative and of the number of classes involved. To gain funding, schools had to make a project application with a plan dedicated to embedding ICT in everyday class activities over a fixed number of years. Selected classes (maximum one per school) received funding for hardware, software and furniture.

The selection process was carried out at regional level and was largely based on the following criteria: the quality of the class project; the school's past experience with ICT projects; teacher preparation in ICT use; availability of broadband connectivity and the existence of additional funds to support the initiative. In total,

Table 1.1 Figures from the Cl@ss 2.0 programme for introducing ICT into Italian schools

School level	n° of selected classes	Budget invested	Years covered by the presented projects
Lower secondary	156	EUR 4.68 million (30,000 EUR each class)	3 (sixth grade to eight grade)
Upper secondary	136	EUR 2.04 million (15,000 EUR each class)	2 (ninth grade to tenth grade)
Primary	124	EUR 1.86 million (15,000 EUR each class)	3 (third grade to fifth grade)

over 4000 schools answered the Cl@sse 2.0 call and 416 were selected, corresponding to 0.13 % of all Italian school classes.

In each region, the schools involved were linked to a local university for support in integrating ICT in pedagogy, although the intensity of interactions between schools and university has varied greatly.

Monitoring of project activities was initially dedicated to lower secondary schools and resulted in a mid-term report (IRVAPP 2012). For this reason, the following analysis concentrates on this specific school level.

The Scuol@ 2.0 programme started in 2011 and unlike Cl@sse 2.0 involves entire schools rather than single classes. The declared objective is to support innovation in aspects of traditional schooling, particularly to inject flexibility into the management of curricula, timetabling, and human and technological resources.

In the 2012–2013 school year, 14 schools entered this programme. An additional 15 are expected to enter during next school year (2013–2014). Each selected school receives a contribution of EUR 250,000 from the Ministry of Education to invest in equipment. To monitor and evaluate the second round of this initiative (2013–2014), the Ministry has nominated a national scientific advisory group that has also examined the Cl@sse 2.0 mid-term results and first outcomes of Scuol@ 2.0.

1.3 Analysis

This section reflects on some key aspects the Cl@sse 2.0 and Scuol@ 2.0 initiatives. It looks in particular at two issues that are crucial for understanding how and under what conditions ICT can become a catalyst of innovation in schools: the enhancement of the learning environment and the trigger of innovation. The analysis is mainly based on the following documents and materials: the first mid-term report on Cl@sse 2.0 (IRVAPP 2012); the documentation of the Italian Plan for Digital schools (MIUR 2012); the first documents produced by the scientific advisory group established by the Ministry of Education (to which the author of this paper belongs); Eurypedia, the European Encyclopedia on National Educational systems (Eurypedia 2012); the review of the Italian strategy for digital schools performed by the OECD (Avvisati et Al. 2013).

1.3.1 Cl@sse 2.0 and Enhancement of the Learning Environment

The Cl@sse 2.0 programme has been carried out in many different ways by the different schools, something which accords with the autonomy they are afforded. For this reason, it is useful to analyse the mid-term evaluation data to understand how the schools in different contexts have faced the challenge of enhancing learning environments with ICT. Two issues are worth noting: (a) in Italy the class is a meaningful organizational unit in which students remain more or less the same over the entire school cycle; (b) the learning environment concept is intended in a broad sense here: it encompasses not only the tools used, but also the organization of teaching and learning activities, their goals, the way ICT is embedded in pedagogy, the physical setting, the roles played by the different actors, the assessment performed and so on. In this paper, analysis of how ICT integration has affected classes 2.0 learning environments is carried out at single class level and at the level of the Cl@sse 2.0 programme's global implementation. Figure 1.1 outlines these levels of analysis and the related issues.

Single class analysis considers the stated goals and objectives of the projects presented for selection of the classes 2.0, the impact of ICT integration on class organization and on teaching and learning activities, and the mid-term results obtained (according to a number of indicators). Analysis of the programme Cl@sse 2.0 as a whole focusses on global monitoring of the initiative and infers its main strengths and weaknesses.

Tables 1.2 and 1.3 briefly summarize the main findings from the two-level analysis of the mid-term report (IRVAPP 2012) and the data and considerations that emerged from the advisory board meetings that the author attended. The issues of concern derived from this analysis are briefly summarized as well. Table 1.2 refers

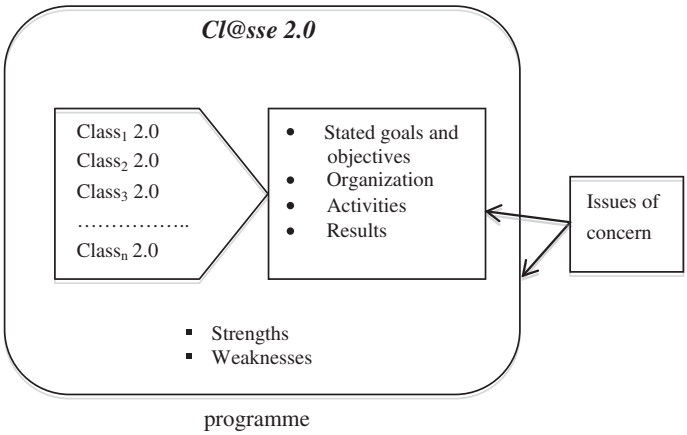

Fig. 1.1 Levels and issues of analysis of the Cl@sse 2.0 programme

Table 1.2 Analysis of Cl@sse 2.0 outcomes at single class level

Cl@sse 2.0	Main findings (classes)	Issues of concern
Stated goals & objectives of submitted projects	The great majority of projects aim to: Develop students' transversal skills and collaborative learning Personalize learning Innovate teaching methods Enhance teachers' digital skills	Teachers need to develop a more widely shared understanding of what is meant by 'transversal skills'
Impact on class organization	Daily ICT use in class rises from 54.4 % (initial data) to 70 % (mid-term report): 23.1 % over 3 h. a day; 38.9 % up to 3 h. a day; 8 % 1 h a day The vast majority of teachers acknowledge the need to change the physical setting of the class	Teachers generally fail to provide details about the kind of activities carried out with ICT and the way they have been carried out
Impact on teaching and learning activities	Almost all teachers state they use Office applications, internet browsers and/or blogs Little interest is expressed in the use of educational software or discipline specific software (under 10 %) 44 % of teachers state they use learning objects to build learning activities Many teachers express an orientation towards using ICT for student assessment	Often the software tools used don't match up with the objectives stated in the project plan Stated learning objectives are often described in quite general terms (e.g. pedagogy innovation, enhancing learning outcomes) with no specific targeted goal
Teachers' perceived results	Enhanced digital skills of teachers (25 % greatly, 75 % moderately) and students (66.7 greatly, 27.8 moderately) Development of students' transversal skills (12.5 greatly, 87.5 moderately) Increase in peer collaborative work (23.8 greatly, 66.7 moderately) Increased student engagement in learning activities (54.1 greatly, 36.1 moderately) Increased student motivation (almost 100 %) No significant increase in students' learning performance (for 43 %) Greater collaboration with families and local institutions Interaction with supporting universities is considered useless (55.5 %)	The relationship between student motivation and performance needs further investigation and adoption of appropriate indicators The way teachers' perceived results are gathered in the mid-term report needs to be reconsidered and tuned The modalities and objectives of external support for schools (from the universities selected by the Ministry) needs to be reconsidered

to the single classes 2.0 while Table 1.3 outlines the main strengths and weaknesses of the programme as a whole.

It is worth noting that the mid-term report took into consideration a variety of qualitative and quantitative data: projects submitted for selection; student

Table 1.3 analysis of Cl@sse 2.0 outcomes at overall initiative level

	Strengths	Weaknesses	Issues of concern
Cl@sse 2.0 initiative	Some classes 2.0 have become school bridgeheads for the local community Classes 2.0 have stimulated collaboration between school, families and local institutions An increase in both teacher and student motivation has been widely reported An increase in collaboration among teachers in the same school (not only the same class) has been reported	Teachers' limited digital competency is reported as a brake on the initiative Some negative impact of ICT use on students' learning is pointed out by teachers: e.g. distraction from disciplinary content learning, content simplification, greater focus on technology than on subject contents, low quality and general inappropriateness of available digital content, perception of ICT-based activities as dispersive, etc Teachers remark a slowdown of teaching pace The use of some tools, like interactive whiteboard, even if element of aggregation can have also a negative impact on class dynamics in terms of distraction, messy interactions, etc.) General obstacles to the initiative have been: the heavy burden of bureaucratic requests made to teachers, the delay in the acquisition of the equipment, the temporary status of many teachers, few support offered to schools by universities involved	The relationship with the universities chosen by the Ministry for local support was generally perceived as a negative imposition unrelated to daily class work It is not make clear what method was used by the Ministry to select and to analyse the qualitative tools used to monitor the initiative (e.g. class logbooks, teacher questionnaires, etc.) and how the generated data can be compared Over time there has been a reduction in the number of class logbooks filled in. In general, teachers perceived the documentation demands to be excessive

assessments (test scores compared to control classes from the same school); logbooks kept by participating teachers; teachers' self-assessment questionnaires; and reports from supporting universities and national agencies. By infusing technology into class activities, students' and teachers' ICT familiarity and competences seem to increase. However, even though ICT use has positive results on motivation, the impact on subject teaching and learning activities seems limited.

Analysis of the mid-term report suggests that a more in-depth investigation of the way teachers perceive the role of ICT for teaching disciplinary contents would be useful for future orientation and for teacher training, also because in some cases teachers perceived the use of ICT on subject learning as negative (see Table 1.3). In the

vast majority of cases, the main goal stated for using ICT in class is the development of transversal skills, even if there is no general shared understanding about what these skills are and how they can be evaluated; ideas on this appear quite generic and do not correspond to specific activities. Closer examination of the correspondence between stated objectives and the type of software and digital resources actually used in class seems to be necessary. Moreover, even though 44 % of teachers state they use learning objects, no further indications are provided about the type, characteristics or content of these materials, or about their origin (e.g. who has developed them).

Other critical aspects for further investigation are the relationship between ICT use and students' learning performance, and how and to what extent assessment methods have changed. It is interesting to note that when teachers refer to the use of technology for learning assessment, they mainly intend the use of e-mail to submit evaluation tests or the evaluation of multimedia contents produced by students.

ICT integration seems to have induced some change in the organization and physical settings of classes, but for effective innovation to be achieved this aspect needs to be reconsidered in a wider perspective: change in whole school organization, curriculum and timetabling, time constraints, modality and content of student assessment, etc. The fact that teachers reported some negative effects of ICT integration, like the perception of ICT-based activities as dispersive or the slowdown in teaching pace induced by ICT use, could indicate that in many cases ICT integration only leads to surface changes that have little real impact on teaching and learning activities, and can often have negative perceived effects on pedagogical activity.

One critical aspect of the monitoring of Cl@sse 2.0 initiative (see Table 1.3) is the way in which perceived outputs were gathered and evaluated. It would be useful to reduce the number of indicators considered and to focus on a limited set of specific issues; this would lead to generation of more homogeneous and focused data, and also lighten the documentation load imposed on teachers.

Although having a class in the initiative had positive effects for individual schools, like increased teacher collaboration and strengthening of family-school ties, the effects were limited. The results obtained in terms of innovation in teaching and learning processes are minor and, in general, the initiative does not seem to have the critical mass needed to induce widespread innovation; too few schools in the country have been involved (416), teachers' professional development is insufficient and not enough digital resources are available.

These considerations suggest that, in order to create an effective innovation trigger via a 'contagion' strategy, it would be more appropriate to engage entire schools rather than individual classes. For this reason, it is worth considering the School@ 2.0 initiative and briefly analyzing the way it has been implemented.

1.3.2 Scuol@2.0 and the Innovation Trigger

Among the main objectives of the Scuol@ 2.0 programme is to establish a limited number of controlled cases to test and analyze how the introduction of advanced technologies can change teaching and learning processes and the entire work

organization in schools. The idea is to identify approaches and methodologies for effective innovation that can be mainstreamed through the system.

As mentioned earlier, 14 schools entered this programme in the 2012–2013 school year. No official report on initial results has been released yet. Considering the early qualitative data discussed during advisory board meetings, the impression is that the criteria adopted for selecting these schools were not entirely appropriate and they were not applied in a uniform manner in the different regions. Thus, the initial outputs vary widely from school to school, making it difficult to identify general trends, also because of the limited number of schools involved. Accordingly, the advisory board adopted more specific, uniform criteria for selecting the 2013–2014 uptake of 15 additional schools and for monitoring the initiative as a whole; these are outlined in Table 1.4. Analysis of these criteria can provide a clearer idea of the conditions considered necessary for ICT to become a trigger of innovation at school level.

Critical selection criteria that test-bed schools needed to meet are the possession of appropriate ICT infrastructure, teaching staff with adequate ICT skills, and limited teacher turnover. Links with outside organizations (universities or research centres, companies, etc.) are considered an advantage, as is the role of the school as reference for the local community (e.g. links with other schools and/or local institutions for training or consulting activities). Applicant schools had to document their experience in the field and to submit projects that feature concrete ideas about learning activities involving medium and long-term use of ICT, new organization and pedagogical practices, and modes of cooperation among teachers.

In evaluating proposals and monitoring results, the stress is on changes not only in technology use, but also in more flexible management of curricula, timetables, and human and technological resources. These factors are expected to help overcome boundaries between classes and between formal and informal learning (inside and outside school). To this end, the Ministry has exempted the participating schools from a number of national guidelines and constraints.

The first general consideration to be made about the future of the Scuol@ 2.0 programme is that, to achieve its ambitious objectives, it requires a higher level of investment so a larger number of schools can be involved and adequately supported. This latter aspect is considered an essential and critical component of the programme. Schools must be supported in changing their teaching organization that means to reconsider the teacher's role in the classroom, the use of software and digital contents, the adoption of distance learning modalities for homework assignments, the adoption of innovative, cooperative learning models and assessment strategies.

This support needs to be centrally coordinated, not left to single entities such as local universities, as was the case with Cl@sse 2.0. In addition, support should not be seen as a top-down intervention, but as a dynamic process built and rebuilt together with all school actors, starting from their daily needs.

Table 1.4 Selection criteria for schools participating in the second round of Scuol@ 2.0 program

Issues considered in the Scuol@ 2.0 application form	Issues	Evaluation criteria
School features (state of the art)	General: n° of classes; % of teachers turn-over; n° of teachers trained in the use of ICT; etc Available technological infrastructure: internet, intranet, Wi-Fi, platforms, school website, etc Teachers' professional development: training initiatives and/or in-field experimentations promoted by the school in the use of ICT for teaching and learning processes Links with the local community: university, research or training centres, companies; participation in inter/national projects involving the use of ICT; offered services	Broadband Low % of teacher turn-over Relevant number of trained teachers Good extra-school links Established collaborations with university or research centres Involvement and results obtained in previous projects Services offered to the local community (e.g. training, skill centres, etc.)
Project features	Description of the proposed project and of the way in which ICT integration will be performed (approach, scaling, etc.) Reorganization of school's physical environments and timetable Pedagogical and methodological innovation Curricular changes Digital resources New evaluation and assessment modes Ties with families New initiatives for teacher training	Scientific and organization quality of the project Indication of concrete learning activities involving medium and long-term use of ICT Structural and pedagogical changes (e.g. how class f2f lessons will be transformed, how ICT will be used for communication with students and families, etc.) How learning will be personalized Modalities of cooperative work among teachers Curricula innovations Integration of digital resources in the teaching of disciplinary contents Development of digital learning resources Methods and tools for formative evaluation Methods for student assessments Foreseen teachers' training activities

1.4 Discussion

Italian schools have in general a low ITC penetration, that is, Italy is not well positioned as far as ICT equipment in schools if compared with other European countries as reported in the 'Survey of Schools: ICT in Education' promoted by the European Commission to benchmark countries' performance in terms of access, use and attitudes to ICT (European Schoolnet 2013). For example, in 2011–2012, the average number of available computers per 100 students (4th grade) was six compared to an average of 14.5 in EU countries. In most countries, the older the students are, the more the computers will be, and this trend is also present in Italy. At grade 8, Italy is ranked among the bottom group of countries with 8.3 computers per 100 students (EU average: 21.1) as shown in more details in Fig. 1.2. Moreover, at grade 4, 80 % of Italy's students are in schools with only basic digital equipment, slow or no broadband, and only limited connectedness (EU average: 48 %). Only 6 % of Italy's students attend schools with advanced digital equipment against 37 % of EU average.

Given this situation, the National Plan for Digital Schools launched by Italian Ministry of Education is an important step towards mainstreaming ICT use in Italy's classrooms and realising its potential as a catalyst for educational innovation.

The adopted strategy has been to target schools and teachers eager and ready to initiate change, to stress pedagogic uses of technology rather than merely equipment, to phase in reform, and to conduct experiments. This seems an appropriate way to trigger wide-scale change. However, the overall level of investment is too small (around 0.1 % of the budget for schools), and this has limited the

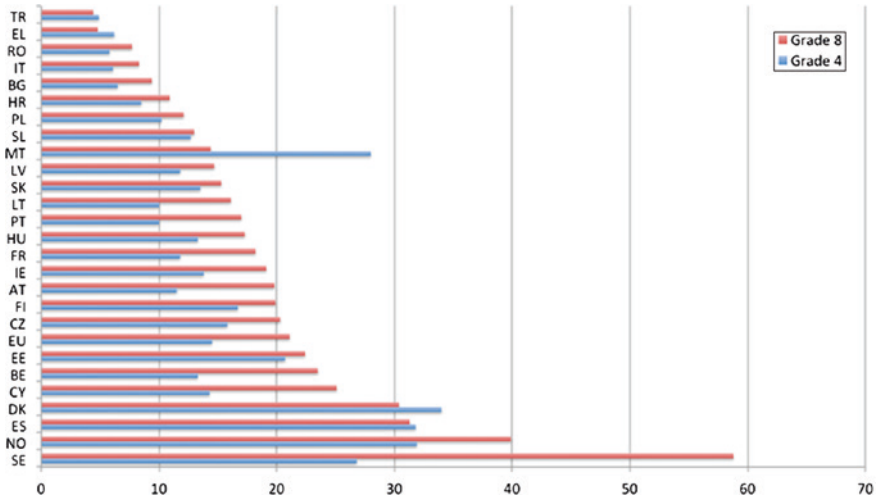

Fig. 1.2 Number of computers per 100 students (school grades 4th and 8th) in European countries (European Schoolnet 2013)

effectiveness of the Plan's various initiatives. The need to raise funding is also acknowledged in the review of the plan carried out by the OECD (Avvisati et al. 2013), which states: 'in its current design, a significant rise in the plan's budget through public or private sources is a necessary condition for its success' (p. 9).

Since a significant budget increase is unlikely in the current economic climate, the OECD suggests concentrating resources on the Scuol@ 2.0 initiative, which focuses on new models of schooling. The school-wide approach of this initiative seems to have greater potential for educational innovation, hopefully leading to the adoption and testing of new teaching practices, new models of school organization, new products and tools to support quality teaching. As highlighted in the previous section, meeting these goals means first of all carefully selecting test-bed schools and supporting them not only in tuning the design, but also in the daily implementation of the project.

Adopting the entire school as the relevant unit of analysis makes it possible to consider issues that cannot be addressed at single class level, for example alignment of ICT integration with other system elements like curricular and assessment changes. Moreover, when teachers use ICT in all their classes they can gain more experience and context-specific knowledge. Since all the school teachers are involved in the project, peer learning is more likely to happen, and the sharing of ideas, resources and methodologies (also at subject level) is more fruitful.

Even if the phased approach and the bottom-up strategy adopted by the Plan seems appropriate in the current situation, results obtained at school level can be better leveraged if test-bed schools are seen not as single units but as a network. For example, the OECD report suggests that the Plan should 'concentrate resources on the Scuol@ 2.0 initiative, redesign it around local school networks and discontinue the Cl@sse 2.0 initiative' (p. 41).

Networks of schools can help to optimize resources. For example, key aspects like teachers' professional development or ICT-based communication platforms supporting schoolwork can be shared. In addition, greater critical mass is helpful for attracting further funding from local institutions or private foundations. When connected in a network, test-bed schools can provide mutual support for piloting new pedagogic and organizational practices and are better placed to foster mainstreaming of ICT in their local area. This would help to spread the benefits of the Plan beyond a limited number of early adopters, providing sufficient investment and support is on hand.

The idea of supporting networks of innovative schools in Italy is not a completely new indication; it has been tested in pilot cases outside the National Plan for Digital Schools, often with interesting results. For example, the Ministry of Education has supported an innovative project called Wikischool (Benigno et al. 2013), which establishes a network comprising the three lower-secondary schools in Italy that have special experimental status and which were previously funded separately. The project aims to instil research and reflection in teachers' daily work, promote cooperation and foster systematic use of ICT in all spheres of teachers' professional practice. The Institute for Educational Technology (ITD-CNR), of which the author of this paper is the director, has collaborated with

the Wikischool network from the beginning, supporting it in the development and management of the schools' ICT infrastructure and in the design of innovative pedagogical activities. Moreover, cooperation has been established between the teachers and ITD-CNR researchers for monitoring and critical analysis of the initiative.

This experience and its positive outcomes have highlighted the importance of establishing closer dialogue between educational research and Education Ministry initiatives in order to provide policy makers with useful evidence and informed documentation obtained from inside the process. Pilot schools require support and monitoring while developing and implementing innovative resources and practices. In addition, documented reflection on critical issues and difficulties encountered needs to emerge from direct interaction and cooperation with the teachers involved. If this partnership is fruitful, it can create the conditions for peer learning, system learning and pedagogic transformation, as recommended by the OECD.

One of the main problems with the initiatives implemented in Italy's Plan for Digital Schools, particularly with the Cl@sse 2.0 and Scuol@ 2.0 initiatives discussed in this paper, is that results achieved locally are rarely scaled up at system level. Even when good practices and successful solutions emerge, they remain largely confined to the context in which they were generated, making it difficult to capitalize on outputs at the general level. Thus, a more coordinated and reflective approach is necessary to assure the success of the Plan.

Of course, the long-term success of the Plan strongly depends on other issues as well, such as teacher training opportunities and the availability of a sufficient quantity of high-quality digital learning resources. These aspects (which fall outside the scope of this paper) have been addressed in other initiatives put in place by the Ministry within the Plan; however, greater coordination and more widespread actions are called for.

1.5 Conclusions

ICT resources are critically important for education, both because their use can improve teaching and learning processes and because they offer an opportunity for innovation in contents, methods and pedagogy. Nevertheless, the integration of technologies in schools has to be approached in a critical and informed manner, taking into account the complexity of the underlying processes. Successful integration of ICT into schools calls for understanding of the opportunities technology offers and of the needs emerging from the context of application. Unless innovation is truly embraced, technology is unlikely to become an integral part of the education system, but outside the prospect of effective teaching and learning improvements, the use of technology will not last over time.

School improvement and system-wide pedagogic innovation is a cumulative and collective endeavour. In recent years, scaling up results from small pilots (often single classes) to statistically significant numbers has become a

pressing issue. For example, large-scale European research projects in Technology Enhanced Learning, such as 7thFP—IP (Integrated Projects), have been required to ensure large-scale piloting involving up to 1,000 classrooms. This strategy certainly increases experimental coverage and data, but largely overlooks the system level since it does not involve schools in their entirety. As this paper has pointed out, the school seems to represent an appropriate unit of analysis for studying the successes and failures of ICT integration. Ideally, test-bed schools should be clustered in networks to increase local opportunities for learning, foster sharing across schools and establish broad communities of practice (Avvisati et al. 2013).

Moreover, in a policy of innovation, documenting successes and failures is key for system learning. For this reason, it is important to strengthen dialogue between academic research and education systems in order to set up monitoring activities and to support teachers' reflection and learning from the work accomplished (Olimpo et al. 2010).

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