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Review of the Italian Strategy for Digital Schools

Francesco Avvisati,
Sara Hennessy,
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Stéphan Vincent-Lancrin

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Francesco Avvisati, Sara Hennessy, Robert B. Kozma and Stéphan Vincent-Lancrin

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The report builds on analysis developed within the CERI Innovation Strategy for Education and Training.

Stéphan Vincent-Lancrin, Senior Analyst and Project Leader, stephan.vincent-lancrin@oecd.org;
Francesco Avvisati, Analyst, francesco.avvisati@oecd.org

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ABSTRACT

The Italian Ministry of Education launched in 2007 a National Plan for Digital Schools (*Piano Nazionale Scuola Digitale)* to mainstream Information Communication Technology (ICT) in Italian classrooms and use technology as a catalyser of innovation in Italian education, hopefully conducing to new teaching practices, new models of school organisation, new products and tools to support quality teaching. The Italian Ministry of Education, Universities and Research asked the OECD to review its Plan from an international perspective and to suggest improvements.

The small budget of the Plan has limited the effectiveness of its diverse initiatives. In its current design, a significant rise of the budget of the plan through public or private sources is a necessary condition for its success. Given current budgetary constraints, a significant budget increase may be difficult, and the report proposes to revise some features of the Plan in order to achieve two objectives: 1) speed up the uptake of ICT in Italian schools and classrooms; 2) create an Innovation Laboratory Network of test bed schools piloting and inventing new pedagogic and organisational practices to improve Italian education, by refocusing the innovation projects on the school 2.0 (scuol@ 2.0) initiative.

RÉSUMÉ

En Italie, le Ministère de l'Éducation a initié en 2007 un Plan National pour l'École Numérique (*Piano Nazionale Scuola Digitale)*, avec comme objectifs de diffuser les technologies de l'information et de la communication (TIC) dans les classes d'école italiennes et d'utiliser la technologie comme un catalyseur d'innovation dans l'éducation italienne, conduisant à l'adoption de nouvelles pratiques pédagogiques, de nouveaux modèles d'organisation scolaire, ainsi qu'au développement de nouveaux produits et outils pour soutenir un enseignement de qualité. Le Ministère italien de l'Éducation, des Universités et de la Recherche a demandé à l'OCDE d'examiner son Plan dans une perspective internationale et de faire des suggestions pour son amélioration.

Le budget modeste du Plan a limité l'efficacité de ses diverses initiatives. Dans son design actuel, une augmentation significative de son budget, à travers des sources publiques ou privées, est une condition nécessaire à son succès. Étant donné les contraintes budgétaires actuelles, une augmentation importante du budget peut paraître difficile, et le rapport propose de réviser certains aspects du Plan afin d'atteindre deux objectifs : 1) accélérer l'adoption des TIC dans les écoles et salles de classe italiennes ; 2) créer un Laboratoire d'Innovation en Réseau constitué d'écoles expérimentales qui pilotent et inventent de nouvelles pratiques pédagogiques et organisationnelles pour améliorer l'éducation italienne, en recentrant les projets d'innovation du Plan sur son initiative école 2.0 (*scuol@ 2.0)*.

ACKNOWLEDGEMENTS

This review of Italy's National Plan for Digital Schools was commissioned by the Italian Ministry of Education, Universities and Research. The Ministry asked the OECD to review its Plan from an international perspective and to suggest improvements.

The review team was composed of Francesco Avvisati, Analyst at the OECD Directorate for Education and Skills; Sara Hennessy, Senior Lecturer in Teacher Development and Pedagogical Innovation at Cambridge University, United Kingdom; Robert B. Kozma, International Consultant, United States; and Stéphan Vincent-Lancrin, Senior Analyst at the OECD Directorate for Education and Skills, who co-ordinated the review and acted as a *rapporteur* for the review team.

The report reflects the views of the review team, who collectively endorses its analyses and recommendations. Francesco Avvisati and Stéphan Vincent-Lancrin drafted the main text of the report based on the diagnosis and recommendations developed by the whole review team. Sara Hennessy and Laura London prepared a background paper on the use of interactive whiteboards and Robert B. Kozma, a paper on international ICT policies. Both papers informed the review and are annexed to the report. Francesco Avvisati coordinated the review visit and was the main liaison officer with the Italian authorities. At the OECD, Florence Wojtasinski is thankfully acknowledged for her assistance on the project. Michele Rimini and Gwénaël Jacotin, consultants at the OECD, helped to compile the statistical annex.

The review benefited from the advice from Paulo Santiago and Simon Field, Senior Analysts at the OECD Directorate for Education and Skills, from the continuous support of Dirk Van Damme, Head of the Innovation and Measuring Progress division as well as of Barbara Ischinger and Andreas Schleicher, Director and Deputy Director for Education and Skills, respectively.

In Italy, minister Francesco Profumo initiated the review, which was coordinated by Giovanni Biondi, Head of the department for planning at the Ministry of Education, Universities and Research. Antonella Tozza, Anna Ficarella and Sara Zoccoli coordinated the review visit. In Florence, the review visit was coordinated by Giuseppina Cannella and Federica Toci. We are very thankful to the interpreters, Silvia Martuscelli, Ennia Cucchiarelli (Rome) and Maria Fitzgibbon (Florence), who contributed to the quality of the exchanges with stakeholders. Jessica Laganà, Stefano Catani and Carla Di Paola, at the permanent delegation of Italy to the OECD, Andrea Maccarini, member of the CERI Governing Board, and Francesca Brotto, at the Ministry of Education, Universities and Research, are gratefully acknowledged for their support at various stages of the review.

During the review visit, the team held discussions with a wide range of education stakeholders and visited three schools. The review team wishes to record its grateful appreciation to the many people who gave time from their busy schedules to inform the review team of their views, experiences and knowledge. The name of persons and institutions visited is presented in Annex D.

The report uses the conceptual framework of the Centre for Educational Research and Innovation (CERI) project entitled Innovation Strategy for Education and Training (*www.oecd.org/edu/innovation*).

EXECUTIVE SUMMARY

Italy lags behind most OECD countries when it comes to equipment and usage of information and communication technology (ICT) in school. For example, in 2011, only 30% of Italian students in 8th grade used ICT as a regular instruction tool in science classes, compared to 48% on average in an OECD country.

A well-designed Plan with big budget constraints

In this context, the Ministry of Education launched in 2007 a National Plan for Digital Schools (*Piano Nazionale Scuola Digitale)* to mainstream ICT in Italian classrooms and use technology as a catalyser of innovation in Italian education, hopefully conducing to new teaching practices, new models of school organisation, new products and tools to support quality teaching. The national plan includes four initiatives: a fund to equip classrooms with interactive whiteboards (*Piano LIM*), and three test bed projects in which pilot schools, selected through open competitions, experiment ICT solutions (*cl@sse 2.0, scuol@ 2.0, Editoria digitale scolastica*).

The Plan uses its very modest funding to implement a convincing and ambitious vision of innovation at the margin. It rightly concentrates on schools and teachers eager to initiate change, favours tools that are not disruptive to current teaching practices, tries to create a demand that can engage other stakeholders to contribute to the plan, focuses on pedagogic uses of technology rather than merely on equipment, and addresses the importance of professional development and of expanding the availability of digital pedagogic resources. It exploits synergies with other ICT policies and has successfully involved regions in its implementation and scale up strategy.

However, the small budget of the Plan has limited the effectiveness of its diverse initiatives. Because of a lack of budget rather than insufficient school or teacher demand, ICT equipment is entering Italian classes rather slowly. The Plan has been allocated EUR 30 million per year for 4 years, that is, less than 0.1% of Italy's public budget for schooling (or less than EUR 5 per student in primary and secondary education per year). *In its current design, a significant rise of the budget of the plan through public or private sources is a necessary condition for its success*.

Given current budgetary constraints, a significant budget increase may be difficult, and the report proposes to revise some features of the Plan in order to achieve two objectives: 1) *speed up the uptake of ICT in Italian schools and classrooms*; 2) *create an Innovation Laboratory Network of test bed schools piloting and inventing new pedagogic and organisational practices to improve Italian education, by refocusing the innovation projects on the* scuol@ 2.0 *initiative*.

Speed up the uptake of ICT in Italian schools and classrooms

As of 2013, the *Piano LIM* is the main measure supporting the equipment of classrooms with ICT, namely interactive whiteboards. (A new law, the *Crescita 2.0* decree, may lead to the diffusion of e-readers and tablets from 2014-15 on.) A big limitation of the *Piano LIM* so far lies in its slow pace. In 2012, 22%

of Italian classrooms (at most) were equipped with interactive whiteboards – an increase by 17 percentage points since 2010. But at the current pace, it would take over 10 years to equip 80% of Italian classrooms – that is, to reach the current level of equipment of the United Kingdom. This has led to a patchy presence of equipment within Italian schools that creates discontinuities in teachers' experience of ICT in teaching, limits their opportunities for learning and thus reduces their ability to unleash the full pedagogic potential of technology.

It is crucial to speed up the equipment process so that ICT enters most classrooms and that the use of ICT leads to peer and informal learning among teachers. This could be done in two ways: 1) *use matched funding schemes to support school equipment*: this would incentivise schools and regions to look for extra funding to equip classrooms; 2) *open the plan to other technologies than interactive whiteboards and incentivise schools to develop school-wide equipment plans*: for example, visualisers and projectors, in combination with a classroom computer, may offer most of the pedagogic functionalities of interactive whiteboards actually used by teachers at a lower cost.

The mainstreaming of ICT in school also depends on teachers' learning and training opportunities as well as on the availability of a sufficient number of digital pedagogic resources. As the plan reaches beyond the early adopters, teachers will need more and more support to integrate the use of technology in their teaching practice. Otherwise the ICT equipment may not be used.

The national plan currently includes professional development provisions, but these provisions do not meet the scale of actual professional development needs. Speeding up the equipment process would multiply opportunities for individual and organisational learning and address some of these needs. Given current budget constraints, the *professional development provisions of the* Piano LIM *could be changed so that schools can choose between the current mandatory formal training of three teachers and a school-wide entitlement to training that can be used more flexibly on a professional development project tailored to local needs (with some accountability)*.

Such a school entitlement would allow schools to fund the participation of individual teachers in externally organised programmes, as is currently the case, but also give them the flexibility to hire external trainers for whole-school training and to fund teaching release time for their most skilled teachers to animate regular local on-demand workshops. Year-round, school-based training is generally considered as the most effective form of professional development for introducing new teaching practices as it encourages informal sharing among teachers.

Finally, while continuing to incentivise publishers to develop digital resources, Italy should take steps to develop quickly a national bank of digital pedagogic resources. To this effect, the Ministry of education could *commission the translation and adaptation of a selected number of high quality open educational resources available in other languages*. It could also *support the development of a virtual exchange platform* where teachers can post their own open educational resources as well as share their experience about using specific digital devices and resources for teaching and learning.

Refocus the innovation projects on scuol@ 2.0 to create an Innovation Laboratory Network of test bed schools

The potential of technology for transforming education goes well beyond equipping each classroom with an interactive whiteboard or other comparable technology. Two initiatives of the national plan give selected teachers and schools the possibility to pilot a variety of pedagogic uses of ICT and reinvent teaching and learning in a technology-rich environment: *cl@sse 2.0* grants a lump sum for one classroom within a school, and *scuol@ 2.0,* for the entire school. These initiatives have two objectives: showcase the

power of educational technology and make it even more desirable; pilot new schooling models for the Italian education system.

Given current budgetary constraints, we suggest *to concentrate resources on the* scuol@ 2.0 *initiative, to redesign it around school networks (*distretti scol@stici 2.0), *and to discontinue the* cl@sse 2.0 *initiative*. Redesigning the initiative as a competitive grant programme requiring matched funding and partnerships could also allow attracting additional budget.

The school-wide approach of *scuol@ 2.0* is more conducive to teachers' individual learning as they can teach with ICT in all their classes and thus become more experimented; it also generates more peer learning as all school teachers are involved in the school project. Teachers are thus more likely to share their ideas, resources, and experiences, to support one another, to learn from their colleagues and design appropriate solutions as new issues arise. In this context, formal training could also be provided more easily and cheaply, and schools can develop or test new organisational routines (*e.g*. lesson study).

Ideally, the test bed schools should be clustered at the local level and be part of a national network. This would enhance local opportunities for learning and sharing across schools and give students more continuity in their ICT-enhanced learning experience. Schools participating in the initiative should also be part of a national network, that is, a broader community of practice.

The school clusters selected as pilots should be used as test beds to research and develop solutions for the remaining schools. Prototypes of new resources (such as digital textbooks or digital assessment tools), new training formats, new forms of work organisation or new assessment frameworks could be piloted in these schools. To this end, the involvement of external partners should be encouraged in the application process, whether government agencies or private-sector stakeholders.

Much of this effort would be vain if it were not leading to learn, at the system level, what works among the variety of local solutions. Italy should thus *ensure that a rich documentation and information system is in place in pilot schools from the onset, fund research on these schools and monitor their progress and varied outcomes*. For example, funding doctoral scholarships and post-doctoral positions for research projects related to the "National plan for digital schools" could generate useful evidence for policy-making, and plant the seeds of a fruitful dialogue between educational research and policy.

A contribution to Italy's Digital Agenda

Italy's whole-of-government "Digital agenda" identified digital solutions as a major source of government savings and pointed to the digital economy as a strategic sector to revitalize Italy's fragile growth. As a consequence, ICT is being introduced massively in school administration. An integration of ICT solutions for administrative and pedagogic purposes may be the next step for Italy's national plan for digital education.

In the years to come, speeding up the pedagogic uptake of ICT in Italian classrooms and developing the next-generation pedagogies in clusters of test bed schools would constitute an important contribution of Italy's education system to its digital agenda. And a first step to equipping students with skills for the digital economy.

THE ITALIAN NATIONAL PLAN FOR DIGITAL EDUCATION

The current national policy for large-scale introduction of ICT in all schools, *Piano Nazionale Scuola Digitale*, was launched in 2007. The current policy marks a clear discontinuity with previous national efforts to introduce ICT in schools: it aims at introducing the use of ICT equipment directly in the standard, everyday classroom, rather than in separated computer labs that have to be booked in advance; and it transcends disciplinary boundaries by seeking ICT adoption in all subject fields and at all levels of education (except tertiary education).

Past initiatives on ICT in education

A brief look at past initiatives confirms this discontinuity. The first national plan for ICT in education dates back to 1985: the "National plan for Informatics" (1985) was mainly a professional development programme that targeted exclusively teachers of mathematics and sciences in upper secondary schools and seeked to update their content knowledge to include elements of informatics[1]. In the early 1990s, the "Programme for the Development of Educational Technologies" offered support to all schools to create computer labs and to invest in the professional development of all teachers. In 2000, a major professional development programme ("For TIC") targeted 180 000 teachers of all disciplines (*i.e.* more than one in five teachers in Italy) (Schietroma, 2011). Starting in 2007, this programme was opened again to science and technology teachers of all school levels by the "National Agency for the Development of School Autonomy" (*Agenzia Nazionale per lo Sviluppo dell'Autonomia Scolastica*, ANSAS, renamed *Istituto Nazionale di Documentazione, Innovazione e Ricerca Educativa*, INDIRE, in 2012) (ANSAS, 2012).

Along with these national initiatives, local authorities (regions, provinces and communes) and sometimes single schools have led their own policies in the field of ICT for education. In Italy, school buildings are built and maintained under the responsibility of local governments (provinces for upper secondary schools, and municipalities for primary and lower secondary schools): some communes and provinces made broadband access and cabling a priority in the context of school renovation or building projects. Recent reforms have transferred much planning responsibility for education from the central government to regions. Moreover, schools are granted significant administrative autonomy, and can raise funds from private non-profit organisations or from local authorities to improve their infrastructure. Teachers value their pedagogical freedom, a constitutional principle in Italy. The central government clearly is not an isolated actor in this field.

This governance structure implies that by 2007, some schools, especially in the richer areas of the country, had already been equipped with ICT infrastructure beyond the standard computer labs, as survey data show (see statistical annex); and some teachers had started embedding ICT in their instruction tools. Starting in 2005, for instance, the regional school office (*Ufficio Scolastico Regionale*) of the Lombardy region (the local branch of the ministry of education) forged a partnership with vendors and raised funds to offer grants of EUR 1000 to schools to equip their classrooms with interactive whiteboards (IWBs). In 2006, the local school office in Bologna equipped 108 classrooms with IWBs and clickers (Parigi, 2010).

Starting in 2007, European regional structural funds became available in the four Southern regions with the lowest per capita income (Calabria, Campania, Puglia, Sicilia) for investments in teachers'

professional development and in school improvement projects. The implementation programme (*Programma Operativo Nazionale*) is administered centrally and was therefore often used to pilot the actions of the national plan for digital schools. The *Digiscuola* initiative, for instance, involved 3 500 teachers of mathematics and Italian at upper secondary level over one year in 2007; their classes were equipped with IWBs, and teachers participated in a blended learning programme administered by ANSAS, with a significant project-based component. In *Digiscuola*, in the absence of recommendations from the Ministry, many schools chose to install IWBs in computer labs or dedicated rooms. It clearly emerged, however, that placing IWBs inside the classroom was a key choice influencing its use (Parigi, 2010). In the "national plan for digital schools", therefore, it was strongly recommended that all technological equipment be placed in normal classrooms.

The national plan for digital schools

The national plan for digital schools comprises one large-scale intervention (interactive whiteboards, *Piano LIM*) and three pilot projects (*cl@sse 2.0, scuol@ 2.0, Editoria digitale*).

The national plan aims at embedding ICT in everyday class activities by making ICT equipment available in classrooms rather than in separated computer labs (Schietroma, 2011). The plan encourages adoption of educational technology on a voluntary basis. Only voluntary schools participate and, for the most intensive interventions, schools have to elaborate and submit a project specifying the intended uses and objectives of ICT to a call for tender. The interventions are rolled out gradually and progressively, partly in response to scarce funding, but also to facilitate the evaluation and overcome resistance ("build a shared vision").

Objectives

The national plan for digital schools has two strategic aims.

The first set of objectives of the Italian plan is to introduce ICT as part of the daily tools of classroom activities, in order to bring schools closer to society and to enhance the Italian population's ICT skills and digital literacy (Schietroma, 2011). In terms of student outcomes, the plan is expected to impact directly on student engagement and ICT skills.

At a different level, the plan is also seen as a catalyser for innovation in education and specifically for the renewal of teaching practices (this pedagogical change is sometimes framed as the move from teacher-centred to learner-centred instruction). By creating a technology shock in the school system, the government expects to change the teaching culture, encouraging more personalised educational paths and promoting more active learning, without interfering in any direct way with the constitutional "freedom of teaching" principle. In the end, this is expected to result in a more effective and equal education system, with improved learning outcomes for all students (Schietroma, 2011; Eurypedia, 2012).

Box 1. The aims of the National Plan for Digital Schools

Recent agreements between the Ministry of Education and the Regions to scale up the national policy provide the clearest enumeration of the strategic aims of the National Plan for Digital Schools.

The framework agreement lists, among more operational objectives, the following aims (art. 1):

a) To overcome the rift between the current modes of teaching and learning in schools and the language of the digital world [...]: the school of the future must use innovative teaching practices in order to equip young people with knowledge and competences that are demanded in the information and knowledge society [...].

c) To develop the use of technologies in teaching and learning activities in order to foster the development of skills for the information and knowledge society.

All operational agreements with single regions then list the following aims (art. 2):

a) To modify the learning environment and adapt it to the needs of the information and communication society […];

b) To promote the use of digital contents in teaching and learning;

c) To foster a transformation of the organisational and pedagogical model, promoting more active roles for students in order to sustain the acquisition of competencies, and breaking the traditional organisation of space and time in schools and at home.

Source: Conferenza Stato-Regioni, Accordo del 25 Luglio 2012 (repertorio atti n. 118/CSR), Regione Lazio and MIUR, Accordo operativo del 18 settembre 2012.

Budget

The initial funding for the national plan was decided with the budget law for 2007 (Legge del 27 dicembre 2006 n. 296, art. 1 c. 633[2]). The budget law set apart EUR 30 million for each of the three following years (2007, 2008, 2009) "to equip schools of all level and type with technological innovations to support teaching and learning activities". This budget has since been extended and complemented with regional funds.

For the four school years 2007-2011, the centrally funded actions within the national plan for digital schools amount to a budget of about EUR 120 million in total, or about EUR 30 million per year. This represents less than 0.1% of the yearly budget of the Ministry of Education for pre-primary, primary, lower- and upper-secondary education (EUR 42 billion for 2011: Ragioneria Generale dello Stato, *www.rgs.mef.gov.it*).

The detail of this investment is given in Table 1. Investments funded with resources administered and raised by schools directly from families, private non-profit organisations or local governments are not included.

Table 1. Allocation of centrally administered funds for the National Plan for Digital Schools (2007-2011)

Purchase of Hardware equipment	*Piano LIM* (IWB)	EUR 91 200 113
	Classe 2.0	EUR 8 820 000
	Scuola 2.0	EUR 1 598 704
Purchase of digital contents (not incl. *Editoria Digitale*)		EUR 5 442 381
Overheads: administration and communication activities		EUR 750 409
Formal training, tutoring and coaching of teachers		EUR 13 323 964
Total		EUR 121 135 571

Source: MIUR, personal communication.

Table 2. The *Piano Nazionale Scuola Digitale* and related initiatives

aim	Introduce ICT as part of the daily tools of classroom activities	Experiment new models of school organisation and of teaching	Support the development of new products
Initiatives in the *Piano Nazionale Scuola Digitale*	***Piano LIM*** Purchase of interactive whiteboard (IWB) kits and training of teachers in their use. *start date:* 2008 *budget:* EUR 104.5m (over 4-years; EUR 91.2m for equipment and EUR 13.2m for training). *penetration:* about 35k classrooms (10.9%) equipped over 4 years, 64 456 teachers trained. The total number of IWBs in Italy is about 70k in 2012.	***cl@sse 2.0*** Selected schools pilot their project of ICT-rich learning environment in one class over 2-3 years. *start date:* 2009 in lower secondary schools, 2010 in primary and upper secondary schools *budget:* EUR 8.8m (30k for each lower secondary class, 15k for primary and upper secondary class). Only equipment purchases are eligible; schools are encouraged to raise additional resources *penetration:* 416 classes (0.1%) in 416 schools. ***scuol@ 2.0*** Same as *cl@sse 2.0*, but the project and funding are not restricted to a single class. *start date:* 2012 *budget:* EUR 3.5m (250k for each school). Only equipment purchases are eligible; schools are encouraged to raise additional resources *penetration:* 14 schools. **State-region agreements**, signed in 2012 with 12 regions, extend the funding of *cl@sse 2.0* and *scuol@ 2.0* initiatives to include more classes and schools.	***Editoria digitale scolastica*** Highly equipped classes act as test beds for the development of native digital textbooks. *start date:* 2012 (first call for tender) *budget:* EUR 3m (150k per school), covering 2-year licences for prototypes of digital textbooks for specific subjects and grade levels. *penetration:* 20 classes in 20 schools. Each school is a test bed for a different textbook.
Other related initatives	**Development of national and school information systems** *Anagrafe Nazionale degli Studenti* is a national longitudinal information system. In 2012-13, all schools must phase out the use of paper records and equip themselves with school management systems and electronic registries that are able to exchange information with *Anagrafe* directly.		
	Phasing out of paper-only textbooks Starting with school-year 2014-15 schools can no longer adopt paper-only textbooks. At the request of families, schools ensure that ICT devices to access digital contents are available. Families contribute to costs, up to a cap amount fixed by law.		
	Smart cities Call for tender for business-led consortia to support the development of new products and services for smart cities. Smart education is one eligible area of application (portable devices for digital textbooks, learning management systems, ...)		

Piano LIM - interactive whiteboards

Through the Scuola Digitale – IWB action (*piano LIM*), the Ministry equipped classrooms with a technological kit (personal computer and interactive whiteboard) and funded specific teacher training for teachers of the corresponding class (at least three teachers per school had to be trained in the pedagogical use of interactive whiteboards, by participating in courses certified by INDIRE – see Box 2). It is estimated that, before the beginning of the plan, the number of IWBs in Italian schools was approximately 4 000 (Parigi, 2010). Over the four school-years 2008-2012, 35 114[3] interactive whiteboards have been bought for Italian schools with Ministry of Education funds, and 64 456 teachers have been trained in using them (Eurypedia, 2012). Table 3 below provides the detail by school level. The most recent census counted 69 813 IWBs in Italian schools as of August 2013 (MIUR, 2013). Assuming that one IWB is in use by one class only, and that all interactive whiteboards are still in use, this corresponds to 22% of the 322 134 classes. The number of IWBs requested by schools in each application round has always exceeded the available funding; apart from certain technical requirements (*e.g.* access to broadband), the order of priority is determined by the objective of equalising existing differences across schools and regions (Schietroma, 2011).

Table 3. Number of interactive whiteboards in Italy

Schools	Ministry of education funds (*Piano LIM*)					**Total amount** (including other private and public funds) as of August 2012
	School year 08/09	School year 09/10	School year 10/11	School year 11/12	Total 08-12	
Primary level		6 454		5 796	12 250	
Lower secondary level	8 939		8 000		16 939	
Upper secondary level		2 944		2 981	5 925	
Total	**8 939**	**9 398**	**8 000**	**8 777**	**35 114**	**69 813**

Source: Eurypedia (2012), MIUR (2013).

The total expenditure on ICT equipment for this programme, between 2007 and 2011, was EUR 91.2 million (Table 1).

The *Piano LIM* relied on a procurement procedure whereby all schools, grouped in local consortia, had to buy their kit through a central marketplace operated by CONSIP SpA, a state-owned company that acts as the central provider of all the public administration.

Within the *Piano LIM*, the average price paid for an IWB is 1 216 EUR in 2010. The biggest market share (39% in 2010) accrued to SmartBoard, followed by Interwrite (17%). The average price paid for a desktop PC was EUR 368 in 2010; and for a notebook PC EUR 400. The average kit to equip a classroom cost therefore about EUR 1 600 in 2010 (Abbondanza, 2011; Consip, 2011).

Technological kits bought with Ministry of Education funds were distributed across all regions (except in the autonomous and bilingual regions of Trentino Alto-Adige and Valle d'Aosta). In the involved regions, over 90% of lower and upper secondary schools, and 95% of primary schools, have been touched by this action (Ferraris, 2011). The number of schools involved in each school year is given in Table 4.

Table 4. Schools involved in the Interactive Whiteboard action: 2008-2011

Level	Number of schools involved	School years
Primary level	5 157	2009-2010
	5 221	2010-2011
Lower secondary level	3 732	2008-2009
	3 786	2010-2011
Upper secondary level	2 499	2009-2010
	2 420	2010-2011

Source: Eurypedia (2012)

It can be estimated that, by the end of 2010, and excluding pre-primary classrooms, 5% of all Italian classrooms had been equipped with interactive whiteboards; by August 2012, the number had increased to 22%. It is moreover possible that schools share the same kit across classes, so that the above figure constitutes a lower bound for exposure: some schools purchased "mobile kits" (mobile IWB and laptop), or share classrooms between different classes. Although traditionally, each classroom is used by a single class group, and pupils stay with the same class group throughout the day and school year, schools are free to adopt a different organisation of their space. Of all IWBs purchased with funds from the "Piano LIM", 10.6% are mobile kits, and 29.1% are located in dedicated labs (science, music or arts labs; multimedia rooms; etc.).

Box 2. Teacher professional development in the national plan for digital schools

INDIRE, the national board for educational research and teacher development, supports all initiatives in the digital school plan with dedicated training offers and resources for self-training. INDIRE (formerly known as ANSAS) develops content for teachers' professional development "with the aim of stimulating innovation in teaching and learning, of bridging the distinction between formal, non formal and informal learning environments, and, in a lifelong learning perspective, of reducing the distance between pedagogical practices and everyday life" (ANSAS 2012; own translation).

INDIRE has a rich resource bank for professional development related to the use of ICT in schools, including over 1 400 text or multimedia resources (of which over 10 hours of video tutorials), many of which introduce subject-specific uses of ICT. Training is often in blended (face-to-face and online) mode, combining preparatory face-to-face sessions with online activities and materials that are specific to subjects and grade-levels and linked to curricular contents and distance tutoring.

Within the National Plan for Digital Schools, INDIRE was mainly responsible for training teachers in the pedagogical use of interactive whiteboards. The training consisted of 20 hours of face-to-face training and 40 hours of online training. The training system is based on a blended model that includes face-to-face meetings and online activities performed on an e-learning environment built on constructivist instructional design principles. Trainees-teachers are divided in groups of 20 to 25, sharing an online virtual classroom and supported by an e-tutor. The e-tutor meets the group of teachers in the face-to-face meetings and supports and moderates the online activities administrating the virtual classroom collaborative tools. As of 2012, 64 456 teachers participated in this training, or about two teachers for each interactive whiteboard purchased through the *Piano LIM*.

Starting from school-year 2012-2013, INDIRE enriched its training offer with the new DIDATEC training. DIDATEC supports teachers in integrating ICT in subject pedagogy, and will be initially offered at base and advanced level in four southern regions (Campania, Calabria, Puglia, Sicilia). These regions are part of the "*Programma Formativo Nazionale 2007-2013*" that is supported by regional cohesion funds from the European Union. The aim of the DIDATEC training is to strengthen ICT skills among teachers to improve the quality of teaching and learning (ANSAS 2012).

Cl@sse 2.0 (class 2.0)

The programme *cl@sse 2.0* started in 2009 for lower secondary schools, and in 2010 for primary and upper secondary schools. The goal of this initiative is to pilot IT-rich learning environments that radically innovate on the traditional organisation of teaching and learning, and thereby to identify effective approaches to embedding ICT in pedagogy and particularly in whole-class activities.

In Italian schools, the class is a very strong organisational unit. The class group of peers remains the same throughout the day and over an entire school cycle; class teachers (the "class council") similarly follow the class over an entire school cycle, and the class often stays in the same physical classroom not only for all lessons, but for many years. It is therefore not unusual to introduce experimental programmes at the class level in Italy.

The first public notice of this programme was issued in April 2009 and concerned only lower secondary schools. It was announced that selected classes would receive funding of EUR 30 000 for each selected class. This initial endowment was to be spent on capital equipment only (hardware, software, and furniture), and for a single class (room) of sixth grade (the first year of lower secondary school).

To compete for the funding, schools had to submit an "idea 2.0", *i.e.* a pedagogical project spanning the three years of lower secondary school (from sixth to eight grade) to embed ICT technologies in everyday teaching. Only equipment mentioned in the class project was eligible for funding; indirect costs (such as those for teacher training, non-teaching personnel) and consumables were not eligible for this funding and had to be covered by ordinary funds administered by the school.

Winning schools (there could be only one class per school in the programme) were selected by a regional jury. Selected classes were to be distributed over the entire country (Valle d'Aosta and Trentino Alto-Adige are excluded), with 6 classes in the 10 less populated regions and 12 in the 8 biggest regions, for a total of 156 classes and a direct cost for the central budget of EUR 4.68 million.

The selection criteria mentioned in the public notice were: the quality of the class project (idea 2.0); past experience with ICT projects, teacher preparation in the use of ICT, availability of broadband connectivity, and the existence of additional funds to support the initiative. In the Lazio region (the region including Rome), a 5-member jury was set up to select classes: four members were internal to the administration, and one scientific expert from the "National Research Council" (*Consiglio Nazionale delle Ricerche,* CNR) completed the panel. To select the classes, out of a maximum of twenty points, nine points were given for the amount of past experience in ICT use by class teachers; eight points for the alignment between the project idea and these past experiences; and three points for the commitment of additional funding sources to the project.

In September 2010, a similar public notice was issued for primary and upper secondary schools. Funding was then reduced to EUR 15 000 for each class. The number of classes concerned was 124 primary classes (with projects spanning three years from third grade to fifth grade) and 136 upper secondary classes (with projects spanning two years only, from ninth grade to tenth grade[4]).

In total, over 4 000 schools have developed their "idea 2.0" and applied for funding under this scheme.[5] This corresponds to approximately one in seven state schools (in 2009-2010, there were 28 792 state schools in Italy at primary or secondary level [MIUR, 2011c]).

The selected schools benefit from operational support by the regional school office (Ufficio scolastico regionale) and by the coordinating agency ANSAS-INDIRE (*Agenzia Nazionale per lo Sviluppo dell'Autonomia Scolastica*). Each regional cluster of schools involved is also linked to a local university

for support in integrating ICT in pedagogy, although the intensity of interactions between schools and university has varied greatly.

In total, there are 416 classes in the programme (*i.e.* 0.13% of all classes); the direct cost for central budget is EUR 8.82 million (see Table 1). This cost does not include the administrative costs of the programme, costs supported by other agencies (*e.g.* ANSAS-INDIRE) and institutions (*e.g.* local universities) involved, costs for teacher training and school-wide infrastructural investments supported by schools or local government bodies.

The intermediate report from the external monitoring and evaluation team (IRVAPP, 2012) gives an idea of the diversity of school projects that have been funded within this action in lower secondary classes. This information is not available for the other levels involved in the *cl@sse 2.0* initiative.

Box 3. The impact of cl@sse 2.0 on student outcomes in lower secondary schools

In November 2009, after the selection of schools but before the class projects started being implemented, the Ministry of Education invited two private foundations (Fondazione per la Scuola San Paolo, Fondazione Giovanni Agnelli) to conduct an external monitoring and impact evaluation of the intervention. The costs of this evaluation are entirely borne by the foundations, and the final report is expected in 2013.

Regarding the impact of this initiative on learning outcomes, the main indicator will be the growth in test scores, between entry tests and exit exams in middle school, compared to control classes from the same school. The evaluation design indeed allows for quasi-experimental comparisons, in that each school had to nominate a parallel class as the "control class" for the evaluation.

Preliminary findings, from teacher self-assessment questionnaires, indicate that most teachers involved in the programme adhere to it. Almost all teachers describe the pedagogical experience as different from that of previous years; most teachers cite positive changes when prompted to motivate this answer. Overall, by the end of the second year of the experiment, teachers are "fully" or "fairly" satisfied with the observed change in terms of student engagement and motivation (over 90%), and effort (64.7%) that they attribute to the use of technologies.

Many teachers however identify certain limits of the programme: the need for further professional development, the need for support staff, and the lack of economic incentives for the teachers involved in the programme. Certain teachers also lament the scarce involvement of other bodies involved in the project, such as universities and ANSAS-INDIRE, while the horizontal collaboration with other experimental classes was cited as a positive aspect.

Source : IRVAPP, 2012.

The specific objectives mentioned in the selected class projects at lower secondary level are manifold; often cited are a shift to innovative teaching practices (particularly collaborative practices and more personalised teaching), digital literacy, and students' transversal skills (self-awareness; communication, collaboration, organisation and problem-solving skills). Many projects also put emphasis on engaging students in active citizenship and social life; innovative teaching practices are seen as instrumental for enhancing student interest for the various subject (IRVAPP, 2012).

The endowment was spent on the purchase of different combinations of IT equipment, although in most cases the kit comprised personal computers or tablets (123 classes out of 141 respondents) and an interactive whiteboard (104 classes) and/or a projector (55 classes). In most cases, there is a 1:1 or 2:1 ratio for pupils to laptops or tablets; but only rarely are pupils allowed to take them home. This class kit was frequently supplemented with digital cameras, camcorders, and network connectivity. A majority of schools (58.9%) shares some of the equipment with non-experimental classes as well; and some money has also been spent on related furniture (curtains, lockers, etc) (IRVAPP, 2012).

On average, students in experimental classes use the ICT equipment for two to three hours per day and almost every day. In almost all classes, computers are also used for class tests, and in two thirds of cases computer-based tests have replaced, at least in part, more traditional "paper and pencil" tests (IRVAPP, 2012).

The first year of the programme, most of the involved lower secondary schools have experienced delays in the programme start. The new equipment bought under this programme was used for the first time in January 2010 for some classes, but by the end of sixth grade (June 2010) still only half of the classes had been equipped. Most of the remaining classes were equipped over the summer preceding seventh grade (IRVAPP, 2012).

Scuol@ 2.0 (school 2.0)

The *scuol@ 2.0* programme started in 2011, with many of the same objectives as the *cl@sse 2.0* programme. The main difference is that *scuol@ 2.0* involves entire schools, rather than single classes. Following the publication of a "pact for 2.0 schools", schools were invited to submit their application to receive funding from the ministry according to their previous involvement in ICT related projects, and to their interest in experimenting with radical new models of ICT-enhanced schooling. In lower secondary schools, priority was given to schools with a cl@sse 2.0 in place. Schools had to ensure adequate support by local governments and seek additional funds (MIUR 2011a).

This call for interest raised over 200 demands for participation; some 100 schools were invited in May 2011 to an international seminar on "Implementing 21st century ways of learning and schooling" in Rome, in collaboration with European Schoolnet (MIUR 2011b). The three panels at this conference suggested three axes of ICT-based innovation in schools that are explored within this programme: supporting innovative teaching/learning methods; supporting innovative ways to organize school time and space as well as personalized teaching; supporting schools in building closer relationships with families and the local community.

In the 2012-2013 school year, 14 schools have entered this programme. An additional 15 are expected to enter a second cohort next year.

To monitor and evaluate the initiative, the Ministry of Education has created a scientific advisory group that holds regular meetings.

The financial commitment for this action is EUR 3.75 million (Eurypedia, 2012). Each selected school receives a contribution of EUR 250 000 from the Ministry, to invest in capital equipment.

Editoria digitale and Impres@ Scuola

An additional objective of the national plan for digital schools is to stimulate innovation in the tools and content industries serving education.

All of the projects of the national plan for digital schools, and particularly the most intensive initiatives (*cl@sse 2.0, scuol@ 2.0*), call for closer cooperation between schools and the business sector – be it content providers or hardware and software developers.

Impres@ Scuola is a new way of building partnerships with the private sector. The business sector has been invited to collaborate with schools involved in the *cl@ssi 2.0* project and to use these classes as a test-bed for strongly innovative products and solutions (without other compensation). A school-business fair has been organised to facilitate the building of these partnerships (Genova, 18-19 November 2011). This has led to 920 "declarations of interest", with which schools have expressed their interest for a partnership

with a company, and 239 agreements between a school and a business to experiment products (MIUR, 2012b).

Under the "*Editoria Digitale*" action (budget: EUR 3 million), twenty schools (at different levels and in different tracks) are given resources to buy prototype digital contents, for different subjects and grade levels, through Consip (and the "electronic market for public administrations"). The aim is to stimulate editors to supply contents for technology-rich classrooms. The action will result in 20 different prototypes, for different combinations of grade level and subject. Each school runs an inverted auction with initial starting price set at EUR 150 000, and selects the winning publisher based on the quality of the proposal. The licence agreements between publishers and schools run for two years and include technical assistance and updates.

Each school involved has identified a pilot class, whose teachers work with the publishers to develop and refine tailor-made content. Contents are expected to be interactive and interoperable, but tailored to the technological devices and platforms in use in these schools. All twenty schools are already highly equipped both in terms of technology and technological know-how – many of them participated in *cl@sse 2.0* – so that they have the competence to judge these prototypes for their pedagogical value. The ministry of education and ANSAS-INDIRE have issued guidelines outlining the criteria for the development of these new products; the digital content must satisfy a multidisciplinary and pluri-disciplinary approach, be flexible in terms of its possible uses (graphic display, practice, individual and social production), and be highly accessible (multi-platform, multi-device, and offline availability) (Eurypedia, 2012).

Distance learning initiatives

Finally, the *@urora* project for adolescents in the penitentiary system (concluded in 2010; budget: EUR 5 million) and the ongoing hospital-school-home initiative (budget: EUR 6 million) also combine investments in ICT equipment and teacher training. They aim to set up distance learning facilities and to leverage the potential of ICT for promoting social inclusion.

These initiatives serve also as pilot models for the development of an appropriate distance-learning model for students living in isolated areas (small islands and mountain communities), so that they may be offered the opportunity of a regular study programme in their lower and upper secondary education when the circumstances do not meet the legal parameters for the opening of on-site classes.

Scale up of the National Plan for Digital Schools

The national digital agenda consultation (see Box 4) identified the scale up of the "National Plan for Digital Schools" as a priority for all levels of government. As a consequence, in July 2012 the government and regions agreed to allocate EUR 20 millions from the ministry of education's funds proportionately to school enrolments in each region for initiatives related to the "National Plan". The detailed allocation across the different actions was to be agreed with each region; moreover, if regions matched at least 40% of the centrally allocated funds with their own contribution, the Ministry of education agreed to increase its part of funding by an additional 20%.

In September 2012, the Ministry signed specific agreements with 12 regions. Each regional agreement differs in the prioritisation between the different programmes in the "National Plan" (*Piano LIM, cl@sse 2.0*, *scuol@ 2.0*). Moreover, in many regions small mountain schools received dedicated funding. As an example, the agreement with the region of Lazio (capital: Rome) assigns EUR 1.2 millions to the *Piano LIM* (with priority given to schools with the lowest level of equipment), and EUR 2.9 millions to the *cl@sse 2.0* initiative (in particular to extend the funding for upper-secondary schools already involved in order to cover the entire upper-secondary cycle, and to involve schools who already applied to previous

calls in the initiative); the region Emilia-Romagna (capital: Bologna) allocated almost equal shares to all three actions; the regions Tuscany (capital: Florence) and Piedmont (capital: Turin) concentrated funding on the *cl@sse 2.0* and *scuol@ 2.0* actions. Although funded in part with regional funds, the *cl@sse 2.0* and *scuol@ 2.0* programmes still rely on a competitive bidding process for which the regional school office (the local office of the Ministry of Education) is responsible.

In addition to the dedicated national and regional funds, in the four Southern regions eligible to European funds under the "Convergence objective" (the poorest regions: Sicily, Campania, Calabria, Puglia), the Ministry of Education informed school offices in June 2012 that schools in these regions could request to use this funding stream for equipping their classes with ICT ressources, in accordance to the principles of the *cl@sse 2.0* programme (circolare protocollo AOODGAI/10621).

Box 4. The Italian Digital Agenda consultation

The "digital agenda" is a cross-governmental initiative to encourage digital solutions for the development of the economy and society and for more efficient government action. Within the coordination board (*cabina di regia*), instituted in March 2012 with members from all ministries and agencies involved, the Ministry of Education led the digital skills (*competenze digitali*) task force. Each task force identified priorities, obstacles, and possible solutions: the first priority identified by the digital skills task force is "to scale up the digital school model: school access to broadband; cloud resources for teaching and learning; transforming learning environments; digital contents and e-books; teacher training through blended e-learning; interactive whiteboards; e-participation".

The consultation provided a framework to coordinate European, national and regional investments in "digital schools"; detailed plans for EUR 40 million of additional investments are being made (MIUR, 2012c), through agreements with the regions (see above). More directly, the legal frameworks identified by each task force as necessary to foster public and private investments in digital solutions were introduced through a decree law – the *Decreto Crescita 2.0* ("growth 2.0", decree law 179/2012, converted into law 221/2012).

Other national initiatives for ICT in education

In addition to the "National Plan", which is the focus of this report, Italy has a few important other national initiatives to promote the use of ICT in education.

School information systems and school cloud

With the objective of introducing savings in the administrative costs related to student enrolment, student transfers, and to the production of certificates, the so called "spending review" (decree law 95/2012, art. 7 cc. 27-32, converted into law 135/2012) requires that, starting with the school year 2012/13, families enrol their children in schools using online forms exclusively; schools communicate end-of-term reports electronically; and schools adopt electronic registry applications and activate electronic communication modes with pupils and families.

During the current school-year (2012/13) schools thus have to equip themselves with richer school management systems to meet these requirements: applications that handle student attendance, family-school communications, end-of-term reports and certificates electronically. The ministry has imposed interoperability standards to the industry, so that all data are transferable to the central longitudinal information system (*Anagrafe studenti*), whose data content will be considerably enriched by this policy.[6]

A national longitudinal information system with electronic records of individual students, the *Anagrafe Nazionale degli Studenti*, exists since 2010[7]. The adoption of online registries opens up the possibility of enriching the system considerably with high-frequency data updates about students, classes, and schools. The missions of the *Anagrafe Nazionale degli Studenti* have also been expanded in 2012: it

can now serve as support for the evaluation of the school system, and to support all institutional activities of the ministry[8].

In parallel, the ministry also promotes the *scuola in chiaro* ("school uncoded") policy, an e-government initiative whereby school-level information is shared with families using the online tool *cerca la tua scuola*[9] ("find your school"). This tool is also being enriched as new information is collected at local level. In 2013, all non-confidential information that is known to the central administration about the school is accessible from this site, and schools can enrich it with more local information (such as the school offer of enrichment activities and improvement plan, *Piano di offerta formativa*). Everybody has access to a synthetic description of the school: the standard information includes the level of ICT equipment (number of desktop and laptop PCs, student/computer ratio, number of interactive whiteboards, wireless and LAN connectivity); information on students (enrolment by year of study, average class size by year of study, percentage of grade repetition, school transfers and school dropout compared to regional and national averages); information on teaching and non-teaching personnel (breakdown by gender, age categories, and contract type, turnover rate and teacher absenteeism by cause, compared to regional and national averages); school budget information. Schools can enrich this information with the school's results at national evaluations conducted by INVALSI (*Istituto Nazionale per la valutazione del sistema educativo di istruzione e di formazione,* National Institute for the evaluation of the education and training system) and with information about pedagogy (textbooks, internships, etc.).

The e-textbooks law

The *Crescita 2.0* ("Growth 2.0") decree (see Box 4) contains a large set of measures to promote the digital delivery of public services and to support digital innovation in the private sector. Two of these measures concern ICT policies for schools: i) the mandatory adoption of e-books or books in mixed format as textbooks; ii) the creation of "digital school centres" in isolated villages.

The provisions concerning digital textbooks (art. 11) state that starting with school-year 2014-15, all schools must exclusively adopt textbooks in digital or mixed format. As a consequence, traditional paper textbooks will be phased out and replaced by textbooks requiring a reader or tablet device to access all or part of the material. The phase out plan starts with the first classes of each school cycle (1st, 4th, 6th, 9th, and 11th grade), and, following the five cohorts over time, will cover all classes by 2016-17.

In Italy, textbooks for all grades are bought by families directly, but the expenditure for textbooks is capped by law: schools must ensure that the cost of buying all adopted textbooks for one child does not exceed the legal maximum. The existing cap on family expenses for textbooks remains unchanged. The law however states that, at the request of families, schools ensure that ICT devices to access digital contents are available, while families contribute to equipment costs within the cap for textbook expenses. The family's budget for textbooks therefore can cover more than just the textbook under the new law. The details will be laid down in future regulations; a hypothetical scenario has, for instance, schools offering families who demand it options for leasing a tablet device to access the content, provided that the cost of the lease, and of all textbooks loaded on the device, does not exceed the cap.

This new law is the most radical measure to increase the availability of technology in the classroom.

Support for business R&D: Smart cities and communities and social innovation

"Smart cities and communities and social innovation" are considered a priority strategic objective within the national research and innovation policy. This is one of the objectives of the European Framework Programme "Horizon 2020" (due to start in 2014) and is in line with the European Digital Agenda: it is therefore expected that additional funding for this objective will flow from European sources.

To stimulate public and private R&D in this area (and prepare bids for future European funding), two calls for tender have been issued during 2012. After a first public notice of a competition in March 2012[10] concerning only projects for the four most economically disadvantaged regions in the South, in July 2012 the Ministry of Education, University, and Research has issued a call for projects[11] concerning the whole country. The total budget for this action is EUR 240 million (from European Convergence funds for the four disadvantaged regions) and EUR 655 million (from the national research budget for business R&D – *Fondo per le Agevolazioni per la Ricerca* – for the second call). Both calls are reserved for private sector R&D projects that involve public administrations as "test-beds" for the experimental phase, and universities or public research bodies as partners. Projects have to be submitted by consortia in which the private sector bears a majority of costs, with the participation of at least one SME, and a university or other public research body contributes for at least 20% of the cost. A small part of funding is reserved for social innovation projects submitted by young entrepreneurs (below age 30).

To be eligible, industrial R&D projects must meet the following generic definition: "develop technological solutions, services, models, and methods that are at the frontier of applied academic or industrial research. The project ideas must fall within the scope of Smart Communities, *i.e.* develop innovative models for solving problems at the city, metropolitan, or more generally territorial level, through technologies, applications, and integration and inclusion models." (Decreto Direttoriale 5 luglio 2012, art 1, comma 3).

Both calls identify "schools" or "smart education" as one area of application; at least implicitly, part of the funding is reserved for this specific area of application (see Box 5).

Box 5. Private sector R&D projects for smart education

Italy issued two calls for tender during 2012 for supporting business driven innovation in the area of "smart education".

In the first call, "smart education" is defined as "fostering innovation in the education and training system, through the development of information systems, technological solutions, and functioning and empowering ICT system components, that enable users to activate and implement new models of individual and class instruction and learning, to realise advanced systems of assessment, to develop e-education services, and improve on existing models of interaction between education and training institutions and the public and private labour market" [own translation]. The three selected project that fall within this area are[12]:

- "S4EDOC – Smart formats For EDucation On Cloud", a consortium led by ANSAS/INDIRE, HP Italy, and Università del Salento (Lecce).
- "SMART EDU@WORK", a consortium led by the Consiglio Nazionale delle Ricerche (CNR), University of Bari, ITEL telecommunications and Olivetti.
- "Scuola Digitale 3.0 (SD3.0).", a consortium with ENEA and CETMA, Interattiva Media (multimedia editor), Infomob (wireless solutions), Università del Salento (Lecce).

The second call identified specific needs for which bidders were invited to submit solutions (Decreto Direttoriale 5 luglio 2012, art 1, comma 5)[13]:

- Design innovative student devices, that are able to function as e-book readers (with suitable screen resolution) while at the same time providing access and use, with open architecture for most OS, to digital multi-media content on the web.
- Learning Management Systems (LMS) able to support the personalisation of learning trajectories, both in terms of flexible schedules, use during classroom activities, dynamic group articulation and instruments for student management.
- Content Management Systems (CMS) that can be integrated in LMS, for teachers to develop multi-media digital contents. [own translation]

This second call closed on 31 January 2013.

AN ASSESSMENT OF THE ITALIAN NATIONAL PLAN FOR DIGITAL EDUCATION

The plan intends, on the one hand, to increase the use of ICT in schools and thereby improve the digital skills of teachers, pupils, and their parents; on the other hand, and in the longer term, it intends to act as a catalyser of pedagogical change. Will the strategy succeed in bringing about the desired change? How fast will this happen, and are there less costly ways of reaching the same targets? In the following sections, we will discuss each objective in turn, and, for each set of objectives, deliver some indications on how to improve the current plan. We will then address a few other measures that could contribute to the success of the Plan, while not being integral part of it.

In a nutshell, we argue that the government should take all measures to accelerate the equipment process of Italian schools and refocus its welcome innovation projects around the *scuol@ 2.0* initiative, which should be an innovation laboratory network for the Italian education system.

Mainstreaming ICT use in schools and improving digital skills

Today's youth lives in a connected world surrounded by digital technologies. Many Italian observers predict a growing distance between school lives and out-of-school experiences of children, unless schools update their instructional tools and methods. In meetings during the review visit, similar views were expressed, in particular by parent and teacher associations, but also politicians, as a major justification for supporting the introduction of ICT in education. Parents and politicians stressed the need to align schools with changes in society, and in particular with the work environments of the knowledge society. Teachers and parents also emphasised that pupils are "digital natives" for whom ICT constitutes a natural way of socialising and interacting. Overcoming the rift between pupils' in-school and out-of-school experience, and channelling emerging modes of socialisation and out-of-school learning into more formal contexts, is a major aim of the policy mentioned in official descriptions (MIUR, 2012a; Eurypedia, 2012). Although the expectations of students for ICT in school must not be exaggerated – students want technology to improve teaching and learning, not to change it radically (OECD, 2012a) – the view that schools have to enter the "digital age" is a main driver of ICT policies in education worldwide.

Along with the idea that schools have to catch up with the more advanced sectors of society, a complementary view sees schools as the vehicle for spreading the use of ICT throughout society. There is significant cross-government support indeed for using schools towards the diffusion of ICT in Italian society and the development of ICT skills, and investments in "digital schools" are one pillar of a coordinated effort to build up Italy's capacity in the digital economy, the *Digital Agenda*.

A well-grounded objective

The use of ICT in a formal education context, at all levels of education and throughout the subjects, is directly associated with several advantages.

Box 6. Findings from a European survey of ICT in schools

A recent survey of the availability, use, and attitudes to technology in European schools described the following findings for Italy:

Availability of ICT

- While the number of computers per 100 students increased by a large amount in most countries between 2006 and 2011-12, in Italy there has been very little change over this period. At grade 8, there were 7 computers per 100 students in 2006 (European average: 11); and there are 9 in 2011-12 (European average: 20). Only Greece has fewer computers per student than Italy. During the same period, Sweden, Norway, Denmark, and Spain increased the number of computers available to 8th grade students to over 30 per 100 students.

- In Italy, the most common location for computers in schools is still the computer lab. Over 75% of school computers available to students are in a computer lab in Italy, and less than 10% are in classrooms. In contrast, Lithuania, Portugal and Spain have the highest proportion of desktop computers in classrooms (33% to 39%).

- Interactive whiteboards (IWBs) are found across Europe, with approximately 100 students to each IWB at all grades. In Italy, there is one IWB for 200 students in grade 4, one IWB for 77 students at grade 8, and one IWB for 250 students at grade 11. While the spread of IWB is not far from average, simple data projectors are rare in Italy: only Romania has fewer data projectors installed per student. Data projectors are standard classroom equipment at all grade levels in Finland, Slovenia, Sweden, Estonia, and Ireland.

- The absence of broadband is particularly acute in Italy at all grades.

- On the basis of a combined indicator, very few schools in Italy can be characterised as “highly digitally equipped schools”: among European countries, only Romania and Turkey have consistently fewer such schools at all grade levels. Highly digitally equipped schools are characterised by relatively high equipment levels, fast broadband and relatively high connectedness.

Use of ICT and training

- Italian teachers report low frequencies of ICT based activities with their class, at all grade levels. Their average frequency is between “never or almost never” and “several times a month”.

- In Italy, school heads report more frequently than in most other countries that additional training hours and financial incentives are used to reward teachers for their use of ICT in teaching and learning. Competions and prizes, in contrast, are relatively rare.

- Over 50% of Italian teachers in primary and lower secondary schools have spent more than 6 days on ICT related professional development over the last 2 years. This is more than in other countries on average. Italian teachers’ confidence in using ICT is close to the European average.

Attitudes to technology

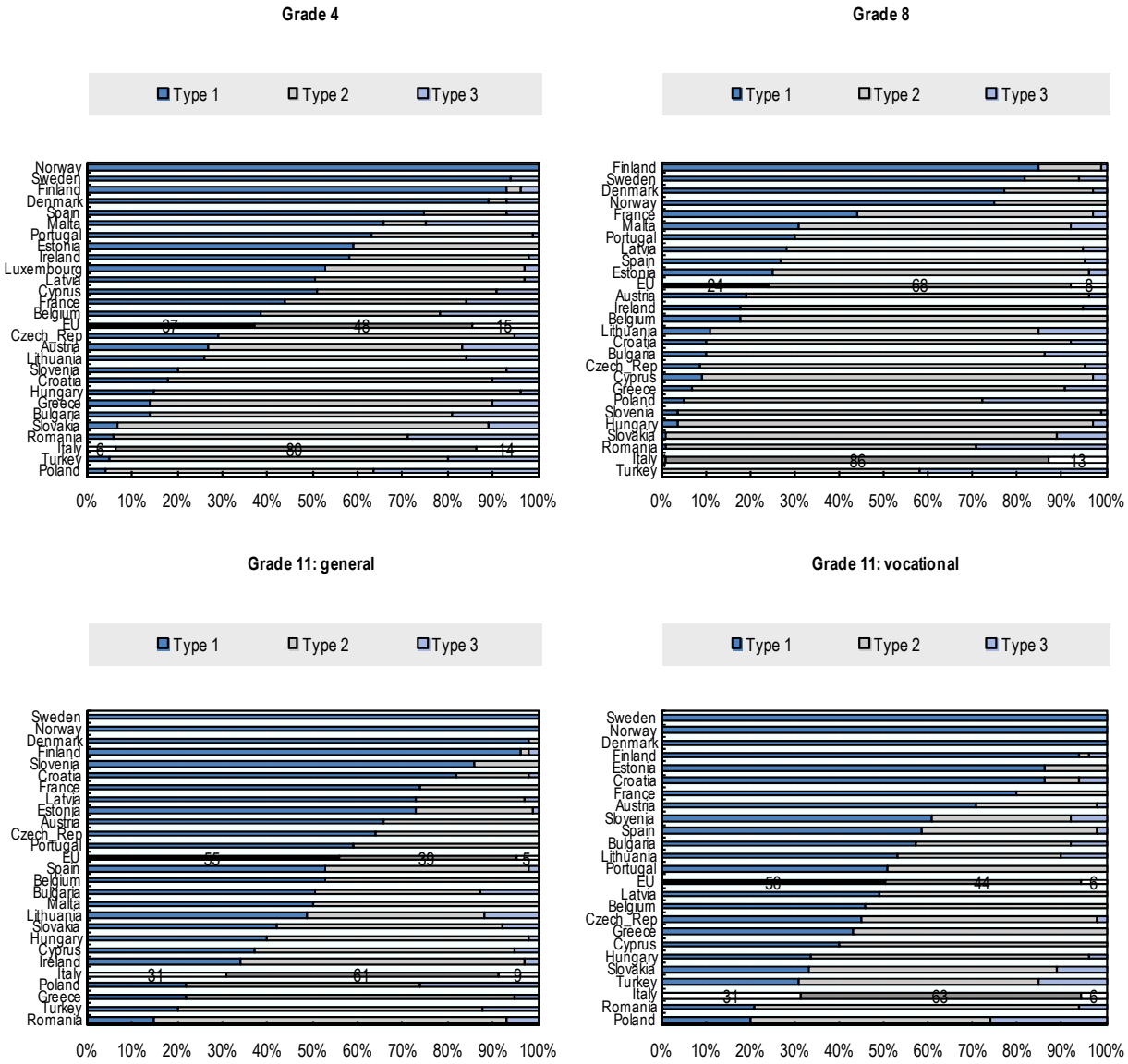
- Teachers in Italy have very positive opinions about the impact of ICT use on students’ motivation, achievement, as well as on the development of their transversal and higher order thinking skills. In particular teachers are more frequently and strongly positive about students’ motivation.

- Italy is also among the countries in which students have the most positive opinions about the impact of ICT use on learning.

Source : European Schoolnet (2013).

First, pupils are expected to develop ICT skills by using ICT for school work. Pupils learn to use computers or digital devices and to navigate information on the web, guided by adults. Schools can reduce the digital divide between families where ICT use is widespread and families where it is not. Some pupils may also develop more technical skills for ICT-related occupations, although not all of them are expected to do so.

Figure 1. Percentage of students in schools of different levels of ICT intensity



Note: Type 1: high equipment, fast broadband, high connectedness (website, emails, etc.); Type 2: medium equipment, slow or no broadband, some connectedness; Type 3: medium equipment, slow or no broadband, no connectedness.

Source: European Schoolnet (2013).

Students may also acquire the habit of using ICT tools as educational tools at schools, and will more naturally use e-learning for lifelong and informal learning as adults. Participation in adult education in Italy is well below the OECD average: in 2006, only 22% of working age adults (aged 25-64) participated in formal or non-formal education, compared to an OECD average of 40% (OECD, 2012b: Table C6.5). Lifelong learning constitutes a necessity to respond to changing skill demands, and e-learning holds great potential to respond to this demand.

Pupils are not the only group expected to develop ICT skills and habits as a result of the plan. By infusing technology into the typical classroom, ICT familiarity and competences are expected to develop among teachers as well, and, more indirectly, among students' parents and other family members (through informal learning with their children). Pupils, teachers, and their families may become critical and responsible consumers of digital products whose demands stimulate innovation in the economy. More indirectly, the use of ICT in formal education contexts can have a transformative impact on pedagogy and school organisation, thus contributing to better student outcomes. The transformative impact of ICT on education, however, is predicated upon a set of complementary changes and will be discussed in a second section.

Italy's aim to increase the use of ICT in schools and, through schools, across society, will bring Italy closer to its neighbours. Comparative data (see statistical annex) confirm that, until recently, Italy was lagging behind most other OECD countries in terms of the use of ICT. According to the EU Digital Scoreboard, in 2011 the proportion of adults who had never used the internet was 38.5% (EU27 average: 24.3%). While the gap shrinks for the younger generations – in 2009, 89% of 15-year-olds in Italy browse the internet for entertainment purposes, compared to 92% on average in the OECD – data also show that within schools, Italian 15-year-olds were exposed to ICT to a much lesser extent than their peers in the average OECD country. The data therefore suggest both a relative lack of ICT familiarity in the Italian population as a whole, and a greater distance between school and leisure activity when it comes to ICT use in Italy.

Strengths

The objective of increasing the use of ICT and the internet in Italian schools is in line with the direction taken by most other countries. A report prepared for the U.S. Department of Education (2011), *International Experiences with Technology in Education*, shows that most countries are investing in ICT for education. Although Italy was not included in the study, its initiatives are similar to many surveyed countries. Plans to support the diffusion of interactive whiteboards have started in the United Kingdom some ten years ago. By 2011, it is estimated that 80% of classrooms in the United Kingdom were equipped with IWBs. The Netherlands (53%) and Australia (49%) have about half of their classrooms equipped with IWBs (Futuresource consulting, 2012), and in Denmark, there are less than 30 students per interactive whiteboard in primary and lower secondary schools (European Schoolnet, 2013). More recently, Portugal, Mexico and Turkey have launched large-scale plans for installing IWBs in classrooms. Pilot initiatives involving classes as ICT test-beds, similar to the *cl@sse 2.0* initiative, can be found in Israel and Spain among others. Whole school pilots (*scuol@ 2.0*) are or have been used in Korea, Singapore ("Future Schools") and England ("ICT Test-beds", see Box 13), commonly seen as leaders in integrating ICT in education.

Italy's national plan for digital schools (*Piano Nazionale per la Scuola Digitale)* has several strengths.

Means are aligned with the goal of increasing the use of ICT in schools

The concrete implementation of the policy is well aligned with the goal of increasing the use of ICT in Italian schools. The central device of the Italian plan is the interactive whiteboard, a technology that

teachers can start using without facing high entry costs and whose possible uses fit all existing modes of teaching and learning – from the more traditional to the more innovative. For this reason, the interactive whiteboard has proven very popular among teachers internationally. IWBs are consistently found, in international research, to act as a "Trojan horse" in drawing the vast majority of teachers to increase their use of ICT tools for work-related purposes (Lee, in press; Somekh, Haldane, *et al.*, 2007): once they have an IWB in their classroom, teachers do not necessarily change their preferred mode of classroom interaction, but can be expected to increase their use of the internet and the personal computer for lesson planning (by browsing for digital resources) and for interacting with colleagues.

The strategy creates teacher demand rather than resistance

The Italian plan can also be characterised as a strategy that builds on existing teacher demand, and develops further demand for classroom technology and for support in using ICT in classroom. The plan indeed largely relies on volunteer schools and teachers to lead the change. In the case of the IWB initiative, schools have to request and eventually buy the equipment themselves, and teachers have to undergo some training towards the use of the interactive whiteboard. The risk that the newly bought equipment accumulates dust in the schools' cupboards is thereby reduced to a minimum. In the context of scarce resources, of considerable uncertainty about teachers' appetite for change, and with limited demand from the public in the initial stages of the plan, such a bottom-up approach is certainly welcome.

The fact that additional funds, from local authorities and from non-profit private sector organisations, are now aligned with the class-centred approach of the national plan testifies to the well-accepted nature of the plan itself: the initial investment has awakened a dormant school demand for more classroom technology.

From 2014 on, the e-book policy will allow and incentivise all teachers to accommodate technology in their classrooms. This may mark a new course in this respect: it will be important to prepare teachers for this change to avoid generating resistance to further classroom technologies.

An efficient procurement procedure

The *piano LIM* has also relied on an efficient procurement procedure for the purchase of interactive whiteboards, desktop and laptop computers. To reduce the costs, but remain responsive to local needs, schools placed the orders themselves through temporary group purchasing structures (with one school acting on behalf of all members); a central marketplace (Consip) facilitated the operation. A welcome side-effect of this scheme was to pave the way for schools who wanted to partner with neighbouring schools to create local user networks or proceed with further grouped orders (*e.g.* for maintenance contracts).

The strategy builds capacity for wider change

Lastly, the plan is embedded in a phased approach that aims at building the capacity for wider change before introducing new changes.

On the one hand the plan builds capacity for wider change by grounding each initiative in the existing ICT skills among teachers. The participation of three teachers, for each new IWB, in pedagogical training for the use of ICT was a condition in the *Piano LIM*. In addition, the more advanced initiatives required considerable past experience among teachers: *scuol@ 2.0* gave priority to schools with a *cl@sse 2.0* in place, and *cl@sse 2.0* to teachers with previous experience in using ICT (including IWBs).

On the other hand, the creation of formal and informal networks for peer-learning is at the heart of the strategy.

Because all initiatives under the national plan for digital schools targeted volunteers, they have capitalised on the demands and energy of teacher leaders within schools. Through this strategy, enthusiastic ICT champions have emerged that could contaminate, with their examples, their wider networks. The strategy hopes to energise the most pioneering teachers and expects practitioner networks to emerge as a result.

In the case of the *cl@sse 2.0* and *scuol@ 2.0* projects, the competitive selection ensured that already in the project elaboration phase the most enthusiastic teachers rallied their colleagues. The selected classes and schools were then formally linked to a region-wide or nation-wide network of schools and classes.

In the case of the IWB initiative, schools had to create formal grouped purchase networks that could well become more stable user networks. A cascade approach to professional development, relying on informal networks among teachers, was also encouraged as the formal training requirement (three certified teachers per IWB) covered only imperfectly teachers' training needs. Indeed, particularly in the lower and upper secondary grades, more than three teachers intervene in the same class. Moreover, in accordance with the objective of increasing ICT familiarity and use, the required training in using IWBs was mostly based on ICT skills and did not include subject-specific pedagogical training. The latter was left to teachers' own initiative, with some resources available online for self-training.

Recommendations to speed up the use of ICT in schools

Despite its strengths, the plan for digital schools faces several challenges. The slow diffusion of ICT equipment in classrooms is the main threat to its success. Deep system-wide changes in pedagogy, time use, and school organisation could occur spontaneously once a critical mass of Italian classrooms and schools is equipped with classroom technology. However, at the current pace, such change still appears beyond reach.

Rather than lack of demand, the slow diffusion of interactive whiteboards (or ICT more generally) comes from the limited budget of the plan. If possible, we suggest to raise the budget devoted to the plan. Given current budgetary constraints, this may not be possible, and several features of the plan could be revised to attract additional funding and accelerate ICT uptake within the current budgetary envelope. As the use of ICT in school depends on teachers' learning and training opportunities as well as on the availability of a sufficient number of digital pedagogic resources, we also make suggestions to address these dimensions of the plan (see Box 7).

Box 7. Recommendations for the Plan to mainstream the use of ICT in schools

ICT infrastructure programme

- **Speed up the uptake of ICT in schools and classrooms by increasing the budget of the *Piano LIM and* redesigning some of its dimensions.**. Generalise matched funding designs to attract external funding from regions, foundations and schools. Open the plan to other, cheaper classroom technology chosen by schools, *e.g.* a kit composed by a classroom computer, visualiser and projector.

Digital learning resources

- **Develop INDIRE digital resources into a central, virtual exchange platform for teachers**. Translate high-quality open educational resources (OERs) available in other languages and adapt them to the Italian context and curriculum. Organise the resource banks for teachers starting from teachers' needs (*i.e.* from the current textbooks in use or from curriculum guidelines). Encourage teachers and institutions to develop and share OERs by establishing quality assurance and reputation mechanisms with social network features and awards. Embed the use of resource banks and OERs in subject-specific training materials for teachers.

Training and professional development

- **Give schools a flexible training entitlement**. Schools could then use their collective entitlement not only to fund the participation of individual teachers in externally organised programmes, but also more flexibly to hire external trainers for whole-school training, to fund teaching release time for their most skilled teachers to provide year-round, school-based training. Provide school principals and teachers with training and guidance on how to develop a professional development project tailored to local needs and on how to create space for informal sharing and learning among teachers.

- **Institute and support teacher awards and innovation fairs** about pedagogical uses of ICT to facilitate knowledge sharing beyond the school unit. Create regional networks of teachers who can support colleagues in integrating ICT in their pedagogy (ICT champions).

Monitoring and evaluation

- **Set operational targets, milestones for programme completion, and metrics for success.** Possible targets could be to equip 80% of classrooms with ICT by 2014-15, to make a certain number of new open digital resources available on the new virtual exchange platform, to have a number of visitors of the platform, etc.

Alignment with other policies

The success of the plan in supporting the nationwide integration of ICT in teaching and learning is also conditioned by contextual factors that require the co-operation of other agencies. The following checklist identifies four critical factors:

- ✓ Ensure cross-government support for providing adequate bandwidth in all schools for the effective use of the new hardware.

- ✓ Ensure parent buy-in by tackling concerns about the safety of the school internet environment, and by supporting local initiatives for parental training programmes.

- ✓ Align curriculum and assessment with the new environment. Issue national guidelines with subject specific learning objectives related to the use of ICT. Develop tools for benchmarking ICT skills and other key competences at regular intervals.

- ✓ Plan the integration of ICT in the classroom with longitudinal information systems (*anagrafe*) and learning management systems (*registri digitali*).

Make even more with severe budget constraints

National policies for ICT in education exist in all European countries, often in relation to the Digital Agenda for Europe adopted by the European Commission (Eurydice, 2011). Even during the recent crisis and the public spending cuts, countries such as Portugal, Spain, France and Slovenia have continued to invest in ICT in education. As an exception to this pattern, the United Kingdom has reduced central support for ICT in schools and closed down the British Educational Communications and Technology Agency (BECTA).

In Italy, the national plan for digital schools has so far used its scarce resources in an efficient way. By targeting volunteer schools and teachers at first, it has reduced the risks of spending where there is no demand. The plan has also relied on an efficient procurement procedure.

Applications for equipment have clearly exceeded available funds. At the current pace of the IWB initiative, it would take over 10 years to reach the current penetration rate of the world leader for IWB use, the United Kingdom (where Futuresource consulting [2012] estimates 80% of classrooms to have an IWB by 2011). Faster classroom penetration of the IWB initiative may result from recent agreements between the State and 12 regions. It may also result from private sector involvement: in many regions, schools have in the past been able to raise funds from bank foundations or other non-profit organisations for school renovation projects, and these external partners may discontinue the funding of computer labs to fund new classroom technologies instead in response to school demands. The regional branches of the Ministry of Education (*Uffici scolastici regionali*) play an important role in aligning these external partnerships with the national policy. The ministry should try to channel these private sources of funding so that they complement its budget.

A priority of the plan should be to accelerate the penetration of ICT in schools as this is important for an effective and sustained use of ICT in teaching and learning. A faster penetration would quickly allow whole schools rather than isolated classrooms to be equipped. We suggest that the Ministry revise the plan so that it gives more incentives to attract additional funding and that other types of technology than interactive whiteboards become eligible:

- *Part of the Ministry budget for classroom technologies should be allocated in the form of matching funds*: matching funds request recipients to commit a sufficient level of funds from their own budget or to raise complementary funds from other sources of funding. The logic of matching funds has been already introduced in the framework for the 12 state-region agreements. We recommend extending this logic to schools to encourage them to raise funds for whole-school penetration of ICT. Different match ratios can be created for different beneficiaries, and the ratio can vary locally to reflect the difficulty in raising funds.

- *The plan should be opened up to other classroom technologies than interactive whiteboards*. Although we recognise the many strengths of the IWB technology, a cheaper option is to complement the classroom computer with a simple projector and a visualiser (document camera or digitiser). Schools should choose themselves what classroom technology best fits their pedagogic needs. A visualiser can effectively support student participation and interactive teaching, with similarly low entry costs for teachers as the IWB. Using a visualiser with an IWB is an ideal combination where funds permit. Mobile forms of technology are also very effective, especially when linked to an IWB. The plan should continue to build on the commendable trend already started towards placing technology in the classroom itself and into the hands of learners in particular.

The e-book initiative will make it possible for all pupils to use a tablet reader to access textbook materials (if schools so wish). In the context of limited budgets, this may lead to much faster and widespread penetration of ICT in the classroom than the current school-based initiatives without additional public cost. However, equipping teachers, producing high quality digital contents, and devising professional development that supports an active pedagogical use of the possibilities of tablets, notably with interactive whiteboards and other projector equipment, does require additional resources. The opportunity cost of delaying such investments should be carefully weighed against competing expenditures.

Support the expansion and distribution of digital resources through resource banks for teachers

The availability of appropriate quality content is a condition for making the best use of technology – and thus for its fast penetration in classrooms.

The lack of native content for interactive whiteboards or tablet technologies may not hamper their use as long as enthusiastic early adopters are involved, given that these devices accommodate non-native content as well. However, it will become a significant constraint as the project expands and reaches more teachers. The untapped pedagogic potential of ICT may be viewed as a lack of potential of ICT to enhance pedagogy.

Supporting the production of digital resources is thus an absolute necessity for the success of the plan. Developing quickly enough digital pedagogic content and tools, meeting a variety of needs, requires the mobilisation of the for-profit and non-profit private sectors, but also the contribution of teachers.

Mobilising entrepreneurs and publishers

The Ministry of education has started to address several economic obstacles to the emergence of a pedagogical digital content industry. It has encouraged investments of private firms in the development of such resources by setting up test-beds for their products. It has also lowered companies' marketing costs by aggregating and structuring teacher demand. As a result, a larger fraction of publishers' resources is expected to flow into the development of quality contents to support teaching and learning (and a small share in their sales department).

Box 8. Public-private partnerships for the development of quality textbooks

Under public-private partnerships for textbook development, for-profit publishers develop prototypes that are made available for no fee to the schools in which they are field-tested, in exchange for user feedback. The publisher benefits from the public investment in educational technology and from teachers' time and feedback to refine the product, but keeps ownership of the product itself. In 1989 the National Council of Teachers of Mathematics (NCTM) agreed on new Curriculum and Evaluation Standards for School Mathematics. To embed this new curriculum in teaching practice, the NSF funded 13 different textbook projects that spanned school education (Reys *et al.*, 1999). Textbooks were extensively field-tested in schools and then revised before becoming commercially available. The resulting mathematics textbooks have been judged of exemplary quality compared to other commercially available textbooks in an independent review by the US Department of Education and the AAAS (Kulm *et al.*, 1997).

The *Editoria digitale* and *Impres@Scuola* initiatives support the pedagogical industry by reducing the development costs for innovative content providers. These programmes indirectly subsidise investments in the quality of digital contents by providing opportunities for field-testing and refining prototype materials. The *Editoria digitale* project involves 20 schools as a test-bed for digital textbooks. It mirrors, in the new digital context, an initiative in the early 1990s by the United States National Science Foundation (NSF) to develop quality textbooks in mathematics (see Box 8).

The development of quality digital content and software for education is also hampered by the highly fragmented demand of individual teachers and schools, and as a consequence, the high marketing costs for firms. The fragmented demand gives rise to monopolistic competition in which publishers seek quasi-rents by investing in advertising and marketing rather than in research and development for the production of innovative products.

Italy is taking important steps to structure market demand for digital contents, and thus reduce entry costs for innovative firms. The new electronic marketplace for public education (*Mercato elettronico della Pubblica Istruzione*, MePI) represents a bespoke adaptation for schools' needs of MePA (*Mercato elettronico della Pubblica Amministrazione*, electronic marketplace for the public administration). It will include integrated solutions and digital contents (and not just technological devices) that correspond to particular pedagogical needs.

Mobilising open educational resources and teacher exchange

In addition to the resources developed by the publishing industry, some interesting Italian initiatives support the production and sharing of digital learning objects. "EduLab" supplies IWB content on the INDIRE password-protected website for teachers. Grass-roots initiatives such as the "Book in progress" project, in which teachers collaborate in a wiki mode to produce (digital) textbooks (*www.bookinprogress.it*), also contribute to this agenda. However, these initiatives fall short of meeting the scale of the needs.

A strong commercial supply of digital resources in Italian does not seem to be available. While publishers will soon have to develop digital content for their textbooks, they currently lack incentives to invest in developing them as the market for them is still too small. However, this market is likely to grow only if enough quality resources show teachers the pedagogic potential of digital devices.

To make a critical mass of resources available relatively quickly, we recommend:

- *To translate in Italian and adapt to the Italian curriculum existing open educational resources available in other languages*;
- *To develop and promote a central resource bank for teachers, including all open educational resources (and possibly other digital resources as well)*;
- *To encourage teachers to develop and share their teaching resources as open educational resources by giving awards and using other reputation mechanisms*.

A host of open educational resources (OER) is already available worldwide: OER are learning and teaching materials that teachers (and others) can freely use and reuse, generally without charge, and which have limited or unrestricted licensing rights (generally Creative Commons or GNU licenses). A significant source of savings from digital technologies precisely lies in the access that they provide to a wealth of readily available OER (OECD, 2007).

A European-wide Learning Resource Exchange project (*http://lreforschools.eun.org*) federates repositories of open educational resources, and INDIRE participates by contributing its resources to the portal. Other repositories exist worldwide, such as OER Commons (*www.oercommons.org*) in the United States, which hosted over 200 000 resources as of 2013, including interactive resources for tablets, computers, or interactive whiteboards.

Although quality resources are available in Italian, their number is still insufficient.

A first step to remedy this problem would be to identify and translate some of the most relevant high quality resources available in other languages, and adapt them to the Italian culture and curriculum.

A second step would be to develop and promote a central resource bank for teachers on the Internet. This platform would bring digital resources available in Italian, these newly translated OER, as well as any other material shared by teachers. Currently, such a platform does not exist in Italy. There is also no platform bringing Italian OER together either or resources developed by teachers themselves. In fact, in response to an OECD questionnaire (Hylén *et al.*, 2012), Italy has indicated that it does not have a national strategy for OER, and that the level of activity in the OER movement for ISCED levels 1, 2 and 3 is low. (In higher education, most universities have their repository of open educational resources, but they rarely include material that can be used as teaching or learning resources in school.)

Ideally, this central resource bank should be organised starting from teachers' needs, be categorised according to the Italian curriculum to make relevant resources quickly accessible, and have certain social features that make it an attractive one-stop-shop for teachers in search of solutions for their classroom. Resource banks that fully exploit the potential of web 2.0 may function as brokers of communities of practice: social networks can support the members and catalyse faster adoption of ICT. Such a resource bank in itself acts as an incentive and support mechanism to develop further resources.

Within the scope of its support functions, INDIRE could maintain such a portal with referrals to existing OER tailored to the curricular needs of specific subjects: free or open source pedagogical software, such as GeoGebra (*www.geogebra.org*) or solutions listed on SchoolForge (*www.schoolforge.net*); digital textbooks such as those developed in the Italian "Book in progress" network; assessment instruments (*e.g.* from an INVALSI test bank); lesson plans, etc. Examples from Korea, the Netherlands, Belgium (Fl.), the United States and France, among others, could inspire this portal (Box 9).

A third, complementary step would be to encourage Italian teachers and institutions to develop and share OER themselves. The mere existence of a central repository for Italian OER will facilitate the sharing, and the mere visibility and accessibility of the resources will encourage teachers to share their own material. Other incentives should be considered though: in addition to the social network features linked to repositories, awards for OER can also act as a reputation mechanism.

Box 9. International examples of web platforms of resources for teachers

In Korea, EDUNET is an educational portal maintained by KERIS (the Korean Education and Research Information System) to support the distribution and utilisation of high quality digital contents (*www.edunet4u.net/engedunet/ed_01.html*). KERIS directly manages the development of digital content by setting standards, models and guidelines. Contents are produced by central or local "learning centres", public or private partners (who remain the owners of content). Content from EduNet is also fetched to the "Edu Café", a community-based social network.

In the Netherlands, Wikiwijs (*www.wikiwijs.nl*) describes itself as "an open, internet-based platform, where teachers can find, download, (further) develop and share educational resources. The whole project is based on open source software, open content and open standards". Wikiwijs is inspired by the idea of wiki (but not using the same wiki platform as Wikipedia) and combines a resource bank for open educational resources (OER), referrals to other digital educational resources (including commercial ones), and a collaborative space where teachers develop and personalise open educational resources (OER). The quality of content is ensured through peer-review, reputation effects, and referrals from trusted third parties (such as teacher training institutions)[14]. The yearly budget for the Wikiwijs project is EUR 1.2 million for the 2011-13 period (Wikiwijs, 2011).

In the Dutch language space, KlasCement (*www.klascement.net*) constitutes a popular web portal for teachers (and by teachers). Created in 2002, it is supported by the Flemish Department of Education (Belgium). The Belgian portal has 56 000 members and over 20 000 entries (documents, website referrals, software descriptions, etc.) at the time of writing.

In the United States, OER Commons (*www.oercommons.org*) provides a host of digital resources of all kinds (ebooks, interactive resources available on the web or designed for specific devices, etc.) searchable by subject matter, school level, etc. Some resources are already translated and rated.

In France, an internet platform centralizes thousands of (commercial) digital resources by level of education, subject matter, type of resource: www.wizwiz.fr. Another example of open educational resources is the website www.sesamath.net which is an exchange platform and repository of resources for math teachers: it claims to have received about 14 million visits in 2012.

Invest in professional development of teachers (and school principals)

Beyond the availability of equipment and digital resources, a condition of success of the mainstreaming of ICT in education lies in the professional development of teachers and school heads. By professional development, we mean formal and informal learning about the pedagogic use of ICT solutions. International research and experience shows very clearly that ICT in itself does not transform teaching and learning.

The national plan currently includes professional development provisions, but these provisions do not meet the scale of actual needs. Speeding up the equipment process would multiply opportunities for informal individual and organisational learning and thereby address some of these needs.

Given current budget constraints, we suggest:

- *To change the professional development provisions of the Piano LIM so that schools have the option between the current mandatory formal training of three teachers and a school-wide entitlement to training that can be used more flexibly for whole-school training, for staff release time, or to support informal peer learning, according to a professional development project tailored to local needs;*

- *To develop the capacity of INDIRE blended learning model and consider to give the agency a certification role for other providers of training.*

These measures would help to provide teachers with more numerous, more timely and more appropriate opportunities of learning.

From individual formal in-service training to flexible school entitlements

The need for professional development has only been imperfectly addressed so far. In all schools receiving funds for IWB through the equipment plan (*Piano LIM*), three teachers per board had to be certified through a training programme. However, this requirement was limited to an introductory training that covered pedagogical uses insufficiently. Ongoing and subject-specific support was left to schools' and teachers' initiative. Most teachers said they had received technical training to use interactive whiteboards from the manufacturer of the device. However effective use of ICT depends less on technical proficiency in using the devices than on a practical understanding of how to embed their use in subject teaching.

All the teachers we met during the review visit expressed the same message: they need more training and professional development opportunities to integrate ICT into their pedagogy. This mirrors international experience, which also shows that teachers generally feel pedagogically unprepared for using ICT.

In the cl@sse 2.0 and scuol@ 2.0 initiatives, teachers were selected for their prior proficiency in using ICT in teaching, and there was no mandatory provision for professional development. Universities had a role of supporting professional development in these initiatives. According to the limited feedback that we received on this support, the training tended to be largely theoretical and, apparently, to use traditional course or workshop formats. International research shows that teachers prefer to be trained by their peers rather than by "experts". TALIS data show that, among all professional development activities, Italian teachers are less likely to report "education conferences and seminars" and "courses and workshops" as having an impact on their subsequent practice (OECD 2009, Table 3.8). By contrast, the most transformative activity would be "individual and collaborative research".

In short, teachers did not have enough training opportunities or necessarily the most appropriate type of training to embed ICT (or the use of interactive whiteboards) in pedagogy.

One way to improve the quantity and relevance of professional development would be to change the individual entitlement of training into a school entitlement that can be used more flexibly. The interactive whiteboard initiative mandates that three teachers receive some training per interactive whiteboard acquired. This provision limits schools' possibilities to use this training budget in other ways that may be more suited to their local context. There are indeed many other ways to shape learning opportunities for teachers.

In the context of a faster equipment process, a school budget for training would allow schools with articulated policies for integrating ICT in teaching to put in place more economical and effective professional development at the school level. It may for example allow schools to organise training sessions for all teachers using interactive whiteboards (instead of three). Neighbouring schools could also organise joint training sessions for using interactive whiteboards in specific subject matters if one school does not have enough teachers teaching these subjects.

More importantly, a school entitlement would enable to better support information learning within the school. A faster equipment process will indeed create more opportunities for informal learning within the school given that more teachers will face similar challenges and feel the need to share tips.

Different models of school organisation could be put in place to emphasise learning from peer experience. We have witnessed in our school visits several examples of collegial learning about ICT use. In one primary school, structured learning activities for teachers were done during the two official weekly "programming hours". In one lower secondary school, an afternoon teacher laboratory had been created

where teachers could seek support for ICT-related issues as needed. The fact that this happened within an existing teaching community naturally fostered exchanges that were not limited to technical issues: teachers also shared lesson plans, digital learning objects, and tips and referrals to external resources. All these solutions emerged to respond to learning needs, and were not part of the national plan (or seen as being part of it). But these organisational solutions currently rely on teachers' and school leaders' creativity and good will and take place in schools with a strong commitment to innovation.

Some countries (*e.g.* England or Australia) have introduced "middle-management" positions within schools and give some teachers a lead role for some subject or programme area of the school. This may be too expensive given current budgetary constraints.

A school entitlement could facilitate peer learning by giving lead teachers a more formal recognition and support for their role. Some teachers who are more advanced in their pedagogic use of ICT may emerge as informal mentors and coaches for other teachers in a school. A school entitlement would allow schools to reduce their teaching time in exchange, for instance, of fixed office hours during which they help colleagues as needed. These "lead users" or "ICT champions" could thus use this released time to assist their colleagues, give them feedback, prepare or search resources that meet several teachers' demand in the schools, etc. Lead teachers could also become certified tutors for INDIRE and work part of their time in neighbouring schools as trainers. Teachers in the school could thus get more timely and relevant support.

Fellowship programmes can also provide recognition for lead teachers without introducing permanent and formal leadership positions (see Box 10). Experience as a "lead user" or "ICT champion" could be considered in future competitions for school heads as well to give teachers extra incentives to take on this role.

Box 10. Fellowships for teacher champions

Fellowship programmes are a way to encourage and recognise teacher leaders such as ICT champions. In the United Kingdom, in 2010 and 2011 the "Sinnott Fellowship" has supported 15 outstanding teachers each year who presented innovative projects for linking the school and the outer community. As a fellowship programme, the project funded release time for teachers (two days a week over two terms) and offered support to implement the project through a network of contacts and resources (Schleicher, 2012, Box 2.13)

While peer learning is a powerful source of professional development, formal in-service training is also important, and is particularly useful when teachers have opportunities to practice what they have learnt in the training. This form of training tends to be more costly, both for the public purse and in terms of time and energy for schools and teachers.

INDIRE, the agency in charge of teachers' professional development, has a powerful and flexible blended learning model that offers 20 hours of face-to-face workshop time and high quality online material (see Box 2). These online materials include carefully scripted video exemplars and an interactive methodology. However, the demand for training still vastly exceeds INDIRE's capacity; and many teachers are unaware of the available resources.

We recommend to strengthen INDIRE's capacity. This would represent an additional expenditure, but one that will be difficult to avoid in the longer run if Italy really wants ICT to be used in teaching and learning. The plan for interactive whiteboards in England was accompanied by enough training provision: one of its lessons is that training is indeed necessary, although it is not sufficient (see Annex A). Given its current level of development, INDIRE's model has the potential to be brought to a larger scale.

Teachers' initial training should also include some pedagogic uses of ICT, possibly by using INDIRE's blended learning methodology. Teachers' entitlement (*diritto-dovere*) to training should be extended to teachers not covered by the national contract (and its content clarified for all teachers).

Separate technical support should be provided so that INDIRE can concentrate on pedagogical issues.

Monitoring and evaluation

The plan should clarify its objectives by setting short and medium term operational targets and metrics for success of its large scale equipment roll out plan.

One limitation of the Plan is that its objectives are only vaguely stated and that no operational target that could give a measure of success is public. This makes a monitoring or evaluation of the plan very difficult. Moreover, this does not communicate a clear vision to teachers and stakeholders, that would allow them to co-design their equipment process. Given the success of the plan in terms of school and teacher demand, such quantified target would be useful. They should concern the main dimensions of the plan: equipment (and possibly the expected cost sharing with other sources), digital resources produced, open educational resources translated, level of frequentation of the resource banks, number of teachers that received different types of professional development, etc.

Other dimensions of research and evaluation will be discussed in the next section.

Recommendations for the plan to catalyse systemic change and pedagogical innovation

The most ambitious aim of the national plan for digital schools is to catalyse change in schools and use ICT as a driver of pedagogic and organisational innovation in the Italian education system. Even if it is at the margin, technology can open up possibilities for new ways of teaching and learning, for new forms of school organisation and of collaboration between teachers, as well as for new curricula and evaluation that reflect the aims of 21st century education.

The potential of technology for transforming education goes well beyond equipping each classroom with an interactive whiteboard or other comparable technology. Two strands of the Plan (*cl@sse 2.0, scuol@ 2.0*) are innovation projects explicitly designed to go beyond this model. They pilot (and showcase) what a technology-rich education system could achieve. As the Plan rolls out ICT equipment at a large scale, it is important to support pilots and experimental approaches that can subsequently inspire other schools and inform policy making.

Box 11. Recommendations for the plan to catalyse systemic change and pedagogical innovation

Innovation Laboratory Network

- **Concentrate resources on the *scuol@ 2.0* initiative, redesign it around local school networks** (*distretti scol@stici 2.0*) **– and discontinue the *cl@sse 2.0* initiative.** The *cl@sse 2.0* does not give teachers enough opportunities to learn to use ICT and become proficient: while it may show other teachers that using ICT is possible and help make ICT more acceptable or desirable, its transformative impact is likely to be much more limited than a whole-school implementation. The scuol@ 2.0 gives teachers and pupils more opportunities to use ICT, learn to use it effectively, and share their learning and teaching experiences. A network of schools in a local area (*distretti scol@stici 2.0)* also creates more opportunities for learning across schools within a city or region and enables the emergence of bigger teacher networks.

- **Use *scuol@ 2.0* as test-bed schools to research, develop, and pilot solutions for all remaining schools**. Given limited available resources, the *scuol@* (or *distretti scol@stici*) *2.0* initiative should be an innovation and research laboratory for the use of ICT in Italian schools. These innovations should encompass new ICT products (such as digital textbooks, applications for integrated information and learning management systems and digital assessment tools), but also other dimensions of education such as new training formats, new forms of work organisation or new assessment frameworks.

- **Use competitive calls for tender to select consortia of *scuol@* 2.0 (or *distretti scol@stici 2.0*)** based on the ability to leverage additional funding and the quality of projects and partnerships with schools, industry and other stakeholders (INVALSI, INDIRE, universities, foundations, municipalities, etc.). Initiatives to develop digital resources such as the *Editoria digitale scolastica* programme should be encouraged within these test bed schools**.**

- **Make staff release credits eligible expenses** in the new plan.

Research and evaluation

- **Ensure that a rich documentation of practices is in place in test-bed schools from the beginning**, and give access to this information to researchers. A nationwide information system collecting longitudinal data on schools, teachers and students would maximise opportunities to learn about successful innovation, and *scuol@ 2.0* could be used to further develop this information system.

- **Fund research grants, doctoral scholarships and post-doctoral positions** to generate research knowledge around the initiative and **institute a national steering body and exchange platform for test-bed schools, and between test-bed and regular schools**.

Grassroots innovation

The learning on ICT integration thanks to the Innovation Laboratory Network should be complemented by other initiatives to stimulate innovation and learn from innovative solutions in other contexts, including non-ICT contexts.

- Stimulate grassroots innovation through awards and innovation fairs for teachers and schools.

- Support innovative school projects proposed by schools and networks of schools, and develop challenge prizes to address well-specified issues in Italian education.

Innovation Laboratory Network

The introduction of interactive whiteboards alone is not sufficient to achieve transformation of teaching and learning. Accelerating the equipment process is a first step to get closer to this objective. When more teachers within a school have to use ICT equipment, the likelihood of school-wide changes increases, and, subsequently, the likelihood of systemic change. However, expecting a deep transformation of teaching, learning and school organisation as a consequence of the introduction of interactive whiteboards is perhaps overly optimistic. As mentioned above, one of the strengths of IWB is that they can accommodate any kind of pedagogy.

In this context, innovation projects experimenting new ways of teaching, learning and schooling play an important role in supplementing the large scale equipment initiative of the Plan. Test bed schools can serve as front-runners to pilot and invent new learning environments so that the entire Italian system can learn from the positive and negative lessons learnt in the medium run. This is precisely what the *cl@sse 2.0* and *scuol@ 2.0* are meant to do.

However, the *cl@sse 2.0* initiative presents the same limitations as the slow penetration of ICT in Italian schools: it does not affect the entire schools, and therefore does not give teachers and schools enough opportunities to learn, to share their experience, and to rethink and review collectively their professional practices. For the very reason that we recommend to accelerate the speed of the equipment plan, we recommend to focus the innovation projects on the scuol@ 2.0 initiative: it has more potential for learning than the *cl@sse 2.0* initiative. In order to kindle change and innovation, ICT initiatives should indeed affect entire clusters of professional relations at once.

Given current budgetary constraints, we suggest to reconsider some features of the innovation projects of the Plan and recommend:

- *To concentrate resources on the* scuol@ 2.0 *initiative*;
- *To discontinue the* cl@sse 2.0 *initiative*;
- *To redesign it around school networks (*distretti scol@stici 2.0*)*;
- *To include professional development provisions in the programme (as a school-wide entitlement);*
- *To pay more attention to the organisational practices that enhance informal learning and continuous improvement;*
- *To strengthen the competitive design of the grant programme and mainstream matched funding and partnerships, including with private actors and research teams*.

Individual and collective learning

The research literature shows that teachers and organisations change their routines much faster when entire schools rather than single classes within schools are equipped with technology. By routines, we refer to their tacit ways of working, their organisational of work as professionals and member of a specific school community. There are two reasons for this.

First, individual learning takes time: according to the research literature, proficiency in integrating ICT in teaching takes at least two years of full-time practice. In Italy, where students (rather than teachers)

traditionally stay within the same classroom, learning-by-doing is hampered if teachers do not find the same technological environment in every single class they teach.

Second, collective learning and organisational change are also enhanced where new technologies are introduced into all of a school's classrooms at the same time. This creates a collective need for learning that can foster collective solutions, mutual sharing, discussions, and thus possibly lead to the improvement of professional practices. Furthermore, new organisational routines that exploit the power of ICT emerge more easily if all teachers have access to ICT. For example, in one school that we visited, mathematics teachers approached an initially sceptical colleague who resisted the use of the interactive whiteboard, and supportively embarked on a joint project with him. This kind of informal, peer-to-peer learning is facilitated by whole-school approaches.

The school-wide approach of *scuol@ 2.0* is more conducive to teachers' individual learning as they can teach with ICT in all their classes and thus become more experimented; it also generates more peer learning as all school teachers are involved in the school project. Teachers are thus more likely to share their ideas, resources, and experiences, to support one another, to learn from their colleagues and design appropriate solutions as new issues arise.

Formal professional development opportunities

It is also easier to organise subject-specific training at the school level when whole schools, or even better, entire school clusters are equipped at once with the same kinds of technology. Having whole-school training sessions, moreover, is a powerful strategy for building a collegial atmosphere and a shared vision for change. When entire schools are involved, informal opportunities for professional development are also maximised.

In this context, formal training could also be provided more easily and cheaply, and schools can develop or test new organisational routines (*e.g.* lesson study). The need for professional development provides an additional reason for focusing on entire schools. The current design of *cl@sse 2.0* and *scuol@ 2.0* does not include any professional development provisions. Some proficiency in the use of technology is a requirement of the application process. However, we believe that schools participating in the cl@asse 2.0 also need resources for professional development so that their teachers can really try innovative pedagogic uses of technology and give support to their teachers who are less proficient in the use of technology.

We recommend that the project proposal by each school contains a customised professional development plan, with precise responsibilities for carrying it out, or that such a plan is elaborated after the selection of grantees but before the start of the programme.

Here again, a flexible school-wide entitlement to training resources for professional development – *e.g.* in the form of staff release credits – should be made available in the next grants for the ICT innovation laboratory.

New professional practices

The whole-school approach that we propose to mainstream is meant to create a community of needs. Transforming this need into a community of shared solutions requires that space and time is made free for peer learning, team reflection on pedagogical practice, coaching and mentoring activities. Creating informal opportunities for professional development should be perceived as a priority for successful change. In that respect, school leaders should also benefit from some training to shape these collegial learning opportunities and organise a multiplicity of feedback channels for teachers.

Many interesting organisational routines that foster informal learning within schools would not require much change of the regulatory framework and, if any (see Box 12). They could be experimented in the context of the scuol@ 2.0 initiative. All these examples do not necessarily require dedicated budgets either, but significant attention to create the conditions for them to emerge as solutions. This effort can have considerable payoffs: the capacity for sustaining change, indeed, does not only depend on the skills of individual teachers, but also on the support that teachers receive from school-wide networks.

To increase opportunities for informal learning, we recommend to give more weight to the organisational learning dimension in future calls of the initiative. Schools could be invited to propose organisational innovations to pilot as part of their bids; in turn, they should receive support for these aspects through in-service training for school heads and through the support activities of INDIRE. Evaluation studies should also evaluate the costs and benefits of the various solutions being adopted. At the very least, they should monitor the types of organisational innovations that have emerged in the test bed schools.

Box 12. Organisational routines for school-wide learning

In Japan, teachers routinely do "lesson study". A group of teachers with a common focus meets and plans a lesson together. The "research lesson" is then taught by one of them, and observed by not only all of the teachers who are doing the planning, but also by observers, including in some cases visitors from other schools. During a debriefing session, the lesson is discussed at some length, with modifications often suggested by the observers, who frequently include an invited academic or "veteran teacher". The tradition of lesson study in Japan means that Japanese teachers work together in a disciplined way to improve the quality of the lessons they teach; this is one of the most effective mechanisms for teachers' continuous improvement (Lewis *et al.,* 2006; Schleicher, 2012, p. 48).

Other routines fit well in more hierarchical, managerial organisations. The "Learning Walk Routine", developed by the University of Pittsburgh (United States), consists in a visit to a classroom by a team composed of the principal, a coach and three teachers. The visit is intended not to disrupt the ongoing teaching activity but to observe it in a systematic way. Each member of the visiting team has a specific observational task. After ten minutes, the team moves to the hall where they briefly describe their observations and raise questions about what they observed. After a few minutes, they move to another classroom and repeat the process. At the end of the day, the team meets with the teachers whose classrooms were observed. The team describes what they observed and the questions that emerged during hallway conversations. The classroom teachers make comments, take notes and raise additional questions (OECD, 2010b).

Local school clusters

In the interest of fostering a local innovative eco-system, we also suggest to bring the logic of whole-school change (*scuol@ 2.0*) one step farther and to group the test bed schools in "school clusters 2.0" (*distretti scol@stici 2.0*). At the very least, test bed schools should be part of a national network.

Grouping pilot schools within a specific geographic area can facilitate the emergence of communities of practice transcending the school boundaries. Ideally, all schools within a school catchment area would participate in the network. This would ensure continuity for students as they move through the school system. The creation of school clusters 2.0 would be a logical next step of the initiative, which so far has proceeded gradually from classes to schools.

Box 13. The English ICT Test-bed initiative (2002-2006)

The ICT Test-Bed initiative in England can provide a model for the Italian ICT innovation lab in education. In this initiative, three clusters of about 10 schools, all in relatively deprived areas, were selected to carry out a project plan of their own to use ICT to raise standards in teaching and learning, and to improve school leadership and organisation. The project ran for four school years starting in September 2002; a total of GBP 34 million was invested (*i.e.* about GBP 1 million per school over the duration of the project); the funding also provided for investment in staffing release and training support to make the most effective use of the new ICT equipment bought (Somekh *et al.* 2007).

Such school clusters can be envisaged either as pilots for a subsequent nationwide roll-out or as mere innovation laboratories.

Within the current budget constraints, it is more realistic to see these school clusters as experimental laboratories testing out (and perhaps even inventing) innovative models. The "experimental" attribute does not refer to solutions that are out of reach for mainstream education nor to the mere novelty of solutions, but to the fact that the experience benefits learning at a wider scale, and to a trialling-and-refinement model: good knowledge management shall indeed ensure that learning occurs about what works and what does not within the constraints of the Italian school system.

The proposed programme of innovation laboratories would concentrate the resources and support given to school innovation projects more than is currently the case, creating local hubs of technological innovation. This could be a political challenge, but would make the lessons learnt even more useful and exemplary. This shift should also be more acceptable if schools receive more quickly interactive whiteboards and other similar ICT equipment in the large scale strand of the Plan.

The difficulty of concentrating resources was also present in England with the ICT Test-bed initiative: in this case, the objective selection of participants gave priority to projects in historically deprived areas.

Matching funds and partnerships

The discontinuation of the *cl@sse 2.0* initiative would free some resources for the *scuol@ 2.0* or *distretti scol@stici 2.0*, but focusing resources on schools rather than classes, and clustering them in some localities will make the initiative very small given the current budget. This is not necessarily a problem for an innovation laboratory. However, we recommend to try to attract additional funding for the initiative by using, again, a competitive selection process using matching funds and involving different partners.

The competitive selection of bids must be maintained and, if possible, strengthened. The project itself, rather than historical or administrative criteria, must be the main selection criterion. Synergies and partnerships for funding, content development or other initiatives, should also be encouraged, involving local and regional authorities as well as cross-sectoral linkages. The participation of universities, research centres, foundations or companies is also crucial to document and evaluate the outcomes of the innovations. This should be a requirement in the school cluster 2.0 option: clusters should apply together and possibly be supported by some local authority or industry. Requesting the support of regions or local authorities could bring more political support and additional budget to the initiative, following the model of the scale up agreement between the State and 12 regions.

Finally, the selection process should be piloted at the highest level, by the Ministry itself, and may involve international experts to demonstrate transparency on the merit-based selection.

Create the conditions for system learning

School improvement and system-wide pedagogic innovation is a cumulative and collective endeavour. If knowledge about the effective solutions flows beyond the class and school boundaries, the benefits of local investments are multiplied for the wider community of educators. Through ICT, the costs of making the knowledge available to a wide community are greatly reduced.

In a policy of innovation laboratories, documenting successes and failures is key for system learning. This documentation must then become available and accessible for third parties through good knowledge management practices. Each new step can build on steps undertaken elsewhere and in the past. Two levers to foster this kind of cumulative learning on the effective uses of ICT are suggested: academic research on test-bed schools and teacher-led exchanges.

Feedback on current monitoring and evaluation of the Plan

The plan has so far paid limited attention to knowledge management and to building a cumulative knowledge base on the reform – even though this very report shows that this is only partially true. There is insufficient monitoring of the initiatives and, lacking routines to collect information on implementation and impact, most knowledge about the process and the impact of these initiatives remains private to the teachers involved, or at best, local to the school. This impedes much organisational and system-level learning.

In the case of the IWB initiative, the information available at the central level tracks the money spent and the equipment bought. It is possible to know how many fixed and mobile IWBs are present in each school, but not where they are. It is therefore not possible to estimate how much exposure individual teachers and students have had to teaching and learning with IWBs.

There is no central evaluation – internal or external – about the impacts of the IWB initiative on the intended beneficiaries. Only anecdotal evidence can be used to tell the effect on ICT skills, teaching practices, learning outcomes, motivation and satisfaction of teachers, students, and their families. We are not aware of any systematic observation that has been conducted on the use of the equipment; to compare, for instance, classroom activities in classes with and without IWB. There is no study tracking the use over time by the same teacher, which would help understand the learning curves and support improvements in the offer of training. The evaluation of formal training options is at best limited to a short subjective user feedback. Given the scant information about individual exposure, in fact, it would be also quite difficult for interested researchers to conduct *ex post* evaluation study (where exposure measures are linked to INVALSI tests or to student and teacher mobility patterns).

Some of these shortcomings originate from a lack of clarity on the plan's pedagogical objectives for ICT penetration. Goals related to teaching and learning are mostly expressed as vague aims ("changing the learning environment", "improving student learning") and therefore are given little attention in the internal monitoring: this monitoring emphasises the operational objectives (*e.g* "to equip x classes with IWBs", "to have a class blog") rather than the pedagogical ones (*e.g.* "to have all students participate in classroom dialogue", "to improve students' results in INVALSI tests"). This limits the possibility of knowing "what works", and of deriving lessons for future improvement.

For *cl@sse 2.0*, in contrast to the IWB initiative, the schools had to commit themselves to collaborate with the monitoring and evaluation of the initiative and to administer the INVALSI tests. However, the monitoring plan was only formalised after the project started. The external evaluation study concerned only lower-secondary classes (the first to start with the project), and the project had already started when the evaluation was designed. A more compelling evaluation study would have required that the evaluators

collaborate in the design of the call for tender and, possibly, in the selection of winners, to achieve experimental standards.

As it turns out, the design of the evaluation study is not compatible with the measurement of impacts in the presence of "spillovers" to non-selected classes within the same school that were in fact encouraged. This limits what can be learnt from this experience. A second control group outside of the selected schools – for instance, among non-selected applicants – could have provided for richer comparisons, but the consent of non-selected schools to participate in an evaluation study should have been secured before the selection of winning classes. Even for the selected classes, despite the formal commitment of schools, the monitoring and evaluation team found an alarming rate of non-response and non-collaborative attitudes.

A missed opportunity to build on past experience is also the fact that instruments (questionnaires, coding guides, etc) developed in the context of the monitoring and evaluation of lower-secondary classes were never used to monitor the primary or upper secondary classes, possibly due to lack of resources. In fact, there is no consolidated monitoring or evaluation report for these levels.

A further missed opportunity is the fact that this experience did not serve as a test-bed for INVALSI to develop new forms of assessment in a technology-rich environment. Even for lower-secondary classes, little effort went into defining the appropriate metrics for success in accordance to the objectives of the plan: while gains in literacy and numeracy were not the main goals of the *cl@sse 2.0* project, INVALSI tests for reading and mathematics were the main outcome measures for the evaluation. Surprisingly, the evaluation study does not measure students' ICT skills and familiarity systematically nor with the same rigour as literacy and numeracy. Teacher outcomes, and teaching practices, received very little attention in the evaluation study – despite the fact that they feature highly in the objectives of the plan.

For *scuol@ 2.0*, applicant schools have again been asked to collaborate in the monitoring and evaluation of the initiative, this time in the form of a written commitment (a declaration, rather than an implicit acceptance of the call's conditions). To date, there is no formalised monitoring plan (*e.g.* periodic data collection on implementation). The central scientific advisory and steering group, however, represents an opportunity to identify and discuss the models at a central level, and thus to inform further initiatives from the centre.

Support research on teaching and learning with ICT

The objective of the innovation laboratory is really to find out if and how ICT supports better teaching and learning as well as other desirable professional practices in Italian education. To turn the pilot schools into real laboratories for system-wide pedagogical improvement, Italy should support to a greater extent research on effective pedagogy and on the conditions in which it emerges. A first step is to clearly specify some objectives of the innovations, while leaving others to the appreciation of schools and researchers.

We suggest three lines of actions in this respect.

A first line of action is, as mentioned above, to ensure that researchers and evaluators are involved in the innovation laboratory network, and that they work with the test bed schools. Researchers should lead action research, ethnographic research and impact evaluation projects in collaboration with teachers and schools, instead of offering workshops or seminars as they currently do. Ideally, they should apply with the schools and work with them on the application and state a few questions that they will investigate.

A second line of action is to ensure that researchers in universities and other research institutes (*e.g.* INDIRE) have access to information on what happens in pilot test-beds without burdening teachers with their requests. To this end, it is important to have a rich information system (a longitudinal data system and appropriate measurement tools) in place in innovation laboratories from the very beginning of

the initiative. The metrics should cover both intermediate and final objectives and include, for instance, log data (on the use of devices, on the assignments, and on the assessment results) gathered directly by computers. Such an information system would not load teachers with over-demanding administrative reporting duties.

The information system would help monitor and document to a greater extent all initiatives, including the baseline situation. It would make it possible to observe the trajectory of change and map the ICT learning curve. The information system would clearly facilitate administrative reporting, and support quantitative research. It would also be a useful entry point for more qualitatively oriented researchers.

Judgements about the impact (effectiveness) or cost-efficiency of a specific solution developed within the test-beds always require some type of comparison: against the initial situation, against the ideal benchmark, or against an external comparison group. While the ideal experimental situation compares two (or more) randomly selected "test" and "control" groups, it is not always possible to isolate the solution from the context in which it emerged, and therefore to assign it at random to a test group. A rich information system, possibly extending beyond the test-bed schools, makes it possible to compare the measured change (rather than the levels, as is sufficient in purely experimental settings) in the group exposed to this particular solution with multiple comparison groups that share similar baseline characteristics.

A third line of action is for the Ministry of Education to stimulate research on what works in pedagogical innovation by directly funding research projects. INDIRE could offer doctoral scholarships or post-doctoral positions for theses that draw on the wealth of experiences and data in the ICT test-beds. Supporting a national science base for teaching in this way would not require huge amounts of resources, but could have significant payoffs in terms of system learning and of stimulating science-driven innovation.

Design a supportive policy environment for the Plan

The two previous sections focused on the design of the Plan. Several other policy measures could help to build an environment that would make the Plan more successful: aligning curriculum and assessment with its objectives; improving physical and virtual infrastructures; addressing parental concerns about security; stimulating innovation and knowledge sharing.

Align evaluation and assessment frameworks with the desired pedagogical change

A typical problem that arises with innovation or reform is the misalignment of new objectives with other formal driving forces in the system – not to mention conventional practice. Two important formal driving forces in education systems are curriculum and assessment. We suggest to:

- *Develop support tools for ICT integration in subject curriculum;*
- *Develop teacher-friendly assessment tools and monitor ICT skills as well as other desired skills.*

Align curriculum reform with ICT policies

ICT skills in Italy have a limited place in the curriculum and are not embedded within subject fields. A reform of the curriculum could be used to align teachers' practice with ICT policies, with rapid effect and without significant budget implications.

In many countries, ICT skills are now seen as foundation skills (along with literacy and numeracy) rather than as applied skills, and feature prominently in curriculum documents. The European Commission,

for instance, included "digital literacy" as one of the eight "key competences for lifelong learning" in Recommendation 2006/962/EC. In France, ICT-related skills are one of seven curricular "pillars" throughout the primary and lower secondary cycle (*socle commun de connaissances et de competénces*). In Norway, the "Knowledge Promotion" reform has identified digital competencies as one of five sets of foundation skills that are developed throughout the grades and the subjects. Learning objectives for each subject involve the use of ICT for subject-specific purposes. In the United Kingdom, use of ICT is statutory in subject teaching.

In Italy, the new curriculum guidelines for primary and lower secondary schools ("*Indicazioni nazionali*") that will be introduced in 2013 are grounded in the Recommendation of the European Commission. The upper secondary curriculum has also changed recently (DM 211/2010). All these new curricula emphasise to a significant extent so-called "21st century skills": digital competencies, cooperative skills, higher order thinking and reasoning, critical analysis, problem solving and posing, creativity. Each school is then expected to elaborate a school curriculum within this framework.

In the national guidelines, the mastery of digital tools is not included among the skill goals ("*traguardi per lo sviluppo delle competenze*") and learning objectives ("*obiettivi di apprendimento*") of any subject, except "technology", "music", and "visual arts". For "technology", specific learning objectives at the end of eighth grade include: exploring the functions and potential of new application software; planning a school trip or museum visit using the internet; programming a computer environment and giving simple instructions to control the behaviour of a robot (MIUR, 2012d). In "music", children learn how to use ICT as a music instrument; learning objectives include accessing music-related web resources and using music software and sound editing software. In "visual arts", there is an explicit accent on creating and interpreting multimedia works. But these subjects represent a small share of instruction hours, and in lower secondary schools, where teachers are subject specialists, teachers may not feel a shared responsibility for promoting digital literacy.

One barrier that teachers often face when they decide on adopting ICT or experimenting with new pedagogical models is the gap between these new practices and the existing school curricula, to which their current practice has been adjusted over the years. The outreach effort that needs to be done to implement these curriculum changes provides an important opportunity to develop digital resources that support their adoption and to guide teachers on how to integrate ICT in teaching (while at the same time drawing them to implement the new curriculum).

The adoption of e-books and tablets starting from 2014 will remove the obstacle of unavailability of ICT devices. It is therefore recommended that in order to make ICT part of everyday pedagogy and assessment practices in schools, subject-specific learning objectives related to the use of ICT are added to the national guidelines.

Align assessment reform with ICT policies

Even when the official curriculum changes, the demands of school evaluations and of national student assessment policies do not necessarily cover the new competencies that teachers are asked to foster. And therefore one can expect that these new skills do not receive the same attention from both pupils and teachers.

In spite of the change in curricula mentioned above, national student assessment practices do not favour the expected pedagogic change. The assessment tools developed by INVALSI are limited to foundation skills and to technical, subject-specific competences in reading, writing, and mathematics (and soon in science). These assessments will gain even greater influence on school practice as they feed into the new national school evaluation system.

There are currently no plans to develop tools for the formative assessment or for the benchmarking of progress in the remaining competencies that are emphasised in the national plan for digital school and in the new curricula.

To foreground the objective of fostering pedagogical change through the ICT initiatives, we recommend that guidelines and tools for the formative assessment of skills such as digital competency, cooperative problem solving, higher order thinking, reasoning and creativity are developed in cooperation with teachers, and shared as open educational resources. These guidelines and tools would put the development of these skills, in addition to disciplinary mastery, under the spotlight.

In fact, assessing new skills would not require changing the traditional assessment practices that are still common in Italian schools – such as oral examinations or essay writing; it would rather enrich the dialogue between teachers and learners about the progression towards all learning goals that is evidenced through these practices (see Lucas *et al.*, 2013, for an example).

We further recommend that INVALSI develops new forms of summative assessments that measure proficiency in cross-curricular 21st century skills (such as digital literacy) and in skills in thinking and creativity embedded in the various subjects. The idea is not to assess the entire population with these new instruments, but rather to introduce them in sample-based surveys and make them available to schools who want to benchmark their results on an externally validated measure. Australia and New Zealand can provide interesting examples illustrating the power of sample-based surveys (Box 14).

Box 14. Sample-based student assessments in Australia and New Zealand

In Australia and New Zealand, sample surveys are used to monitor, among other skills, the nationwide progress in developing ICT skills and the skills of pupils in navigating information. The sample-based approach allows matching national assessments of students with the full breadth of the learning goals in the official curriculum. Assessments are not limited to foundation skills and do not create an unwanted hierarchy among learning goals.

The Australian National Assessment Program includes cyclical sample surveys to monitor student outcomes in science, ICT, civics and citizenship. These tests draw on a statistically representative sample of students at target grade levels (equivalent to about 5% of the corresponding population). Each area is an agreed national priority and is tested once every three years. The first survey was run in 2003 for science, in 2004 for civics and citizenship and in 2005 for ICT. Each assessment results in a national report and allows a reporting of progress over time, as each subject is assessed every three years. For both ICT and civics and citizenship, students are assessed in Grades 6 and 10 (Santiago *et al.,* 2011).

In New Zealand primary schools, progress towards the achievement of national curriculum goals has been measured via the National Education Monitoring Project (NEMP) since 1995. No full cohort national tests exist. NEMP is conducted every year on Grade 4 and Grade 8 students, but assesses a different set of disciplines each year; over a four-year cycle, it covers all curriculum areas. The four cycles are as follows:

(1) Science, visual arts and information skills (graphs, tables, maps, charts, diagrams);

(2) Language (reading and speaking); aspects of technology and music;

(3) Mathematics, social studies and information skills (library, research); and

(4) Language (writing, listening, viewing), health and physical education.

About 3 000 students are selected randomly each year to take part in the assessments. To cover a broad range of items without overburdening individual students, three different groups of students are created for each subject, with each group being tested on one third of the tasks. The tasks are not necessarily related to particular year levels – many tasks are the same for Grade 4 and Grade 8 students (Nusche *et al.*, 2012).

Build an integrated ICT infrastructure and vision

The national plan for digital schools requires the further development of a national digital infrastructure for schools. This is not only necessary to support the large-scale roll-out of digital devices and a more intensive use of ICT in classrooms (and schools), but also to prepare the next phases of the Plan that should rely on the integration and interoperability of ICT platforms and devices. We thus suggest to:

- *Prioritise the provision of adequate bandwidth for more intensive ICT use in school as part of cross-government policy*;
- *Address parental concerns about the safety of the school internet environment and support local initiatives for parental ICT training programmes*;
- *Develop a long term ICT strategy around the integration of different educational ICT platforms and tools (longitudinal information systems (anagrafe), learning management systems (registri digitali), digital resources banks, teacher social networks, etc.) and design related inter-operability standards.*

Prioritise investments in the digital infrastructure of schools

As for physical ICT infrastructures, the bandwidth of school networks needs to accommodate more intensive uses of ICT. If pupils are to use tablets, e-readers, notebooks, clickers, smartphones and other devices in school, bandwidth problems may rapidly become a concern.

To overcome these problems, the involvement of other sectors – such as the telecommunication sector, through the Ministry of Development and the newly created *Agenzia digitale italiana* – and of local governments is desirable. The Digital Agenda sets the framework for such cooperation.

Design a safe and parent-friendly school internet environment

During our consultations, parent associations expressed some concern about the safety of children using the internet and digital devices in school: these concerns need to be addressed with high priority to secure the critical support from families to the national plan.

ICT-related safety risks that need to be addressed at school (or, more generally, for children) typically concern exposure to inappropriate materials, inappropriate or illegal behaviour while using technology, physical danger and sexual abuse related to the use of the internet or ICT, copyright infringement, obsessive use of ICT, inappropriate and illegal behaviour by school staff (Becta, 2005). Similar problems can also arise from home use (NFER, 2010).

The ministry could centrally support the development of a protected Internet environment for children in schools. There are a host of guidelines and resources available internationally that can be adapted to the Italian context.

Other concerns related to the cost of ICT to families as well as to the lack of preparation of some parents to use ICT to communicate with the school (*e.g.* registration) or to support their children. Training programmes and information campaigns could be organised to address these issues. Ideas and examples about how to involve parents in the implementation of the national plan should be shared. For example, two schools that we visited relied on some technology-literate parents to support them in the introduction of ICT, or to assist other parents of the school to become more familiar with ICT. One of them managed to successfully mobilise parental funding to buy additional equipment for the school.

Prepare the design of an integrated ICT infrastructure

The Ministry should also develop a long-term strategy and vision for the use of ICT in education. We believe that the integration of the different digital tools and platforms that have been developed should play an important role in this vision, enabling teachers and other stakeholders to access a one-stop shop where they can access, store and exchange most, if not all, of the digital information, resources, and tools that they need. We are still very far from this horizon, in Italy as well as in all other countries, but some promising efforts in this direction are currently underway. Instead of building on existing ICT tools and functionalities, such a strategy should try to identify long-term strategic objectives for education and then try to develop the appropriate ICT infrastructure and solutions to make it happen.

As it builds on multiple initiatives and develops over time, educational technology tends to reproduce existing fragmentation between data gathered for administrative and for pedagogic purposes. Platforms for administrative purposes, information systems for statistical purposes, learning management systems at the school level, teachers' social networks, digital resource platforms, etc., tend to be developed separately and are not necessarily inter-operable. The integration – or at least interoperability – of these different tools would help maximise the power of technology to support educational innovation and improvement. For example, data gathered through the administrative process could be brought to bear when choosing digital resources or when making some diagnosis on the learning of some students. Handheld devices could be used to gather data seamlessly, avoiding data entry duplication or data export (and thus mistakes). For example, longitudinal information systems are not just administrative or accountability tools that can give feedback on the system or school performance, they could inform teaching and learning if the rich information they include on pupils, teachers and schools could be linked to pedagogic tools.

Recent measures taken by the government in setting interoperability standards between school management systems (dealing with school enrolment and electronic registries) and its central longitudinal information system (*anagrafe*) already go in this direction. But Italy still needs to develop much further the data system infrastructure at school and country levels that would support and enhance the use of ICT in teaching and learning, including within the classroom.

The use of learning management systems is for example very limited in schools and still needs to be mainstreamed. As schools get equipped, these systems should be integrated or interoperable with other information systems available within schools. Learning management systems are platforms in which teachers and students can upload materials, create content, and interact through blogs, wikis, and discussion fora; teachers can also post assignments, note grades and absences, etc. Cloud-based learning management systems may be a quick way to spread their use within schools. They reduce software maintenance costs and risks of data loss – but may raise data security issues. In Austria, EduMoodle is a platform hosting cloud-based learning management systems that substantially reduces the costs of local investments in servers and maintenance.[15]

As learning management systems, digital resource banks, teacher exchange platforms and other tools develop, the design of interoperability standards that allow all these systems to communicate with each other and with the existing longitudinal information system (*anagrafe*) could increase the pedagogic power of technology. Interoperability standards foster cumulative innovation: local application software (*e.g.* to manage communication with parents when children are absent from school, to edit exam report cards, certificates, etc.) can be developed and can build on the existing data architecture rather than create data silos of their own. Standards also ensure the interoperability between schools, and therefore facilitate the exchange of information between levels, with significant savings in the medium term. In Korea, families not only enrol online in their schools (as will be the case in Italy, starting from 2013-14), but upon request schools can directly transfer the students' data to universities, or deliver online certificates to families. Korea's National Education Information System (NEIS) was a significant investment, but succeeded in

reducing administrative costs and in reducing teachers' administrative workload. The Korean Ministry of Education, Science and Technology (MEST) estimates that it produced yearly savings in the orders of USD 200 million (OECD, 2010).

The advantages of an integrated data infrastructure at school and national levels are manifold. In addition to producing significant savings in administrative costs, the introduction of digital technologies in school administrations can be expected to contribute to push teachers to develop their ICT skills and familiarity, even when they are reluctant to change their teaching practices. It would also bring schools closer to workplaces in knowledge-intensive sectors. It would also make it much easier to pilot and monitor innovation initiatives without imposing burdensome reporting on schools.

In the longer term, such an infrastructure could prepare the ground for deeper changes that could well emerge spontaneously among the willing – in the organisation of teachers' work, in the personalisation of learning, the evaluation of students, etc. As it did in the retail trade and health sectors, "big data" has the potential to transform education.

Support innovation and knowledge sharing

In addition to what is already done through the national plan, the Ministry of Education should continue to support innovation in education, the development of new tools and practices by businesses and schools, and to strengthen knowledge management mechanisms within the system. Some of these measures can be simple and relatively inexpensive. They should concern ICT-related, but not ignore other substantial forms of innovation. Among different possibilities, we recommend to:

- *Design awards and innovation fairs for teachers and schools to stimulate grassroots innovation, be they ICT-related or not;*
- *Support innovative school projects proposed by schools and networks of schools;*
- *Develop challenge prizes to address well-specified issues in Italian education;*
- *Incentivise businesses and other stakeholders to develop innovative solutions for Italian education.*

Make knowledge sharing an engaging experience for teachers

In all innovation experiences, much knowledge inevitably tends to be embodied in the innovators themselves. Data logs and research reports can only partially reflect the richness of their knowledge, which remains largely tacit.

A simple, and often cost-effective way of stimulating innovation and its dissemination is through prizes and awards. Thanks to competitive incentives, an award effectively leads participants to publicly document their inventions, discoveries and innovations, and thereby to share their knowledge. Awards must not be limited to breakthrough innovations: innovative teachers awards can be used to stimulate marginal, continuous improvements, and to foster local adaptation of existing solutions. Awards do not necessarily require large budgets: the public recognition of the value of the innovation as well as the reputation effect that it creates can be as effective as monetary incentives (and sometimes more effective). A critical condition for the success of the award, therefore, is establishing its reputation.

Box 15. Awards for innovative teachers

In France, the *Journées de l'Innovation* initiative invites pedagogical innovation projects and distinguishes each year five of them with an award. The *Expérithèque* website, through which participants post their application, functions as a permanent repository of pedagogical innovation projects. The Spanish *Instituto Nacional de Tecnologías Educativas y de Formación del Profesorado* (INTEF) funds an annual prize for learning materials developed by teachers, non-profit organisations, or schools. In Chile, *Innovo en Clases Integrando Tecnología* is a competition for teaching practices documented in short videos (4-5 minutes).

Regular awards, with small monetary amounts but with prestige, could be given out at annually held fairs or in otherwise visible events. They may have the potential to foster teacher-led innovation and broker communities of practice among the most pioneering teachers, overcoming their possible feeling of working in isolation.

Importantly, innovation awards in education should encourage teachers to document programmes, learning objects and processes that can be implemented elsewhere (*e.g.* a lesson plan, the script for a science experiment using ICT, a routine for cooperative learning in the classroom, or an online platform for managing student collaborative projects) rather than the result of their local implementation (*e.g.* the DVD produced by students).

The design (or redesign) of these awards or of the context in which they are granted could be inspired by some existing international examples (Box 15).

Continue to stimulate innovative solutions

Beyond what is done through the Plan, Italy's innovation policy in education should continue to stimulate innovative solutions developed by schools and businesses. A combination of policies supporting innovations designed by schools and businesses and of innovations designed to address problems or needs that are identified by public authorities is recommended.

In the same way as the Plan creates a laboratory for test bed schools to experiment new ICT usages and transform Italian education, other initiatives should create room for other schools to develop or pilot innovative solutions of their own. These can relate to ICT or not. In order to create a lively innovation ecosystem in education, and have more comparison points for the innovations devised by test bed schools in the *scuol@ 2.0* initiative, it is important to support schools and school networks which are not part of the initiatives of the Plan to test and pilot other kinds of innovations. Depending on the budgets required, this should be done with a more or less stringent selection process.

Efforts for the business sector to invest in the development of innovative solutions for the education sector should also continue to be encouraged. This could be done in coordination with traditional tools of industrial innovation policies, which often prioritise other areas than education (when these priorities exist).

Public venture capital can support entrepreneurial innovation in education that require considerable budget and technical expertise. Italy is already relying on this solution through the recent "Smart Cities" call for tenders financed by public R&D credits for the private sector (*Fondo per le Agevolazioni alla Ricerca*).

Box 16. Challenge prizes

Challenge prizes specify a need in advance (the challenge), rather than recognising achievements retrospectively as prizes for inventors usually do. They are awarded to whoever can first meet the challenge. Historical examples include the British Longitude Prize (awarded to John Harrison in 1714) and the Orteig Prize for transatlantic flights (awarded to Charles Lindburgh in 1927). The "X PRIZE Foundation" creates and manages some of the world's largest contemporary challenge prizes. The British National Endowment for Science, Technology and the Arts (NESTA) promotes and funds research on contemporary challenge prizes (*www.nesta.org.uk/areas_of_work/challengeprizes*).

Challenge prizes may work in conjunction with patents: a particular design for a challenge prize is indeed to announce a "patent buyout" as a prize, so that all uncertainty about the commercial prospects of a patent are removed. Under patent buyout schemes, the government purchases a patent and places it in the public domain (Kremer, 1998). In 1839, for instance, the government of France bought the patent for Daguerreotype photography and placed the technique in the public domain, accelerating further adoption and refinements of the technique.

Building on this first experience, we recommend that similar calls are issued each year in accordance with the priorities of education policy.

Challenge prizes are an alternative instrument to stimulate breakthrough innovation in education. Challenge prizes find their application to stimulate breakthrough innovation when the expected social benefits exceed the prospects of private benefits from monopoly rights awarded by patents (Box 16). In the case of technologies with significant network externalities that serve the needs of public education, the patenting incentive to perform R&D might be small. This concern can be addressed by having innovators compete for the prize rather than for market. One of the advantages of challenge prizes is that they attract stakeholders that are outside of the field of education, and allow for many different ideas to be proposed. For well-specified problems at the system level, Italy can consider the opportunity of opening challenge prize competitions to national and international entrepreneurs.

Concluding remarks

Given the low penetration of ICT in education compared to most other OECD countries, Italy launched in 2007 a national plan for digital schools to mainstream ICT in Italian classrooms and use technology as a catalyser of innovation in Italian education, hopefully conducing to new teaching practices, new models of school organisation, new products and tools to support quality teaching.

The plan uses its very modest funding to implement a convincing and ambitious vision of innovation at the margin. It rightly concentrates on schools and teachers eager to initiate change, favours tools that are not disruptive to current teaching practices, tries to create a demand that can engage other stakeholders to contribute to the plan, focuses on pedagogic uses of technology rather than merely on equipment, and addresses the importance of professional development and of expanding the availability of digital pedagogic resources. It exploits synergies with other ICT policies and has successfully involved regions in its implementation and scale up strategy.

However, the small budget of the Plan has limited the effectiveness of its diverse initiatives. Because of a lack of budget rather than insufficient school or teacher demand, ICT equipment is entering Italian classes rather slowly. The plan has been allocated EUR 30 million per year for 4 years, that is, less than 0.1% of Italy's public budget for schooling. *In its current design, a significant rise of the budget of the plan through public or private sources is a necessary condition for its success*.

Given current budgetary constraints, a significant budget increase may be difficult, and we propose to revise the Plan in order to achieve two objectives: 1) *speed up the uptake of ICT in Italian schools and*

classrooms; 2) *create an Innovation Laboratory Network of test bed schools piloting and inventing new pedagogic and organisational practices to improve Italian education by refocusing the innovation projects on the* scuol@ 2.0 *initiative*.

Should these two objectives be achieved, Italian schools would make an important contribution of Italy's whole-of-government "Digital agenda" and make a first step to equipping Italian students with skills for the digital economy.

NOTES

1 *http://it.wikipedia.org/wiki/Piano_Nazionale_Informatica*, accessed 16 July 2012.

[2] *www.parlamento.it/parlam/leggi/06296l.htm.*

[3] *http://rep.itespresso.it/adv/12/03/agendadigitale.pdf.*

[4] In upper secondary schools, while the class group is in general the same for all four or five years, the class teachers change after the first two years.

[5] *http://rep.itespresso.it/adv/12/03/agendadigitale.pdf.*

[6] *http://hubmiur.pubblica.istruzione.it/web/istruzione/prot1682_12bis*, accessed 19 December 2012.

[7] *www.istruzione.it/web/istruzione/dm74_10.*

[8] *www.istruzione.it/web/istruzione/prot2033_12* and *www.istruzione.it/web/istruzione/prot924_12*, accessed 13 July 2012.

[9] *http://cercalatuascuola.istruzione.it/cercalatuascuola/*, accessed 13 July 2012.

[10] Avviso prot. n. 84/Ric. del 2 marzo 2012, *www.ponrec.it/media/1093/dd_2012_03_02_prot_0084_avviso.pdf.*

[11] Decreto Direttoriale 5 luglio 2012 n. 391/Ric., *http://attiministeriali.miur.it/anno-2012/luglio/dd-05072012.aspx.*

[12] *www.ponrec.it/media/91323/elenco_idee_progettuali_approvate__d.d.84_ric._del_2marzo2012.pdf.*

[13] School education is only one field among many. The complete list of specific fields of intervention concerned by the second call includes security, ageing, welfare technologies and inclusion, home automation, judiciary system, schools, waste management, marine technology, health, ground transports and mobility, last-mile logistics, smart grids, sustainable architecture and materials, cultural heritage, management of water resources, cloud computing and technologies for smart government.

[14] *www.wikiwijs.nl/task.international.psml*, accessed 23 November 2012.

[15] *www.edumoodle.at/moodle/*, accessed 3 December 2012.

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ANNEX A[1]: LEARNING FROM INTERNATIONAL EXPERIENCES WITH INTERACTIVE WHITEBOARDS: THE ROLE OF PROFESSIONAL DEVELOPMENT IN INTEGRATING THE TECHNOLOGY

Sara Hennessy and Laura London
(Faculty of Education, University of Cambridge, United Kingdom)

Introduction

This paper describes teacher strategies and experiences with interactive whiteboards (IWBs) and draws on the published research in this area to understand how a systemic approach to technology-based innovations in schools can contribute to quality education for all. It explores ways to support the cultural shift in teacher and learner roles that helps to integrate the technology effectively into classroom teaching. It begins by considering how the features of IWB technology might potentially be exploited in the primary or secondary school classroom to support subject teaching and learning. International experiences of implementing IWB programs are then described, mostly from the United Kingdom where integration efforts are the most prominent, and implications for future intervention efforts are examined. The review concludes by defining the organisational conditions for enhancing teacher commitment and thus the likelihood for successful change. In particular, the role of teacher professional development is foregrounded and characteristics of effective programmes are outlined. Some comments about the relative costs and benefits, and recommendations for policymakers, are made.

Exploiting the interactive whiteboard to support teaching and learning

The interactive whiteboard (IWB) technology combines a large, touch-sensitive electronic board with a data projector, specialised software and a computer. The board displays the projected computer image and allows direct input via finger or stylus. Software provides a variety of functions, including those that replicate non-digital technologies such as flipcharts, dry-wipe boards, overhead projectors, slide projectors, and video players (Mercer *et al.*, 2010, p. 196). Tools provided as part of the IWB software package include those for annotating text, highlighting, drawing, hide-and-reveal, resizing and zooming.

Images from other technologies can easily be displayed on the IWB, and objects can be moved or transformed to produce enlarged and interactive images, animation and text (Northcote *et al.*, 2010). These objects can be directly manipulated by students and teachers to provide an interactive experience in lessons that is accessible to all. Transformed objects can also be stored and retrieved in future lessons to further spark discussions. These functions can help to draw attention to salient features of a representation or process, coupled with teachers or students publicly interpreting a display.

The term “interactive” has two meanings associated with the IWB: the tactile manipulation of objects and words on the board, and interactive contact with the content of the lesson, which creates a more fluid and discursive environment where students feel more comfortable and capable interacting with the lesson content (Gray, 2012). Likewise, Smith *et al.* (2005) distinguish “technical interactivity” (physical interaction with the device) from “pedagogical interactivity” (interaction between students and others in the context of classroom IWB use, that is designed to bring about learning).

IWB features perceived to support learning include immediate feedback (responding to user input contingently), dynamic representation of processes, and provisionality (the facility to change or eradicate content), access to a wide range of digital resources, visibility and multimodality. Multimodality refers to the multiple modes of representation and communication within a classroom (Kress *et al.,* 2001; Jewitt, 2006): image, gesture, gaze, interaction with objects, writing, and speech. The IWB in particular facilitates the interaction of teacher and students with a wide range of digital media resources: texts, drawings, diagrams, still photographs, multimedia presentations, animations, simulations and models of dynamic processes, interactive diagrams, maps, concept maps, databases, graphs, tables, hyperlinked web pages, audio and video files, mathematical representations, etc. Not all features are consistently supportive of learning, so care needs to be taken in managing activity at the board. Kennewell and Beauchamp (2007) point out that student inputs and real-time feedback help to reduce the fear of failure for learners, but students may also exploit these features to achieve their goals through trial and error. This avoids the cognitive effort that would be expected to result in learning. (In some contexts, trial and error is, of course, desirable.)

The IWB is considered particularly useful by teachers in supporting visualisation to assist in teaching difficult concepts or demonstrating skills – for example in using a ruler, thermometer or microscope at primary level (Somekh, Haldane *et al.,* 2007). Graphical and dynamic representations and audio or video help to make complex concepts and processes more explicit, concrete and transparent. This offers opportunities to check understanding and supply clarification. Teachers of course use traditional resources, as well as talk, gaze and gesture, alongside the IWB.

The IWB can also be effectively combined with other peripherals such as "visualisers" (also known as document cameras), where physical objects placed beneath the camera stand appear on the screen, or a standard digital camera. Such peripheral cameras can be used to display, critique or compare students' work or experimental results, or to project an image as a task stimulus. When visualisers are combined with IWBs, one can also freeze an image, then remove the object from the visualiser and manipulate it, and compare it with the original.

Table A.1 provides a helpful summary of the teacher and learner actions that IWB features support or allow (these activities would not be possible with traditional blackboards). Examples of classroom activities are given alongside each action.

Many of the examples of classroom activities imply learners' rather than only teachers' use of the IWB. To fully exploit the possibilities of IWBs, Essig (2011) therefore argues that new and more creative classroom activities need to be designed so that the majority of children can have an opportunity within the same lesson. Adolescents may, however, be quite self-conscious and hence reluctant to come to the board. To overcome this reluctance, IWBs can be combined with handheld computers (tablets) or remote pointers (clickers, wireless mice): this reduces exposure of students, releases the teacher from the front of the room, and saves time spent on students moving to the front. Students' use of such remote input devices to interact with IWB content can extend the action around the classroom and add new strategies to engage everyone in learning activities. It can also create more space for learner involvement in the creation of lesson content.

We have presented an overview of some ways in which teachers and learners might exploit the interactive features of the IWB. Some of these uses can potentially be combined with a "dialogic" pedagogy that is known to promote learning in classroom contexts both with and without technology. Box A.1 summarises the key principles of this promising approach and considers how the interactivity of the IWB might be more fully exploited.

Table A.1. Possible actions with IWBs and examples of use in classroom activities

Action	Meaning	Example of classroom activity with IWB
Composing	Ideas can be recorded accurately as they arise.	Students brainstorm on IWB
Editing	Data or text stored and displayed can be changed easily with no trace of the original	Class collectively edit report of a science experiment after whole-class discussion of outcomes
Selecting	Choice of resource or procedure can be made from a list	Students select the appropriate words from a list of vocabulary in a language exercise
Comparing	Features of same object from different views or different items displayed can be compared	Teacher displays pictures of flower taken from different angles or different flowers looking for common features
Retrieving	Stored resources can easily be retrieved for use	Teacher retrieves examples of same work from different classes or students retrieve files to complete work or demonstrate to peers
Apprehending	The display (text, images, sound, diagrams) is easy for students to see or interpret	An image can be added to illustrate the meaning of an unfamiliar word
Focusing	Attention can be drawn to particular aspects of a process or representation	Teacher uses highlighter, or “reveal” tool to focus attention on component part before revealing its place in the whole object or uses zoom/magnify to look closer at a seed to identify how it becomes attached to an animal for dispersal
Transforming	The way that the data is displayed can be changed	Students and/or teacher enter data in a spreadsheet and view in different graph formats to discuss which is most appropriate for task
Role Playing	Activities can be carried out in a way which is similar to activity in the “real world”	Students use a simulation on the IWB to conduct a virtual scientific experiment
Collating	The facility to bring together a variety of items from different sources into a single resource	Students collect data around the school grounds and load into graphing or database project for whole class
Sharing	The facility to communicate and interchange resources and ideas easily with others	Teacher retrieves PowerPoint presentations compiled by colleagues from school network
Annotating	Notes can be added to a process or representation at the time of use	Teacher annotates a poem with student’s interpretations or students predict the direction and shape of a graph and draw on the IWB for class discussion
Repeating	An automated or stored process can be repeated at will	Students can replay an animation of the flow of blood through a heart when writing an explanation of it
Simulating	A process can be simulated by representing relationships between variables	Students enter different food quantities into spreadsheet and watch effect on graphs representing high energy foods, food for growth and so on
Cumulating	Building up a representation of knowledge in a progressive manner	Students compile a group presentation (using a variety of media) over the course of a term/topic before presenting to peers
Revisiting	Repeating an activity or returning with a different focus	A list of ideas generated by the class at the start of the lesson is reviewed following an Internet search and discussion
Undoing	Reversing an action	A tentative idea or solution to a problem is removed without trace
Questioning	Piece of dialogue requiring a response	“Can you find two numbers which add up to 7?”
Prompting	Action or piece of dialogue which suggests what someone should do	“Try to find another word which means the same thing there”
Responding	Action which is contingent on a previous question/prompt	Change “big” to “enormous” when prompted

Source: Adapted from Kennewell and Beauchamp (2007, p. 232-233)

Box A.1. A dialogic pedagogy for using the IWB more effectively

Recent case studies by Hennessy and her colleagues show how the interactive whiteboard can be used to support classroom dialogue (Hennessy, 2011; Mercer *et al.*, 2010; *http://dialogueiwb.educ.cam.ac.uk/).*

Dialogue is more than just "talk", it is shared enquiry that bridges the gap between two or more perspectives (Bakhtin 1986; Wegerif 2007). Dialogic classroom interaction is an evolving and increasingly recognised pedagogical approach in which teachers and learners actively comment and build on each other's ideas, pose open-ended questions, and jointly construct new knowledge (Mortimer and Scott, 2003; Mercer and Littleton, 2007). Importantly, dialogue is cumulative and responsive to the previous person's contribution. It involves chained sequences of questioning and responding and chained lines of thinking and enquiry (Bakhtin, 1986; Alexander, 2008). Dialogic pedagogies have benefits for individuals' subject learning and for the development of language, reasoning and collaborative inquiry skills (Knight, in press; Mercer *et al.,* 2004; Mercer and Sams, 2006; Wegerif *et al.*, 1999; Rojas-Drummond *et al.*, 2010; Wegerif *et al.*, 2004).

The IWB is particularly well-suited for supporting a dialogic pedagogy because it expands the possible modes of classroom dialogue beyond talk and gesture. New dialogues can evolve around digital artefacts: images, texts, and other digital objects that teachers and learners iteratively manipulate and develop through collective scrutiny and collaborative activity.

In a dialogic classroom, learners reflect on their own explanations and others' critical perspectives. The IWB facilitates this process because it helps learners to create and share concrete representations of ideas and to receive feedback. Different ideas can more easily be juxtaposed, explored, connected and compared, highlighting strengths and weaknesses. Digital artefacts make words and ideas available for manipulation – as 'improvable objects' (Wells, 1999). Interacting with these provisional knowledge objects helps both to highlight differences between perspectives and to continue dialogues over time. By making both learning histories and trajectories more visible, including tracking them over time, digital artefacts can help dialogue to progress cumulatively.

While most of the research on IWB use focuses on whole class teaching, work by Warwick *et al.* (2010) has shown that the IWB has certain features and perceived benefits of those features that make it a suitable tool for use in group work activities where the teacher is not physically present, but s/he prepares the task structure beforehand. This can provide a highly productive environment for dialogic group activity and interaction.

The IWB also has the potential to assist with specialist teaching of children who are dyslexic or have severe difficulties with basic number work. A small, yet significant body of work by Somekh, Haldane *et al.* (2007) provides evidence that the IWB is a very useful tool in the hands of an experienced teacher or properly trained teaching assistant working with a small group. Moreover, the tools can potentially be used to improve the functional capabilities of children with disabilities (Basilicato, 2005).

The potential of the IWB as a powerful learning tool is beginning to become apparent. We now turn to examining the nature and extent of its integration in classroom teaching around the world.

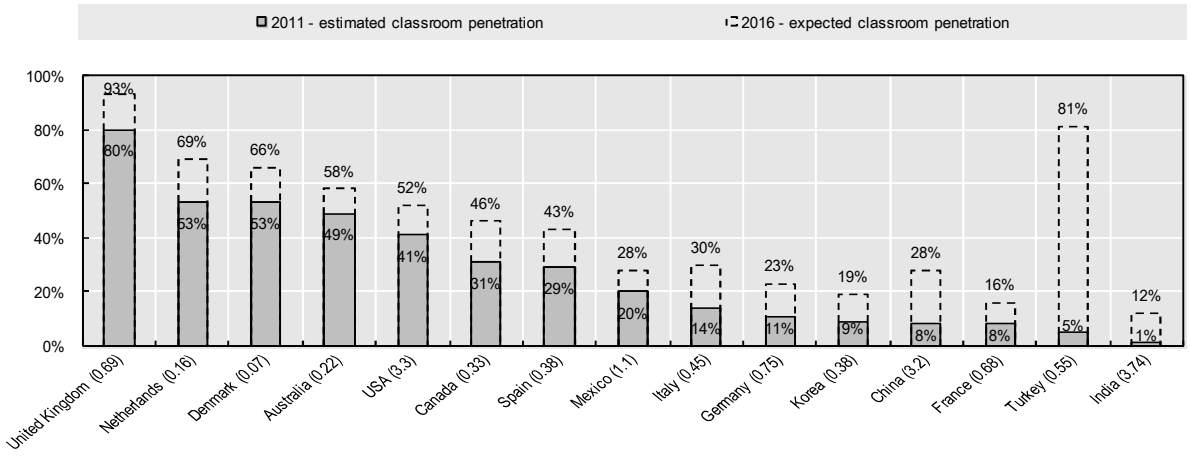
Policy initiatives in the United Kingdom and the spread of IWBs worldwide

The decision to introduce interactive whiteboards (IWBs) in the United Kingdom, the country with the highest penetration of IWBs worldwide, was based on an intention to improve student literacy and numeracy, targeting mainly primary schools, through interactive whole class teaching (Higgins *et al.* 2005). Policy required what the technology seemed to offer – a visual tool for supporting well-paced "interactive whole class teaching", and one that was cheaper than a class set of computers. Initial government-sponsored programmes involved parallel large-scale rollouts during 2003-04 in London secondary schools (Schools Whiteboard Expansion or SWE), and in 2004-05 in primary schools across the country (Schools Whiteboard Expansion Evaluation Project or SWEEP).

A further parallel programme, "ICT Test Bed", invested a total of GBP 34 million (EUR 50.6 million) over 4 years (2002-06) in 28 British schools and three further education colleges across three geographical regions. This initiative provided access to very high levels of hardware and appropriate software, and offered a model that other countries may want to consider. Test Bed schools procured laptops for every teacher and appropriate presentation technology such as interactive whiteboards and projectors in all teaching areas. The funding covered staffing release and training support. The schools were supported in developing a bespoke continuous professional development plan including strategic leadership in ICT use and integration of ICT resources into curriculum delivery. This plan derived from an analysis of existing staff skills. The project provided dedicated support to assist with change management, plus advice to Test Bed Schools on how they could ensure the long-term sustainability of the benefits derived from the project once direct project funding had ceased. Significant changes in performance on national tests were measured against matched comparator schools and national averages. (The independent evaluation of Test Bed by Somekh, Underwood *et al.,* 2007, offers more detail.)

Mexico initiated an IWB expansion scheme in 2004, shortly after the first initiatives in the United Kingdom. IWBs were installed in fifth and sixth grade classrooms and in initial and continuing teacher education institutes, as part of a MXN 20 billion (Mexican pesos; EUR 1.43 billion) Ministry of Education IT infrastructure scheme, *Enciclomedia*. The scheme included teacher training and educational support, equipment, evaluation and monitoring. The associated software comprises a database with digital resources (video, text, virtual visits, audio and images) corresponding to the curricular contents of the official textbooks used in primary schools.

Figure A.1. Classroom penetration of IWBs across the world



Source: Futuresource consulting (2012). The total number of classrooms (teaching spaces) in each country is given in parentheses.

Today, The IWB is an increasingly popular educational technology globally; according to the market research company Futuresource Consulting (2012), one in eight classrooms (34 million teaching spaces) across the world now have an IWB and by 2015, one in five will have one. It is found in 80% of British classrooms. Figure A.1 indicates that its prevalence is rapidly increasing in a number of other countries too, notably Netherlands, Denmark, Australia and the United States. The graph also highlights where further rapid growth is expected in the next few years. Turkey is expected to have the most rapid growth: the 5-year FATİH project, launched in 2012, will equip 620 000 classrooms in Turkey with IWBs and will provide tablet PCs to all teachers and students (*http://fatihprojesi.meb.gov.tr*).

Unlike many preceding forms of educational technology sponsored by the government (some of which still remains in boxes in school cupboards), uptake of IWBs by classroom teachers in England at least has actually been very high.

Several reasons can explain its rapid adoption by English teachers. First, in many contexts the old dry-wipe whiteboards were ripped out to force teachers to use the new ones. Teachers consequently were forced to learn basic skills in how to use the boards exceptionally quickly, often pooling knowledge and providing mutual self-help. Somekh, Haldane *et al.* (2007) point out that learning together when there is a pressing "need to know" is a powerful strategy for creating a sense of urgency and encouraging teachers to learn together. Second, teachers perceive the IWB as a tool in line with popular views of effective whole class teaching practice. Third, the IWB is billed as a tool that allows different types of learners ("visual" and "kinaesthetic" in particular) to access lesson content; despite lack of evidence for its validity, this perspective had a major impact on IWB popularity and uptake (Franklin, 2006). Lastly, IWBs can accommodate many different teaching styles and activities, including non-interactive pedagogies. Compared to other technologies, it is not disruptive and can replicate all the features of the traditional, dry-wipe board; it can be placed in an otherwise traditional classroom. Indeed, a key reason for the astonishingly rapid uptake in the United Kingdom was rather cynically expressed by Gray (2010, p. 80): "It is no coincidence that the most popular technological application so far in schools is one which meets many teachers' desire for control over content, learning and behavior rather than one which promotes independent learning."

While the evidence on the impact of IWB programmes is now accumulating, as we shall see in subsequent sections, it is extraordinary, but not uncommon in the context of technology, that the demand for such evidence has followed rather than driven the scale-up phase – in the United Kingdom as well as in many other countries. Governments often do not seem to learn the lessons of their predecessors and global neighbours where technology is concerned. There is a common but unfounded assumption that educational "innovation" (whether technology-based or not) is a positive step forward, but not all new ideas work well in practice of course. Summarising the lessons learned from a 2009 OECD meeting in Brazil that considered a range of recent technology innovations, Johannessen and Pedró (OECD 2010, p. 147) concluded: "Technology-based school innovations are rarely the result of an embodied set of knowledge or empirical evidence accumulated over the years, knowledge or evidence from which stakeholders nourish their decisions and to which they contribute with their feedback."

The IWB rollout is one more such innovation. The authors suggest that in reality "the availability and, in some cases, even the fascination for technology is the main driver behind innovations in this area. The link between technology and pedagogy is too weak or in the worst case non-existent" (*ibid.,* p. 144). Indeed, as new IWB features, new technologies, and richer forms of interaction emerge, these attract attention from researchers and educators and the education technology sector. For example, smart tables – horizontal multi-touch boards – and other technologies are now more affordable and available to support collaborative learning within and between groups (Higgins, Mercier, Burd and Hatch, 2011). Group members are able to work simultaneously on such a table device and the focus of attention can be shifted away from the front of the classroom. Teachers can also centrally manage student tables and project them onto the vertical IWB. As always, however, educators must harness these new tools mindfully and purposefully as they can also be used mundanely.

Lessons learned from implementing large-scale IWB programmes

The research into integration of IWBs was carried out predominantly in England, and other countries then endeavoured to learn from the English experiences.

In this section, we first review the results of past IWB expansion plans and show that the debate is still open about the effect of IWBs on teaching and learning. Reaching a consensus about the "impact" of many new educational technologies has proved notoriously difficult and is actually considered unrealistic by many researchers in the field. The impact of educational technology depends on teachers' uses of the technology, which depend in turn on their understanding of the pedagogic purpose. Research has consistently shown that the IWB, like the myriad of preceding forms of educational technology, itself has no agency or transformative power over pedagogy: therefore, understanding the benefits within particular contexts and for particular educational purposes is essential to focus any evaluation.

We argue nevertheless that the rapid adoption of IWBs fundamentally changed stakeholders' perceptions of the place of technology in schools. Indeed, the thrust of interest that this diffusion created helped catapult it to the top of the pile of educational technologies (Gray, 2012). We assert that this in turn helped to bring far more technology into the classroom where it could be used flexibly and at any time in conjunction with other classroom resources, and thus away from confinement to centrally located computer labs.

We then present the recommendations for school organisation and for the design of teachers' professional development that emerge from these evaluations, as well as more generally from research on the effective integration of IWB in teaching and learning.

Impact of IWBs on pupil outcomes and classroom pedagogies

English schools began using IWBs without being able to rely on established and detailed professional knowledge about what the technology's role in enhancing pedagogy might really be. There was little available research evidence to define what might constitute effective practices. The Department for Education and Skills therefore commissioned two evaluations of the initial government-sponsored plans for IWB expansion: SWE, for London secondary schools, was evaluated by Moss *et al*. (2007); SWEEP, involving primary school nationwide, by Somekh, Haldane *et al.* (2007).

The main interest of policymakers in England and elsewhere has been in tracking whether or not the IWB expansion plans had a positive effect on standards of student achievement through their impact on teachers' pedagogy and use of ICT. Although there have been a number of studies evaluating the rollout of IWB use in teaching and learning and its systemic impact internationally, to date the investment in this research and evaluation remains small in comparison to the enormous investments made in the equipment itself.

Some key conclusions emerge from these evaluation efforts.

First, IWBs as such have no transformative power on pedagogy. Teachers' diverse beliefs about pedagogy and student learning, their preferred uses of conventional boards, their goals and their prior experiences, shape the way in which they use all educational tools, including the IWB. New approaches can be developed if supported by adequate investments in professional development, but not imposed.

Second, professional learning about IWBs and their effective use takes time. Pedagogical change only comes with significant investment in professional development and is generally only observed after at least one year of full-time use by teachers.

Third, because their impact on pupils is mediated by their use by teachers, there are no robust, clear-cut positive effects on pupil learning associated with IWBs as such: the context and the nature of use of IWBs are all-important. Nevertheless, effects on learner achievement attributed to IWBs are generally more positive than for all other forms of technology.

Lastly, IWBs have been a major factor in accelerating teachers' use of technology and web resources.

The impact of IWB introduction on classroom pedagogies

Interactive whiteboards have generally been introduced with an explicit aim of encouraging more "interactive" classroom teaching. What are the ascertained impacts of interactive whiteboards on teachers' pedagogies?

Research in general has disputed the claim that IWBs fundamentally change teachers' pedagogies. Higgins *et al.* (2005) carried out a longitudinal study of the use of the IWBs in the early programme in the United Kingdom. 184 lessons were observed in primary schools in 6 geographical regions over 2 years, comparing teaching with and without an IWB. The outcomes were mixed. Lessons which used IWBs had faster pace and less time was spent on group work, reflecting the intended increased focus on whole class teaching (Smith, Hardman and Higgins, 2006). Worryingly, fewer uptake questions (feedback which goes beyond evaluation of a student's answer and makes connections with other contributions during the lesson topic) and extended answers were observed; answers during IWB lessons were frequent, but brief. However, in those lessons that used an IWB there were significantly more open questions, repeat questions, probes, evaluation, answers from students, and general talk. The research team concluded that "while our findings support some of the claims being made for IWBs, they do not suggest a fundamental change in teachers' underlying pedagogy" (*ibid.,* p. 254). Likewise, according to Gray (2010), teachers (foreign language teachers, at least) have resisted the discourse of "transformation towards constructivist practices" and appropriated the IWB to serve their own needs.

In practice, the impact on teaching varies depending on their pre-existing beliefs, goals, and experiences of teachers. Indeed, in contrast to the constructivist discourse that usually motivates their introduction, the technology can also reinforce a transmission style of whole class teaching in which the contents of the board multiply and go faster, whilst students are increasingly reduced to a largely spectator role. The evaluation of SWE (the IWB expansion plan in London secondary schools) similarly concluded that successful exploitation of IWBs in secondary schools depended on a clear understanding of the pedagogic purpose of their introduction. A focus on technical interactivity led to some mundane activities being over-valued, especially in classes with lower ability students, where it could actually slow the pace of whole class learning as individual students took turns at the board (Moss *et al.* 2007).

Research on implementations in other countries confirms that in practice, teacher responses to the arrival of an IWB vary; no simplistic messages emerge. Cutrim-Schmid and Whyte (2010) examined the integration of IWB technology by non-native speaking teachers of English as a foreign language in state secondary and vocational schools in France and Germany. (Teacher uptake and technology training are low in France and Germany compared with other countries, such as the United States, the United Kingdom, Australia and Mexico). Findings from their 3-year longitudinal study suggested that in spite of communicatively oriented, socio-constructivist training, teachers used IWB technology to implement a variety of different pedagogical approaches. These were shaped by multiple factors, such as teachers' teaching and learning experience, pedagogical beliefs, institutional demands, and alignment with their curricular and personal goals. The research suggested that with appropriate

training, feedback and time for development, teachers can acquire the knowledge, skills and resources to respond positively to the socio-constructivist computer-assisted language learning approach, which the authors identify as the current best model for language teaching with technology. But it was clear that changes in pedagogical practice cannot be imposed from above, via isolated training sessions and in the absence of ongoing support in the classroom.

Fernández-Cárdenas and Silveyra-De La Garza (2010) examined Mexico's implementation of IWBs in more than 170 000 primary classrooms. The researchers videoed and compared practice with IWBs and traditional boards and solicited teacher perspectives. Their findings show that the way a teacher uses conventional dry-wipe whiteboards has a direct impact on the way s/he uses the IWB; for instance, similarities were observed in proportions of time on individual, small group and whole class activity, in pedagogic beliefs, and in the perceived importance of learners interacting directly with the board (Fernández-Cárdenas and Silveyra-De La Garza, 2010, p. 177). Pedagogic ideologies remained static between IWB and non-IWB contexts despite the change of artefacts, although those ideologies themselves varied between individuals.

Slow-burner development of IWB proficiency

Professional learning about IWBs requires time. Teachers must become confident users of the technology and must adapt their practice to integrate its use.

In the already mentioned study by Higgins *et al.* (2005), most of the differences in the frequency of various classroom activities were only observed after the IWBs had been in use for over a year – an embedding effect. Somekh, Haldane *et al.* (2007) observed during SWEEP that it took about two years before teachers felt truly comfortable and proficient enough to use the IWB interactively and for its use to become embedded in their pedagogy as a means of supporting their interactions with learners, and learners' interactions with one another.

The more powerful and functionally complex a technological tool, the longer it will take teachers to learn how to use it effectively and how to develop and refine their pedagogic approaches in relation to the tool (Wright, 2010). IWBs are deceptively complex and to fully utilise the interactive aspects of the technology, teachers must invest time to build confidence, design resources, adapt practices and learn to harness their power. For example, Gillen *et al.* (2007, p. 254) concluded that the effective use of IWBs involves striking a balance between providing a clear structure for a well-resourced lesson and retaining the capacity for more spontaneous adaptation of the lesson as it proceeds. Teachers need time to develop the knowledge to exploit technology in ways that effectively enhance student learning in their specific contexts (*e.g.* Cutrim-Schmid and Whyte, 2010).

Some research has characterised a number of "stages" that teachers progress through in accommodating the IWB in their classrooms, with increasing pedagogical interactivity (*e.g.* Haldane, 2010). Moss *et al.* (2007) suggest that there is "a continuum in which new technologies initially support, then extend and finally transform pedagogy as teachers gradually find out what the technology can do" (p. 6).

Teachers need time to become confident users of new tools; teachers in addition need targeted support to adapt their pedagogy to integrate the potential of new technology. Recent research by Hennessy and Warwick (2010, p. 127) indicates that teachers take the initiative to develop their ICT proficiency to support and enhance their established interactive pedagogies; in contrast, it is unrealistic to expect the technology to drive teachers to new forms of pedagogy. The reason for this asymmetry is that IWB tools are designed to make it simple for teachers to create interactive multimedia teaching

materials. Ease of achieving "technical interactivity" using the IWB encourages dialogically oriented teachers to extend opportunities for dialogue.

Fancy use is not a prerequisite, however, and can even be a distraction. "We all know how easy it is to get swept along by new technology, but as professionals we need to remember that we are simply using it to assist in providing quality teaching. We must stay focused." (Betcher and Lee, 2009, p. 135).

The effect of IWBs on student outcomes

In the years preceding the major IWB expansion plans, government-funded research in England led to the assertion that school standards are positively associated with the quantity and quality of school ICT resources and the quality of their use in teaching and learning, regardless of socioeconomic characteristics (Pittard *et al.*, 2003). However, effects are notoriously inconsistent across technologies, subjects and phases, with greater impact often documented at primary level in England where ICT is more regularly used for teaching purposes (Machin, McNally and Silva, 2007).

In interpreting these results about educational technology in general, caution is needed since most of the available data demonstrate statistical association, but cannot prove causality, and generalisations are often unfounded. Moreover, much of the evidence base derives from small-scale studies and is limited, fragmented and unsystematic according to the landmark review of the literature by Condie *et al.* (2007).

What impacts on student learning outcomes, then, can be attributed to the introduction of IWBs in particular?

Given the stark differences in the uses of IWBs across teachers, any effect on pupils' learning outcomes is likely to be highly contingent on the wider pedagogical and socio-cultural setting. Moreover, the time it takes for teachers to develop IWB proficiency reduces the ability to draw general conclusions from pilot phases. Accordingly, Thomas and Cutrim-Schmid (2010, pp. 20-23) introduce their edited collection of work on IWBs by asserting that "impact" depends crucially on how the technology is used and not on its mere absence or presence in the classroom. We need to understand the benefits within particular modes of teaching, for particular student groups, within particular social, cultural and political contexts, and for particular educational purposes.

Nevertheless, the few studies looking at IWBs in particular almost unanimously report increased student motivation (Somekh, Haldane *et al.,* 2007). Regarding achievement, in the literature review by Condie *et al.* (2007), effects attributed to IWBs are reportedly greater than those for all other forms of technology: "The outcomes are almost universally positive, particularly where [IWBs] are used in conjunction with other technologies and there are clear pedagogical reasons for their use. Display and presentational software, including animations and simulations, combined with IWBs, help pupils to develop an understanding of abstract concepts through concrete examples and graphical images of, for example, microscopic processes." (Condie *et al*., 2007, p. 5). Somekh, Haldane *et al.* (2007) observed during SWEEP that a positive impact on attainment emerged when students were taught with an IWB for at least two years, particularly for those with average or high prior achievement. This time lag most likely reflects the learning curve of teachers in using the IWBs effectively.

The impact of IWBs on teachers' use of technology and web resources

Although their direct effects on teaching and on learning remain open to debate, we argue that IWB expansion plans changed teachers' and other stakeholders' dispositions towards technology more than any other ICT initiative before.

The key difference between the IWB and a set of desktop computers is that the IWB allows technology to be used flexibly, and it brings technology firmly into the classroom and away from confinement to now-outdated computer labs. Lee (in press) observed from experiences in Australia that while the IWB does not change the nature of teachers' pedagogy, it draws the vast majority of teachers into the digital world in a way that desktop computers never could. Lee (in press) argues therefore that the real impact of IWB use is that it moves teachers from their traditional paper-based *modus operandi* with its constancy and continuity to teaching that is primarily digitally based and characterised by constant evolution. Somekh, Haldane *et al*. (2007) corroborated this assertion through their observation of greatly increased "live" use of the Internet during SWEEP.

Such impacts on teachers' dispositions towards technology need not be limited to the classrooms equipped with IWBs and may only appear with a lag; as such, they are more difficult to attribute with certainty to IWBs. Nevertheless, a positive disposition among teachers towards the use of technology and of web resources to support their professionalism could lead in the long run to significant benefits for the quality of teaching.

In sum, the impacts of IWBs on classroom activities and on students' learning depend strongly on the pedagogical culture in which they are deployed and on a set of complementary investments that facilitate their integration in existing contexts. While IWBs can be used to support a variety of teaching styles, they have been found to trigger little resistance from teachers and, on the contrary, to draw them over time to increase the use of technology and of web resources in and out of class. This in turn helps teachers document, share, and easily locate best practices, thus brokering decentralised collaboration and catalysing continuous improvement.

Organisational conditions for successful integration of IWBs in schools

The research summarised above has shown that IWB expansion plans have not always had the expected result of promoting the use of interactive pedagogies. What can be learned from the success and challenges of past plans?

The conditions that enable the successful adoption of IWBs span a wide range, from the simple availability of equipment and connectivity, to technical and pedagogical support for teachers, as well as the production and distribution of digital learning materials. In this section we summarise the organisational conditions that support teachers in developing both technical and pedagogical proficiency in using IWBs and are therefore associated with higher impacts of IWB introduction.

Teachers' proficient use of IWBs positively depends on the informal opportunities for practice and exchange that the school offers: this requires regular and uniform access to technology for all teachers in a school. Teachers' effective use of IWBs also depends on the availability of digital resources that support the school curriculum. Finally, teachers' ability to involve all students in classroom dialogue may be limited by the traditional organisation of subject lessons in short units: more flexible time arrangements provide greater room for interactive teaching.

Regular and uniform access to technology

Personal access to PCs or laptops has a major impact on teachers' roles and those of support staff, giving flexibility and choice with regard to the location of work and increasing confidence with technology, according to Somekh, Underwood *et al.* (2007). This is corroborated by Betcher and Lee (2009) who argue that every teacher needs a laptop of their choosing. This need was never considered in the Australian programme, but it needs to be met if teachers are to use digital tools in their classrooms.

Moreover, priority should be given to installing IWBs in *all* classrooms in a school as this ensures continuity for students as they move through the school, and enables teachers to learn together (Somekh, Underwood *et al.,* 2007). A culture of sharing and mutual support develops as the whole staff faces the task of embedding the technology into their pedagogy. Collective need leads to collective solutions being found and shared, and thus to change embedded in practice.

Access to quality digital resources

Availability of digital resources can be a supportive or constraining factor in using the technology interactively in lessons. In Ireland, where prevalence of IWBs is relatively low, a study by Hallinan (2009) found that teachers given an IWB did integrate ICT use, but the lack of training and digital resources available proved a significant drawback. The report concluded that there were not enough interactive resources that support the curriculum, and a transmission approach to learning resulted.

Schools need to build sustainability – of both resources and pedagogic change – into their change management strategies from the start. For example, shared server areas and virtual learning environments make it easier for teachers to find, store, share, create and reuse resources and lesson plans. This ensures long-term value from the initial high investment by the workforce and makes it easier to induct new teachers into the school ethos. It also provides greater consistency for the learners, though it brings with it new tasks for organising and maintaining resources. Schools can even join with others locally to create resources.

Flexible school timetables

Timetabling is an issue, especially at secondary school level where in many countries subject lessons are constrained by a rigid structure of 50-minute chunks. Thus work that really requires continuous engagement over several hours has to be fragmented (Pearson and Somekh, 2006). In the Test Bed programme, impact of ICT use on attainment levels was greater for primary schools than secondary schools (Somekh, Underwood *et al.*, 2007): one possible explanation lies in the greater flexibility offered by a single teacher in a class to incorporate the use of ICT into extended sequences.

The benefits of introducing more flexible timetables are illustrated by one of our case study schools in Cambridge. Recently, this school doubled the length of its lessons; with a significant effect on teachers' ability to support learning through extended classroom dialogue. According to the Deputy Head, Lloyd Brown, "With many lessons now 100 minutes not 50 and no bells half way through, there are opportunities for teachers to develop more in-depth, investigative student-centred work [across all subjects]. This [work] seems to be emerging more quickly than the leadership team envisaged."

Characteristics of successful approaches to professional development

Conducive organisational conditions are a necessary but insufficient prerequisite for teacher adoption of IWBs. Of paramount importance is a programme of well-structured, well-coordinated and sustained professional development to support the process of integrating IWBs into the classroom; a consideration of the developing proficiencies, confidence and views of teachers is central in embedding the use of IWBs (Hennessy and Warwick, 2010, p. 128).

Yet, the experience of many countries shows that the adoption of IWBs in many schools has outpaced the delivery of professional development of adequate quality and length. As a consequence of patchy professional development provision, IWBs remain a poorly or under-utilised resource in many classrooms today, in England and elsewhere (DeSantis, 2012).

There is often lack of both clarity about responsibilities and planning for training. In the case of the SWE programme, for instance, an ongoing and pedagogically-oriented programme was not included in the design. The funding stream did not include money for training: Moss *et al.* (2007, p. 55) report that operational training was assumed to be available from suppliers, whilst pedagogical training was initially expected to be provided either by ICT coordinators or by software suppliers (Becta, 2004). Education authority consultants were intended to contribute to pedagogical support, but no monies were committed to this end. It was anticipated that funding to pay for the necessary support would be available at school level as part of existing budgets for in-service training. It was apparently always clear that the introduction of IWBs would generate training needs, but there was uncertainty about exactly how the costs would be met, within what timescale, and who was best placed to offer what kind of support. The lesson is that clarity is needed about who should take the lead on which aspects of policy development and meet its associated costs, and that action needs to be aligned across stakeholders.

The importance of well-designed professional development in supporting pedagogical change is developed further in this section and forms the key thrust of this paper. After reviewing the effectiveness of professional development components in past IWB expansion plans, we examine the extensive literature on teachers' professional learning in technology-enhanced and other contexts to propose an optimal approach to support IWB integration.

The effectiveness of professional development in the English IWB expansion plans

Although the ultimate objective of investing in teachers' professional development is to benefit students' learning outcomes, it is always difficult to measure improvements in learning outcomes and to attribute them to a single cause. To assess the effectiveness of professional development, it is therefore equally important to gather information on all the intermediate levels of impact through which effects work. A useful framework for assessing the effect of teacher professional development distinguishes five critical levels of impact (Guskey, 2002): (1) participants' reactions, (2) participants' learning, (3) organisational support and change, (4) participants' use of new knowledge and skills, and (5) students' learning outcomes. Guskey (2002) cautioned that "[w]ith each succeeding level, the process of gathering evaluation information gets a bit more complex. And because each level builds on those that come before, success at one level is usually necessary for success at higher levels" (p. 46).

The nature of professional development activities matters more than the amount of time and money invested in it. Research on professional development consistently indicates that the effectiveness of professional development efforts is strongly dependent on its nature and format: a synthesis across the literature on professional development concluded that much investment in teacher

professional development has no effect on valued student outcomes and some actually has negative effects (Timperley and Alton-Lee, 2008).

Although there is no systematic analysis of the effectiveness of professional development to support IWB integration, the literature on IWB integration initiatives identifies some pitfalls and promising approaches among the professional development components of past IWB expansion plans. Most of the time, the evidence refers to teacher-level outcomes only, because pupil-level outcomes were affected simultaneously by many concurring changes.

A first message from the literature is that pedagogical change requires pedagogically oriented professional development – of a kind that prepares teachers to exploit the IWB in ways that are consistent with current models of teaching for each subject (Cutrim-Schmid, 2010, p. 170). A major shortcoming identified in the longitudinal study by Higgins *et al.* (2005) was that many of the schools involved failed to focus the teacher training on improving literacy and numeracy; instead, the focus was on how to use the IWB technology. The typical introduction that teachers receive – in all countries – is a short one delivered by the company supplying the IWB. It often focuses purely on the technical features of the equipment. Research indicates that this type of training is woefully inadequate to help teachers make the best use of IWBs. Haldane (2010) examined how teachers acquire proficiency in the use of IWBs for the enhancement of whole-class teaching and concluded that they are unlikely to make optimal use of the affordances of the technology through preparatory training alone; such an expectation could adversely affect the chances of successful implementation. In contrast, the evaluation of the secondary whiteboard expansion (SWE) in London (Moss *et al.* 2007) showed that three-quarters of all teachers found subject departmental training in IWBs to be useful. This has the advantage of being directed to very specific areas of the curriculum, with a body of teachers agreeing where an IWB resource should be integrated into existing working patterns, and thus effectively doing so.

The format of professional development also makes a difference. A clear message deriving from the key IWB initiatives in the United Kingdom is that in-school professional development sessions led by colleagues are more effective than other approaches, and teachers prefer them.

The evaluation of SWE (Moss *et al.* 2007) found that the preferred source of learning for most teachers (83%) was informal day-to-day assistance in using IWBs. Moss *et al.* (2007, p. 139-140) concluded that teachers' preference is for training on a "need to know" basis that can accommodate to their existing working patterns.

The evaluation of the Test Bed initiative (Somekh, Underwood *et al.*, 2007) identified the most effective forms of professional development not only in terms of teachers' preferences, but also in terms of their impact on teachers' ICT skills and on the use of ICT during teaching activities. In Test Bed schools, external trainers were used for specific events, but as teachers became more proficient, they supported and sustained activity undertaken by their colleagues. In primary schools, ICT coordinators used their increased non-teaching time to work with colleagues; in secondary schools, specialist ICT teachers, advanced skills teachers[2] or other teachers, technicians and content developers designed and delivered specific training for colleagues. The evaluation of the Test Bed initiative found that the most effective forms of professional development were often informal, involving teamwork and mutual support. Training became more effective when staff could see what colleagues were doing, take part in more informal team learning, pick up tips and new techniques, and practice with the equipment on their own. In primary schools, action research supported professional development and pedagogical change. The development of "champions" with expertise in using particular equipment was valuable – both in primary schools and within secondary departments – in providing support at the

point of need. This was particularly effective when the role of "champion" was spread among colleagues and not focused on a single school/department expert.

The indications that emerge from IWB initiatives on this point are in line with the richer conclusions from a rigorous evaluation of the national initiative to train all school teachers in England to use ICT in teaching carried out in 2004 (Davis *et al.,* 2009a; 2009b). Among the approaches proposed by the various providers, centralised skills-focused approaches, especially those with online access to trainers, were found largely ineffective. In contrast, the most successful professional development model against Guskey's criteria proved to be an "organic" approach that provided school-based training designed to support evolution of each teacher's classroom, school and region. In addition to face-to-face training and case studies of good practice, groups worked on classroom assignments that made specific links to participants' professional practice. Teachers set personal objectives and there was also a collective needs analysis for each training group.

Trainers themselves need to be part of a wider community of practice in order for professional development to be effective: The simple strategy of sequentially "training the trainers" centrally so they may cascade workshops to others in their locality was not recommended by Davis *et al.* (2009a, 2009b).

A proposed approach to professional development in support of pedagogical change

A school-based, active learning model, combining formal and informal learning opportunities, emerges as the most effective approach from the limited literature on the professional development components of large-scale initiatives for ICT integration. These indications can be developed into recommendations by considering the larger practical and theoretical literature about professional development for pedagogical change.

In this section, we expose the central tenets of the professional development approach developed by Hennessy and colleagues through collaboration with practitioners in a series of research studies over the last decade. The approach involves sustained, planned and purposeful opportunities for teacher learning and reflective practice sits at the core. This collaborative inquiry approach has inspired in particular the development of resources for supporting IWB use (as described in Box 2).

The six principles can be summarised as follows:

1. Professional development is school-based, and includes action research led by practitioners.

2. The focus and course of action is initiated and driven by teachers' needs and beliefs.

3. Professional development is a team inquiry process proceeding in cycles of reflection and trialling.

4. The inquiry is focused on supporting student learning.

5. Professional development activities are embedded in the teachers' normal work organisation.

6. School leaders and administrators actively support the process.

Each principle is explained below, and illustrated with suggestions relating to programmes supporting ICT integration.

First, professional development is school-based, and includes action research led by practitioners.

School-based professional development implies that the professional development activity is situated within an established and supportive community of practice. The issues that its members choose to explore and the actions and theories-in-use that they implement are contextualised through their situation within a localised school and/or departmental learning community (Retallick, 1999).

In the proposed approach for ICT integration, teachers receive support or mentoring mainly from more expert colleagues ("champions"). The teachers collaborate as equals, act as peer mentors, work in small groups and observe each other in order to develop and evaluate new ideas. Thus, teachers themselves lead professional development and share responsibility for embedding improved practices in their schools (Frost 2012).

The professional development may also include support – at least initially – from an external facilitator who can expose teachers to new pedagogical approaches and can familiarise them with the full range of IWB features (Moss *et al.* 2007). New practices however should never be prescribed or imposed on a passive audience, as in the traditional meaning of "training", but negotiated and developed with the active engagement of teachers, who bring their own experiences, outlooks, expertise and contexts to bear in that process of professional learning.

Although we emphasise the importance of the school as a community of practice, wider communities of practice may play a role too, particularly for internal and external trainers, champions, and mentors (as the Test Bed 'cluster' approach linking local schools showed). Their network extends beyond the single school, brokered through online exchanges. Personal Learning Networks (PLNs) are reshaping the way that many educators view professional development (Betcher and Lee, 2009). Instead of waiting for their school to "deliver" professional development, these PLNs are creating a global learning environment for many lead educators that operates all year round, working across schools, educational sectors, countries, and time zones.

Second, the focus and course of action is initiated and driven by teachers' needs and beliefs.

Teacher learning requires that teachers take ownership of the material, interpreting and adapting it for themselves, and building on what they already know, believe and do. This is most likely to happen when the professional development activities are localised, adaptive and available on-demand.

In the proposed approach for ICT integration, professional development programmes are tailored to subject discipline and individual teachers' pedagogy and practice (Davis *et al.,* 2009a). Too often the specific needs of teachers are poorly targeted. If professional development cannot be structured in an ongoing, relevant and on-demand way, experience suggests that much of it will be wasted. Professional development for embedding the use of IWBs in pedagogy should start from where the teachers currently are and encourage them to question their existing practices and beliefs. In an already pedagogically interactive context, teachers need to learn how to exploit the potential of a powerful tool to support that pedagogy; the professional development activities will be very different from what is useful in a transmission-based context where the need is to develop both a new pedagogical approach and the ICT skills required. Research shows that teachers otherwise respond to ICT integration initiatives by simply adapting new ideas and technology resources to their existing practices and beliefs (Kennewell and Beauchamp, 2007). Effective interventions secure commitment by building teachers' confidence in their own abilities to use new technology (Zhao and Cziko, 2001).

Every school will also be at a different point in its evolution and will be situated in a different context, requiring its own tailored and responsive professional development programme. A critical factor in the effective use of ICT generally is the existence of a well-defined school-level e-strategy that addresses future development and sustainability and includes some means of monitoring progress against identified milestones (Condie *et al.,* 2007).

Third, professional development is a team inquiry process proceeding in cycles of reflection and trialling.

In the proposed approach, video exemplars of other teachers' (or their own) lessons, and multimedia resources and texts highlighting the underpinning approaches, stimulate reflection and dialogue between colleagues, for change and innovation. The videoed lessons are not intended to be models of "best practice" but illustrate a mixture of different approaches for consideration. The materials include specific built-in prompts for reflection on teachers' own current practice, reflection upon the approaches and practices illustrated, and discussion with peers. The guidance can be more or less structured, depending on how experienced the teachers are with the technology and the pedagogical techniques.

New ideas that emerge from this reflection process are then related to classroom practice through a cycle of trialling and refinement. This helps to test the practical applicability and boundaries of the new approaches in a given context, resulting in re-contextualised techniques and practices. Considering teaching as inquiry is a central success factor in professional development programmes generally (Alton-Lee, 2011).

Fourth, the inquiry is focused on supporting student learning.

In the proposed approach, both the prompts and the classroom inquiry activities focus on the impacts of the new practices for learners' engagement and learning outcomes; on which pedagogical strategies are applicable, assistive and appropriate for the context; on the added value of the technology and the extent of its exploitation.

Fifth, professional development activities are part of a sustained, long-term process, supported by the organisation; opportunities for dialogue, planning and team teaching, are embedded in the teachers' normal work organisation.

In the proposed approach, training is coordinated with the introduction of the equipment so that teachers are immediately able to practice their newly learned skills. Importantly, professional development programmes supporting ICT use need to continue after the initial phase in order to ensure that new learning can take place and so that "bad habits" can be addressed (Somekh, Underwood *et al.* 2007). Yet ongoing or pedagogically-oriented support is rare. The general literature on professional development concludes that it needs to be part of a sustained process (1-2 years) of reassessing pedagogy and reflecting upon practice, rather than a one-off intervention or one-day course (Cordingley *et al.*, 2004; Hoban, 1999). The intended changes must be understood and embraced at all levels, creating a collaborative and collegial learning environment that supports opportunities to change teachers' practices, knowledge and effectiveness (*e.g.* Hord, 1997). The process involved enables teachers to embed new ICT practices in their own classroom settings, in particular through dedicated non-contact time, collaborative lesson planning within workshops and team teaching (Bowker *et al.*, 2009; Cordingley *et al.*, 2004).

Opportunities for professional dialogue between colleagues are central here. British teachers, for example, have regular discussions about teaching with their line manager but performance

management meetings typically focus on their own classroom teaching. The discussions stimulated by critiquing video clips of other teachers' practice can be more wide-ranging, allowing teachers to process new learning with others and to examine the effects of different types of activities without needing to account externally for their own actions and decisions.

Sixth, active support from school leaders and administrators is crucial.

Although it can be a huge challenge, experience from Australia indicates that shifting the focus towards a whole-school approach to ongoing professional development can make a major difference to progress in integrating IWB technology (Betcher and Lee, 2009, p. 137). The research emphasises the importance of the school principal in visioning, leading and funding interventions. It shows that strong support from the school leadership team and winning over a majority of the staff to the educational value of the boards are a critical combination to starting out on the path to successful school-wide implementation (*ibid.,* pp. 116-117). This reinforces the suggestion made earlier that IWBs should be introduced into all classrooms simultaneously (Somekh, Underwood *et al.,* 2007). Betcher and Lee (2009) argue that sufficient resources and induction should be provided to enable all staff to work collaboratively to embrace the powerful possibilities of the IWB and learn the necessary new skills to effectively embed IWBs into daily practices. A successful whole-school approach additionally depends on giving teachers "recognised responsibilities, authority, time to collaborate and [active] support from school administrators to assume leadership roles" (Teacher Leadership Exploratory Consortium 2011, p. 12).

School leaders play an often unrecognised role; along with teaching assistants they are often shortsightedly left out of IWB training initiatives (Moss *et al.,* 2007). Yet, rigorous syntheses of research evidence on professional development across the world clearly show that by far the largest effect of school leadership on student learning outcomes is when leaders promote and themselves participate in teacher learning (Alton-Lee, 2011).

The lessons we can learn from previous professional development programmes and associated research are clearly pointing towards a peer collaboration model for integration of IWB technology into classrooms in new contexts. The benefits of collaborative professional development (in general) can also extend beyond the areas targeted by the professional development (Cordingley *et al.*, 2003), and can in fact be very wide-ranging. Teacher benefits include enthusiasm about professional learning; increases in confidence and self efficacy; a greater commitment to changing practice and willingness to try new things; activities to generate more effective and targeted dialogue between students; and a conscious effort by teachers to use computers more for both instruction and to increase the range of teaching and learning strategies targeted at specific student needs. Student benefits include: a demonstrable enhancement of student motivation; improvements in performance on tests; more positive responses to specific subjects; an increased sophistication in response to questions; the development of a wider range of learning activities in class and strategies for students.

Box A.2. Existing resources for a collaborative inquiry approach to professional development for IWB integration

Previous research by Hennessy and colleagues carried out both in the United Kingdom and Zambia (Haßler, Hennessy, and Lubasi, 2011) in close collaboration with practitioners using new forms of technology confirms the value of the above approach in terms of teachers gradually changing their practices and thinking over time.

The T-MEDIA project documented case studies of IWB use in science, history and English, and projected graphware in mathematics. It produced thematically organised multimedia representations of them, with built-in professional development activities (freely available at *http://t-media.educ.cam.ac.uk/*). A follow-up study found lasting tangible impacts of engagement with theory, reflection and trialling new approaches and tools on the professional thinking and practice of participating teachers (Hennessy and Deaney, 2009). There was also evidence of their spread and independent adaptation by colleagues.

In the Dialogue and IWBs project, we collaborated with three (primary, middle and secondary school) teachers to analyse and develop dialogic practice in different subjects (Hennessy, Warwick and Mercer 2011). Teachers then designed and taught lessons employing new dialogic approaches supported by IWB use. Spontaneous whole-school initiatives took place, evaluating new uses of IWBs. This collaborative work led to the development of a further multimedia resource for using the IWB to support dialogue. The resource, co-authored with the three practitioners involved in the research, includes:

- A guided programme of collaborative action research containing discussion and practical activities
- A resource bank of video clips (freely available online at *http://sms.cam.ac.uk/collection/1085164*) and screenshots, each with a description of potential classroom application
- IWB flipchart templates for lesson activities
- Photocopiable resources for teachers and school leaders
- A series of accessible background readings, including the teachers' own detailed case stories of authentic classroom practice with accompanying lesson materials.

Source: Hennessy, Warwick, Brown, Rawlins and Neale (in press)

An independent evaluation of a series of workshops based on the resource was carried out in two English schools by an IWB-expert teacher. The (unpublished) report highlighted the value of the materials as a powerful stimulus for critique, discussion, reflection and testing out of new ideas, rather than a model to copy. The resource bank in particular was considered an excellent stimulus for discussion and development of ideas about how to link dialogic teaching with the IWB. The resource is adaptable to other subject and country contexts (see further information about the resource and the original research project at *http://dialogueiwb.educ.cam.ac.uk*).

A cost-benefit analysis of IWB programmes

IWBs are expensive to install and maintain. Funding to meet the costs of sustaining laptops, data projectors and bulbs over time needs to be built into school budgets. Debate continues to rage about whether the costs are proportionate to the benefits, and about the "added value" of IWBs over other forms of projection technology such as a simple data projector and computer or laptop combination. One local authority region in the Test Bed project, for instance, chose to invest in the latter combination along with visualisers in order to equip far more classrooms, and was very satisfied with the outcomes (although of course they had no direct means of comparison); this combination is also frequently found in Singapore.

Cost savings can be expected as new, cheaper hardware options are becoming available – a cheaper, LCD IWB, and data projectors with in-built interactivity. A simple data projector coupled with a tablet computer or laptop plus slate can act as an alternative input device that retains access to the technology and – even the specialised IWB software – in the learners' hands and costs less than half the price of an IWB. Free screencasting programs can be used to capture/record lessons for subsequent playback. However, many argue that the IWB and its specialised software tools continue to offer significant pedagogical advantages. The technical issues arising from the various options are not within the scope of this review.

The benefits of introducing IWBs to support interactive pedagogies and to more generally embed ICT across the curriculum are evident from some of the research and evaluation studies discussed above. These benefits however are to a large extent conditioned by a larger set of conducive conditions.

Creating conducive conditions for integrating technology into classroom teaching inevitably costs more than the price of the equipment infrastructure, but it is difficult for policymakers and educators to gauge. In particular, the costs of professional development within large-scale IWB programmes are very elusive; they are not referred to in published reports and anecdotal evidence derived from personal communication with those who led the programme evaluations in the United Kingdom confirms that they were not examined. We have seen that confusion was evident in some cases about how professional development costs would be met and by whom. Betcher and Lee (2009, pp. 133-135) suggest that to set more realistic expectations, educators should discuss progress with similar schools using IWBs, including how much time and money has been set aside each year. Some further tentative suggestions can be made, as follows.

If teachers are to have the time they need to develop professionally, then money must be allocated for the vital ongoing development and support. Teachers ideally need to be released from formal teaching duties on a regular basis in order to participate in any form of professional development, and this incurs teaching cover costs. However, for school-based professional development this can if necessary be minimised through using staff meetings already scheduled outside of teaching time (although it is not ideal to undertake this kind of professional development after a full day's teaching). Informal support from knowledgeable colleagues is clearly a low-cost as well as a popular option. Action research is likewise a successful, sustainable and low-cost approach to reflective practice.

A cascade approach involving working with a small number of teacher mentors (and "champions") who then work with their colleagues teaching the same (primary) ages or (secondary) subjects would be cheaper than inducting all teachers initially, and it allows the recommended peer collaboration model to flourish. Where specialist external help or workshops are desired, there are various options. Teachers attending centralised workshops within a university or national/local education authority setting are usually more expensive in terms of travel and cover time than a regional hub model in which teachers from neighbouring schools congregate at one of their institutions. Location might be rotated, potentially offering an additional valuable opportunity to observe and learn from practice in another context. Secondary schools in England at least already do effective outreach work with feeder primary schools and such clusters offer a fruitful model for building ICT expertise and sustaining it throughout a child's schooling (Somekh, Haldane *et al*., 2007). Similar schools may also work together to share practices, ideas and digital resources. As mentioned earlier, trainers or mentors themselves need to be part of a wider and ongoing community of practice in order for professional development to be effective (Davis *et al.,* 2009a).

Finally, it must be acknowledged that positive outcomes of the impact of collaborative professional development sometimes may emerge only after periods of relative discomfort in trying out new approaches. Cordingley *et al.* (2003, p .4) observed that practices often worsened before they improved and collaboration was critical in sustaining change. This finding resonates with early experience of IWB initiatives; in Test Bed schools, there was a dip in performance until the ICT became embedded and staff developed the requisite skills (Somekh, Underwood *et al.*, 2007). A long-term investment is needed to secure and sustain long-term gains, however the costs can be kept to a reasonable level through relying largely on peer rather than "expert" support, at least after initial induction by pedagogical experts. Structured support materials are important in helping to guide teachers' progress within this model; initial costs of developing or procuring these materials are mitigated through their replication and re-use over time *(ibid.).*

Conclusion

This paper outlined the lessons learned from international experiences with IWBs. It considered ways to support the shifting roles of teachers and learners, in particular to foster more interactive and dialogic pedagogical approaches. The relevant organisational conditions for successful integration of IWB technology were described.

Research confirms that the skills and professional knowledge of the teacher in mediating interactions with learners is the most crucial factor in determining how much value is gained from IWBs (Higgins *et al.*, 2007). The roles of appropriate professional development and institutional capacity building here are utterly essential to support the continuous learning through innovation that underpins technology integration. Based on these considerations, and the fact that technology by itself has no transformative power, the research literature on effective forms of professional development was drawn upon in introducing a suggested, school-based professional learning approach. This model is primarily teacher-led, sustained over time, school-wide and actively supported by school leaders; it is based on peer collaboration, reflection, inquiry, direct classroom application and trialling, plus some external input. Overall it is also relatively low cost and may offer educational policy makers in other contexts a way forward that avoids the mistakes of some past technology integration initiatives.

NOTES

[1] This annex is also available as Education Working Paper No.°89: *http://dx.doi.org/10.1787/5k49chbsnmls-en*.

[2] Advanced Skills status (and a significant salary increase) is awarded upon application to recognise expert United Kingdom teachers and release them from 20% of their teaching in order to share their subject practice through outreach with other schools. They are not necessarily present in every school; in 2012 there are 4500 nationwide.

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ANNEX B. THE TRANSFORMATIVE IMPACT OF ICT POLICIES IN EDUCATION: LESSONS AND CHALLENGES FROM AROUND THE WORLD

Robert B. Kozma, Ph.D.

Introduction

This appendix provides an international context for the analysis of the Italian ICT policies for education. The report focuses on ICT but it goes beyond this focus to consider the transformative potential of ICT to change other aspects of the educational system, such as teacher professional development, curriculum, pedagogy and assessment (Collins and Halverson, 2009; Kozma, 2011a).

Capitalizing on ICT's potential for transformative change is a challenge. Countries as diverse as Singapore, Uruguay, and Rwanda have identified ICT as a means to transform their educational system (UNESCO, 2011). Yet findings from the OECD's Programme for International Student Assessment (PISA) 2006 and 2009 study have found no relationship between school use of computers and students' assessment scores (OECD, 2010; 2011a). Why is this so and how can Italy and other countries apply ICT more effectively? Furthermore, how can ICT policies be structured to promote innovation and transformation?

One reason for disappointing results, studies have found, is that despite the significant investments over the years to equip schools with computers and networks, it is only recently that ICT is being used regularly in the classroom. In 2006, the SITES study of 22 education systems by the International Association for the Evaluation of Educational Achievement (IEA) found that when lower-secondary mathematics and science teachers were asked how often they used wide range of educational applications of ICT in their teaching, the mean response, across countries, was somewhere between "never" and "sometimes" (Law *et al.*, 2008). In the same year, a survey of teachers in 27 European countries found that of the 66% of the teachers who said that they had students use computers in class, 62% said they used it in less than 25% of their lessons (Empirica, 2006); and the 2006 PISA study of 39 countries found that while 86% of 15-year-old students, across countries, reported that they were frequent computer users at home, only 55% reported frequent use in schools, an increase from 44% in a similar 2003 study (OECD 2010). More recently, in 2009, the PISA survey found that in the average OECD country, only 26% of 15-year-olds reported using computers during language of instruction classes, and 24% during science classes. Teachers reported in the 2011 Trends in International Mathematics and Science Study (TIMSS) that on average 39% of 8th grade science students, across countries, used computers at least monthly to look up information, with the highest proportions (above 70%) found in Kazakhstan and Norway (Martin *et al.*, 2012). In primary schools, teachers reported in the 2011 Progress in International Reading Literacy Study (PIRLS) that 32% of 4th grade students use computers at least monthly to read or write texts during language of instruction classes, with the highest proportions (above 70%) found in New Zealand for reading and in Denmark, Norway, New Zealand and Australia for writing (Mullis *et al.*, 2012).

Second, the use of ICT in schools is typically not of a transformational sort: the most frequent uses of computers are to support traditional classroom activities. In the SITES 2006 study (Law *et al.*, 2008), the most often used ICT applications in teaching were productivity software and tutorials. The Empirica (2006) study found that while 74% the teachers reported using a computer in class, 63% said it was used to support teacher presentations. Again, in the 2011 TIMSS science study, looking up information was the most-often-used application of computers (Martin *et al.*, 2012). The percentage of

students using computers for scientific simulations was 30% at the 8th grade level, as reported by teachers.

Third, it takes time for ICT to have a significant impact, even after widespread adoption, at least if experience in the private sector is an indication. In their study of business practices around the world, Brynjolfsson and Saunders (2010) found that it can take three to four years before the widespread use of technology results in productivity gains.

Finally, Bynjolfsson and Saunders (2010) also found that the introduction of ICT alone did not result in productivity gains in the private sector. It was only when ICT investments became connected to a set of complementary changes in organisational structure and business practices that productivity gains were realised.

Consequently, the purpose of this paper is to examine the structures and practices associated with ICT use that might lead to the transformative changes envisioned by Italy and other countries. In doing so, I examine the international research on ICT policy and focus in on three countries that might provide Italy and other countries with useful insights on how to harness the potential of ICT to transform education. The countries chosen for this purpose are: France, Norway, and the Republic of Korea. Four lessons are derived from the analysis of the policies, structures, and practices of these three countries, as well as others. They are:

1. Align strategic goals of ICT policies with implementation initiatives. There should be a direct, causal connection between the high-sounding rhetoric used to frame ICT policies and the programmes and initiatives developed to implement policy.
2. ICT policies can create teacher demand rather than resistance. Structuring teachers' work in such a way that ICT helps them is likely to be more effective than requiring them to take ICT training.
3. Curriculum reform can be used as a lever to align teachers' practices with ICT policies. Embedding ICT throughout the curriculum is likely to change the work of teachers such that they will use ICT regularly and demand training in the skills that will help them do that.
4. Strive for phased, systemic change. ICT equipment, as such, has little transformative impact; its impact on student learning is likely mediated by classroom pedagogy, student assessment, teacher professional development and the availability of digital resources.

These lessons are discussed and warranted in the main body of this appendix. But first, the three focal cases are presented.

Case Studies

Selection of Countries, Analytic Approach and Limitations

In-depth analysis of a small number of cases requires the selection of cases for specific purposes, relative to the goals of the study (Miles and Huberman, 1994). In this study, the objective is to provide compelling comparative evidence for the review of the Italian ICT policy in education. The selection of countries was therefore a balance between the similarity of the national context to Italy's, on the one hand, and innovativeness of the policy, on the other, so that the comparisons could generate relevant policy options for Italy.

France was identified as a country most like Italy in many ways (see Table B.1, below). Italy and France are close in the size of their population, economy, and per capita income. In terms of their

educational performance, both score at or near the European Union (EU) mean on PISA (see Table C.6 in Appendix C). They also share a common, Latin-based cultural heritage, a similar legal framework, coming out of the Napoleonic Period when many of Western Europe's public institutions were first formulated, and a shared membership of the European Union.

However, France is not considered to be on the cutting edge of ICT policy. Consequently, two other countries were selected for their innovative approaches. Norway has a much smaller population than Italy, yet shares with Italy a European heritage. Korea is an Asian country, but it is closer than Norway to the size of Italy. Both countries are pioneers in the integration of ICT in education.

Table B.1. Comparison of Italy, France, Norway and Korea on various indicators

Indicator	Italy	France	Norway	Korea
Total country population (million), 2011 (WB)	60.8	65.4	5.0	49.8
GDP in current USD (billion), 2011 (WB)	2 194	2 773	485	1 116
GDP Per Capita in equivalent USD (using PPPs), 2011 (WB)	32 927	34 998	61 882	30 258
ICT Indicators				
Network readiness index rank 2012 (WEF)	48	23	7	12
Mobile subscriptions/100 2011 (ITU)	151	105	116	108
Internet users/100 2011 (ITU)	57	80	94	84
Fixed broadband subscribers/100 2011 (ITU)	23	36	36	37
Education Indicators				
Percent of schools with 5 or fewer students per computer (SITES 2006)	12%	19%	50%	m
Percent of 4th grade students in schools with 5 or fewer students per computer (TIMSS, PIRLS 2011)	54%	81%	84%	68%
Percent of 9th grade students in schools with 5 or fewer students per computer (TIMSS 2011)	59%	m	96%	32%
Annual expenditure per primary student in equivalent USD (using PPPs), 2009 (EAG)	8 669	6 373	11 833	6 658
Annual expenditure per secondary student in equivalent USD (using PPPs), 2009 (EAG)	9 112	10 696	13 883	9 399

Source: WB: World Bank *http://databank.worldbank.org/data/home.aspx*; WEF: World Economic Forum *www.weforum.org/issues/global-information-technology/the-great-transformation/network-readiness-index*; ITU: International Telecommunication Union, *www.itu.int/ITU-D/ict/statistics/explorer/index.html*; SITES 2006: Law *et al.*, 2008; TIMSS 2011: Martin *et al.*, 2012; PIRLS 2011: Mullis *et al.*, 2012; EAG: OECD, 2012

An analysis of the similarities and differences of policies across these countries can suggest strategies that Italy and other countries might adopt. Because the collection of new information was not possible, the analysis is limited to information available from existing public resources. The primary sources of information were ministry websites and two international collections of national policy case studies: The "International Experiences with Technology in Education" (Bakia *et al.*, 2011), a cross-national study of 22 countries, conducted for the US Department of Education by SRI International (for which the author of this appendix was a consultant) and the 2009 report on policies in 37 education systems, "Cross-National Information and Communication Technology: Policies and Practices in Educational" (Plomp *et al.*, 2009). Both reviews have case studies on the three countries addressed in this report. The case studies of France and Norway are also informed by country reports provided by European SchoolNet[1]. These case studies often rely on information available from the ministries and on the knowledge of local experts. They often lack data on current level of implementation, cost and impact. These limitations in turn limit the conclusions that can be drawn.

As with any qualitative study, the external validity of recommendations is limited by the small sample size. Consequently, findings from these three cases are reinforced by findings from the cross-case analyses of a larger number of cases in the studies above, as well as other qualitative and quantitative international policy studies.

France

According to a comprehensive report on France's ICT policies (Fourgous, 2010, summarised in Bakia *et al.*, 2011), France has lagged other European and Asian countries with respect to the use of ICT in education. But several ICT initiatives have been launched in the past several years, the rationale being to harness the potential that ICT has to transform French education and prepare students for the 21st century knowledge economy.

At the national level, ICT policy was administered until 2010 by a separate unit within the Ministry of Education, the Department of Information and Communication Technology in Education (SDTICE) created in 1997. The mission of SDTICE was to encourage teaching practices using ICT, support the procurement of school equipment, create networks, train teachers, facilitate the production of multimedia content, and support the ICT product and services industries. In 2010, the unit's missions were transferred to the curriculum, teacher training, and digital development unit under the Directorate General for School Instruction (DGESCO).

But much of the action in educational ICT is at the local level. As in Italy, primary schools in France are linked to the town council, which funds school buildings, equipment, and digital services. Secondary schools are linked to regional authorities. Both SDTICE and local authorities therefore provide schools with infrastructure and services, while the 26 *académies* (local education authorities) retain full responsibility for and control of learning contents and teacher ICT training. Each *académie* has an ICT advisory who contributes to local decision making. All schools have an administrative council that, together with the staff, parents, and students, reviews and adopts the "school working plan". The plan defines for the school the specific strategies the school will take to implement the national policy goals, including the use of ICT.

The main programmes launched by SDTICE are the following.

- The Infrastructure and Services Programme provided the educational community with the infrastructure and service necessary to support the development of IT practices.
- The Plan for Development of ICT in Rural Schools: under this scheme, 6 700 primary schools located in small communes (fewer than 2 000 inhabitants) received EUR 10 000 each for the acquisition of laptops, interactive whiteboards, and teaching software. Municipal governments in turn had to commit funds to connect the equipment securely to the web.
- The ICT Uses in Education programme developed ICT applications that meet the needs of all school subjects and encourages the production and sharing of educational resources.
- The Digital Textbook Programme, started in 2009, focuses on the development of interactive multimedia content in partnership with commercial textbook publishers. The state, which finances paper textbooks for lower secondary subjects, spent EUR 430 000 euros on 4-year rights to use the digital textbooks. More than 8 000 students in 65 lower secondary schools in 12 *académies* (out of the 26 in France) participated in the experiment.
- The ICT Training and Support initiative aimed to broaden and systematise ICT training to include trainers, teaching staff and support staff.

The national curriculum in France includes ICT skills in the Common Base of Knowledge and Skills (*socle commun*) that all children are expected to achieve through primary and lower secondary education.

Private-public partnerships, as in the Digital Textbook programme, are an important component of the French national policy. Since 1998, 225 digital resources have been developed with government assistance. In 2008, the average grant for the development of multimedia resources was EUR 75 000 euros. More than 750 products have been recognised by the Ministry as having education merit.

An annual national survey is conducted by the Ministry in primary and secondary schools to collect and organise information about ICT in schools and to analyze the evolving situation regarding ICT use, to compare ICT policies at different levels, and to inform decisions about ICT acquisitions and use. The 2010 survey found an average of one computer for every six students at the primary level and one for every three students at the secondary level. Nearly all schools have internet connections. Approximately ten percent have connection speeds greater than 10 Mbps.

Norway

Recent policy developments in Norway have embedded ICT in a larger context of education reform to help all pupils develop fundamental skills that enable them to actively participate in the knowledge society. Under the title "Knowledge Promotion", ICT competencies and ICT-based pedagogy and assessment are embedded in the curriculum at all levels and in all subjects, thus providing one of the unifying themes for the new reform.

At the national level, ICT is the purview Directorate for Education and Training within the Ministry of Education and Research. The Directorate is also responsible for national policy and for formulating the national curriculum. These central directives guide the efforts and initiatives of local education authorities. Related to ICT, the MOE recently established the semi-autonomous Norwegian Center for ICT in Education (IKT Senteret; *http://iktsenteret.no*), merging three small ICT-related agencies, to increase the visibility and importance of ICT and to conduct ICT-related research, create networks, and develop policy-related services.

Counties are responsible for overseeing the implementation of national policies, generally, and, more specifically, are primarily responsible for upper-secondary education. Municipalities are responsible for primary and lower-secondary education. These local authorities are responsible for implementation of national policies – including the curriculum – but now have significant decision making power related to learning goals, methods, teaching materials and evaluation. They can adapt the national curricula to local conditions and develop their own ICT implementation strategies. Local authorities are also responsible for teacher training.

The MOE provides funding which local authorities can use to purchase learning materials, including digital resources. Municipalities provide additional funding for these resources. The MOE relies mainly on the private sector to develop digital resources. However, the MOE supports development where the market is too small for private investment, such a vocational education, minority languages and students with special needs. Teachers also develop and share some learning resources.

There are three principal initiatives in Norwegian ICT policy.

- The primary one is the Knowledge Promotion revision of the national curriculum, which not only highlights ICT as one of five basic skills needed by students in the 21st century but as a consequence requires all teachers at all levels and all subject to incorporate ICT into their curricula, pedagogy and assessment.

- Another initiative is the collection of digital resources that are made available to teachers and students through online portals. At the upper-secondary level in particular, the National Digital Learning Arena (*http://ndla.no*) contains both commercially-developed and locally-developed materials that are shared as open educational resources with all teachers. The operating budget for the portal in 2011 was NOK 62 million (EUR 7.96 million).
- Lastly, Norway is developing digital exams and tests. Since 2009, a digital literacy assessment is used as part of Norway's biennial survey of ICT use. The assessment includes both basic ICT skills, as well as problem solving with ICT. Beyond their use to assess ICT skills, computer-based exams have also been developed for the final examination after year ten. Exams in Norwegian, English, and mathematics are optionally delivered in computer-based form.

Korea[2]

Currently, Korea is seen as a leader in education and ICT. Korea has had a highly centralised education system, with the Ministry controlling both the curriculum and the instructional materials used to implement it. However, over the past several years it has been moving toward a more-decentralised system, with local adaptation of curriculum, teachers and students having more control over personalised instruction at the upper secondary level, and diversified criteria for university admission. ICT is supporting this decentralisation.

The Korean Education and Research Information Service (KERIS), established in 1999, is the organisation of the Ministry of Education, Science, and Technology that is responsible for implementing ICT in education and practices that support policy. Specifically, they are charged with improving the technological infrastructure of schools, developing standards for digital learning resources, producing and distributing materials aligned with standards. They provide centralised service and support to help teachers integrate ICT into their pedagogy and support an online community for teachers (Edu-Café).

Korea's current ICT policy builds on fifteen years of work and two previous ICT plans. The first plan, in 1996, focused on supplying schools with hardware and software and on the development of the Edunet, a portal that allowed teachers to access digital resources. It also focused on enhancing teachers' use of ICT by providing computers to all primary and secondary teachers. The second plan, from 2004 to 2010, focused on access and participation of students and teachers, establishing virtual communities to support interesting and effective teaching and learning and to encourage student-centered activity. The current (2010-2014) plan aims to create a decentralised ecosystem of ICT-education to support a creative, productive workforce and support any-time, any-where lifelong learning.

Two national infrastructures play a significant role in the Korean ICT in education policy. Edunet (*www.edunet4u.net*) provides integrated services and digital resources that support teaching and learning, related to the school curriculum; the Edu-Café section of Edunet is the Ministry's online professional community for teachers. On the other hand, the National Education Information System (NEIS) is an integrated information management system that collects all administrative information on schools, staff, and students. All metropolitan and provincial Offices of Education, all local Offices of Education, and all schools in Korea are hooked into NEIS. Parents can access NEIS to monitor school activities, contact teachers, and issue certificates. The development of NEIS in the early 2000s represented a significant investment in hardware and software of KRW 94 billion (Korean Won; EUR 74 million). The system handles all administrative, teacher, and student records and provides access to appropriate information to administrators, teachers, parents, and students. These data are

analysed by KERIS in support of policy decisions. NEIS and Edunet both have annual operating budgets of about EUR 2 million.

The Cyber Home Learning System (CHLS) is a distance learning portal that supports learning at home. The online tutors, who are in-service teachers from around the country, respond rapidly to questions from students in grades 1–12. This e-learning portal, whose annual budget is about EUR 7 million, is intended to make widely available educational resources of the quality formerly available only to the elite, who would typically invest in private tutoring to supplement their children's education.

The Digital Textbook pilot project is the most significant initiative in the current ICT plan. It targets a rollout of interactive digital contents for all primary and secondary students in 2014, delivered in a one-to-one scheme on mobile devices. In the Korean approach, a digital textbook provides various digital resources and interactive functions, that include didactic text, reference works, dictionaries, interactive workbooks, video clips, animations, and virtual reality environments that can be accessed at school or at home, any time of day or night. The pilot project started in 2004 with the development of grade 5 social studies and science textbooks for the Web, CD-ROMs, and PDAs. Next digital textbooks were developed for grades 5 and 6 mathematics. These were field tested in schools in 2006-2007. In 2007, textbooks for music and art were developed in the "free style" method, in which the contents of existing texts were redesigned for the capabilities of the technology. Texts in the other subjects were essentially digitised versions of traditional texts but combined with various digital functions to enhance their effectiveness. In 2008, digital textbooks were developed in additional subjects. The plan is to go nationwide with the project in the 2014 school year.

Cross-National Patterns

There are many commonalities among the ICT policies and programmes in France, Norway and Korea, despite the significant differences between these countries. In terms of context, all three countries have a history of a centralised approach toward education policy and all three are moving toward a more-decentralised approach, much like Italy. In practice the three countries take a mixed approach, much like Italy, with the Ministry formulating policies and general guidelines for their implementation and various local authorities having a degree of responsibility and discretion in the actual implementation. This discretion usually includes the selection of equipment, the training of teachers and the modification of curricula to meet local needs. The implementation of policies is funded by the national government and sometimes supplemented by local contributions.

Each of the three countries has established a center or office that is primarily responsible for educational ICT: SDTICE in France, IKT Senteret in Norway, and KERIS in Korea. These centers are influential in formulating ICT policy. They often have centralised responsibilities, such as supporting the creation and distribution of digital content. But they are also responsible for providing support services for local ICT functions, such as the purchase of equipment or the training of teachers.

All of the countries have generated digital content and national portals for the distribution of content to schools, teachers, and students, and sometimes parents. The countries vary in how they go about generating this content. At one end of the spectrum, KERIS takes a very direct role in the development of content. At the other end is Norway that relies primarily on the private sector to generate content, although the Ministry provides funding for the local purchase of this content and they also develop content when the market is not sufficiently large to generate a response from the private sector, as in the case of software in minority languages or for students with special needs. France is in the middle, relying on the private sector but providing grants to companies for the development of digital content, in response to specific proposals. All of the countries encourage the

development and dissemination of teacher-generated content. In each of the countries, digital content is disseminated on national portals or digital collections. Sometimes these portals are variegated by grade level but in all cases the materials are organised by or searchable by grade level and subject.

Lessons Learned

There are four lessons that can be derived from the analysis of these case studies, supplemented by other writings. These can be used by the Ministry of Education, University and Research in Italy, and by ministries in other countries, to guide the development of ICT policy.

Lesson 1: Align strategic goals of ICT policies with implementation initiatives

Kozma (2008) identifies a variety of strategic goals that can drive nation ICT policies, including: support for economic growth and competition, the promotion of social development, advancement of education reform, and support for more efficient education management. Often policies cite two or more of these objectives. In the current analysis, all three of the countries reference the importance of education – and ICT, more specifically –in preparing students for profound social and economic changes. In France, this is framed in economic terms: preparing students for the 21st century knowledge economy. In Norway and Korea it is framed more in social terms: to enable students to participate in the knowledge society.

However, Kozma (2008) notes that the effectiveness of ICT policies is likely to depend on, among other things, the alignment between the stated strategic goals of policies and their operational components. Often in national policies there are disconnections between these two; it is difficult to see how the programmes and initiatives specified in the policies will lead to the desired goals. In the three cases in this paper, the connections are rather strong. In the case of France, the stated goal of preparing students for the 21st century knowledge economy is directly connected to the embedding of ICT competencies required of the knowledge economy in the national curriculum as transversal skills integrated across the curriculum. Similarly in Norway, ICT skills are among the five basic skills that all teachers, at all levels must incorporate into their curricula, pedagogy and assessment. And finally, in Korea, the goal of preparing students for participation in the knowledge society is connected to student-centered pedagogy that is being integrated into all subjects, pedagogy that includes group projects, collaboration, experiential learning, and real-world problems.

Lesson 2: ICT policies can create teacher demand rather than resistance

Tyack and Cuban (1995) observed a prevailing pattern throughout the history of modern education that policies which impose tightly-controlled change from the top down often induce resistance on the part of teachers and result in failure. This observation is particularly relevant to ICT, where the introduction of equipment into schools and classrooms has often not resulted in use by teachers. Tyack and Cuban recommend the development of policies and programmes that build on teacher knowledge and take advantage of teacher skills and inputs. Indeed, findings from the cross-national SITES 2006 study (Law *et al*., 2008) establish that the greatest predictor of ICT use in the classroom is teachers' is self-perceived pedagogical competence in using ICT. Tyack and Cuban argue that policies are likely to result in lasting change when teachers are enlisted in defining problems and devising solutions, adapted to their own varied circumstances and local knowledge. In situations where teachers see new programmes as interesting and useful, they are likely to adopt them and adapt them to their local circumstances. In such situations, new curriculum frameworks, teaching methods, technology, assessments, etc., are regarded not as mandates from outside or above but as resources that teachers can use, with help from each other and outsiders, to help students learn better.

In the present study, all three countries used a mixture of centralised leadership and local control. National policies were formulated and curricula revised by national ministries but it was left up to local agencies to implement these policies, modifying them to fit local conditions. In all three countries, ICT teacher competencies were specified and resources provided but training was not mandated. In each case, the ministry uses a "pull" rather than a "push" approach to teacher engagement in ICT training and use. That is, rather than "push" training at teachers through requirements and mandates, ministries in these countries have embedded ICT in the curriculum and, often, in the pedagogy. They rely on teachers' current skills and interests to implement these strategies. In Korea, teachers have extensive ICT skills, after 15 years of ICT programmes that have encouraged the use of ICT. Similarly in Norway, ICT training was a central part of earlier ICT policies. But for teachers who need and want training, they can "pull" it from training materials and resources provided by the Ministry.

All of the countries provide significant resources for teacher professional development. These training materials are often online, engaging teachers in the type of learning that is desired of their students. The availability of online training is common across the 22 countries in the SRI study (Bakia *et al.*, 2011). The materials included lesson plans, scenarios, and video examples of ICT use in the classroom. The online training covers the technical aspects of ICT use but also, and more importantly, the pedagogical aspects of integrating ICT into the curriculum. These resources are made available to teachers in a national portal specifically designed for teacher use. The portals also allow for teachers to contribute and share digital resources and lesson plans that they had developed.

In France, distance, self-training, and on-site training are used to help teachers, administrators, and supervisors become ICT literate. In-service teachers in France have 9 days per year allotted for all kinds of professional development. Teachers may choose to use some of that time for ICT training. Much of the ICT training for in-service teachers in France is online and based on Intel's Teach Online programme. It is a targeted model, guiding teachers in creating and experimenting with pedagogical scenarios and then sharing them with their peers.

There are several portals that make pedagogical scenarios and digital resources available to teachers in France. Educnet contains resources for all educational stakeholders and especially for teachers. Features include a searchable online library of subject-specific lesson plans involving ICT, a how-to video library for integrating ICT into one's pedagogy and links to additional information resources. The PrimTICE portal provides resources at the primary level. And EDUbases are resource banks for secondary education. The scenarios are written by teachers, for teachers and are reviewed by the inspectorate before publishing.

In Norway, although not required, the use of ICT is pervasive in both pre-service and in-service teacher training, in large part because the integrated use of ICT is a required part of the curriculum and all levels and with all subjects. The training of new teachers focuses on facilitating greater pedagogical integration of ICT. And all three of the national ICT portals offers activities to in-service teachers that help them acquire both technical and pedagogical ICT skills and help them develop and share online materials.

In Korea, KERIS provide teachers guidelines for ICT use, rather than standards. Teachers are expected to reach competency on these guidelines but they are not assessed. Through Edunet, teachers can access high-quality resources and professional development programmes; 180 hours of courses are available to teachers on ICT and pedagogy. Also KERIS provides in-service training and small scholarships to teachers who excel. In addition, Edu-Café provides teachers with different social spaces for different levels and different subjects in which they can chat and modify and share materials. Parents and teachers can also participate in the use of these environments.

Lesson 3: Curriculum reform can be used to align teachers' practices with ICT policies

ICT is driving profound transformations in society and the structure and practice of businesses (Kozma, 2011b). For example, a study by Autor, Levy, and Murnane (2003) of labor tasks in the workplace found that commencing in the 1970s, routine cognitive and manual tasks in the US economy declined, and non-routine analytic and interactive tasks rose. This finding was particularly pronounced for rapidly computerizing industries. The study found that as ICT is taken up by a business, computers substitute for workers who perform routine physical and cognitive tasks but they complement workers who perform non-routine problem-solving tasks. Because repetitive, predictable tasks are readily automated, computerisation of the workplace has raised demand for problem-solving and communications tasks such as responding to discrepancies, improving production processes and coordinating and managing the activities of others. The net effect is that companies in the USA and in other developed countries are hiring workers with a higher skill set (Lisbon Council, 2007; European Commission, 2010; OECD 2011b). In the twenty-first century economy and society, the memorisation of facts and implementation of simple procedures is less important; crucial is the ability to respond flexibly to complex problems, to communicate effectively, to manage information, to work in teams, to use technology, and to produce new knowledge – capabilities that have come to be called "twenty-first century skills" (Partnership for 21st Century Skills, 2005; International Society for Technology in Education [ISTE], 2007; European Commission, 2010).

At the same time, the pervasiveness of ICT has changed the way people access information and other people, as well as the way they use information and create new knowledge. People use the internet to find jobs, look for mates, stay in touch with relatives, do their shopping, book flights, run for office, solicit donations, share photos, post videos, and maintain blogs. Studies in North America, Europe, and Asia document that large numbers of people use the internet regularly and do so to conduct online purchases, use online chat or messaging and download music or movies, play games, exchange email, conduct banking transactions, and search for information. In the U.S., according to the Pew Internet and American Life Project, more than half of all Americans turn to the internet to find answers to common problems about health, taxes, job training, government services (Fallows, 2008). And more and more Americans, particularly young people, are using the internet to access multimedia material and to create digital content (Rainie, 2008; Lenhart *et al.*, 2007). In the United Kingdom, 49% of the children between the ages of 8-17 who use computers have an online profile; 59% use social networks to make new friends (Ofcom, 2008). As a consequence, students come into classrooms with new ICT skills but in many education systems, they are not drawn on in the formal curriculum nor are students able to use these skills to collaboratively solve complex, real world problems.

However in the present study, all three countries are using ICT throughout the education system. In France and Norway, ICT is integrated throughout the curriculum. That is, ICT is not taught as a separate subject, as in past years, but across subjects as a set of transversal skills. Mastering ICT skills is one of seven curricular "pillars" in the French national curriculum, along with mastering the French language, acquiring basic knowledge in mathematics and science, and developing autonomy and initiative. Specified ICT skills include:

- Knowing how to use a ICT based environment
- Awareness of the legal and social constraints entailed in judicious use of technologies
- Data processing
- Searching the web efficiently
- Communicating using technologies

The competencies are intended not only to enable students to effectively use technology but to use ICT to facilitate higher-order thinking and problem solving. Within this curricular framework, teachers are relatively free to choose their own pedagogical approach.

As mentioned earlier, a major component of the Norwegian ICT policy is the integration of ICT into their curriculum reform, known as Knowledge Promotion. Digital competencies are now one of five sets of basic skills in the national curriculum, the others being: the abilities to read and write, perform mathematical operations, and express oneself orally. Included among the digital literacy skills are the abilities to use general tools, such as word processors, spreadsheets, presentation software, and the internet. In addition, competency is required of subject-specific ICT tools in arts and crafts, music, and science. For example, the curriculum calls for fifth-grade students to plan and build models of houses and rooms using digital tools and simple craft technique. Students must also apply critical assessment in the use of information sources, exercising digital judgment. The principal feature of the Norwegian approach is that ICT must be included in every subject at every level of education. Consequently, ICT is becoming part of the everyday pedagogy and assessment in schools.

In Korea, the emphasis is less on embedding ICT into the curriculum, in a formal sense. Rather KERIS is working towards embedding the entire curriculum in ICT so that education will become more student-centered and students will have access to digital learning at any time of day in any place. In this way, Korea is using ICT to fundamentally change the pedagogy, as well as the curriculum. The explicit intent of the Ministry is to move toward a more student-centered pedagogy throughout the system, with more individualised instruction, group projects, collaboration, experiential learning, and real-world problems. In Norway, too, the goal is that pedagogy will change as a result of integrating ICT throughout the curriculum.

In all three of the countries, ICT is beginning to be used in student assessment, either as a way of assessing ICT skills, as in Norway, or in the assessment of school subjects.

Lesson 4: Strive for phased, systemic change

Investment in ICT equipment and networking was a central component of ICT policies in all of the countries in this study. But given research findings to date (OECD, 2010, 2011a), there is a risk that investment in ICT could lead to no significant improvement in student learning. Indeed, if research in the private sector (Bynjolfsson and Saunders, 2010) is an indication, the mere introduction of computers into the classroom will not have a major impact on education. Most likely, the transformative potential of ICT will be realised only if it is part of an interconnected set of complementary changes in organisational structure and school practices, a process which is likely to take years.

All of the countries in this study included not only the provision of ICT equipment and networking in their policy but, over time, used ICT as a lever to bring about changes in curriculum, pedagogy, and assessment. This corresponds to trends found in larger multi-national comparisons (Ottestad and Quale, 2008). Korea and Norway, the two countries in the present study that are most advanced in their ICT plans, built their policies on extensive previous experience with ICT policies and programmes. It was only after 15 years and two previous ICT policies that Korea felt it was in a position to expect pervasive use of ICT to make fundamental changes in classroom pedagogy. Each of these countries began by providing equipment to schools and training teachers in its use. In Korea's first ICT plan, which began in 1996, all primary and secondary teachers were provided with a computer. Equipment was the foundation upon which these countries could increase the provision of additional equipment and more sophisticated, comprehensive approaches to their use through curricular and pedagogical innovation. The goal of Korea's second plan, in 2004, was to support

improve teaching and learning, encourage student-centered activity, and create a community for learning. The current plan, launched in 2010, aims to support any-time, any-where lifelong learning. But it is important to note that of the three countries, only Korea is implementing a one-to-one model for ICT-based instruction. This is based, in part, on the pervasiveness of ICT throughout Korean society and high speed internet access in a large majority of Korean homes.

Korea stands out among the three countries both in the comprehensiveness of their ICT policy and the role they see for ICT in transforming their educational system. The high priority given to ICT policy and programmes is driven by its direct link to the nation's social and economic goals. In creating an educational system in which students can learn online anywhere at any time, Korea wants its graduates to be able to respond quickly to changes in the dynamic knowledge economy. This aspiration is, perhaps, best symbolised by the fact that every citizen in Korea has a right to online education, a right enshrined in the Constitution. This overarching priority serves to motivate and organise the ICT efforts in Korea's Ministry and in its schools.

Concluding Remarks

Italy is in a demanding period in its history. Faced with new challenges to be competitive in the European and world knowledge economy, the development of a high-quality, world-class education system has never been more important. At the same time, Italy is highly constrained in its financial resources.

The three countries in this study illustrate the benefits of a phased approach to the integration of ICT in education In the long run, policies and programmes that create demand, or "pull" from teachers rather than their resistance will be far more efficient and cost effective– and transformative – than policies and programmes that "push" ICT on teachers. A phased approach of 8 to 10 years seems necessary to build a significant experiential base among teachers and develop their skills, and to give local authorities and publishers time to develop programmes and high-quality resources that increase the likelihood of success. At the same time, the specification of key milestones over the period would keep the implementation on track. The mass introduction of ICT equipment without curricular, pedagogical and, ultimately, assessment changes that restructure the work of teaching, merely loads ICT on top of what is currently the teachers' "real" work and creates resistance. As one teacher in field interviews put it, "Start with changing the teaching, *then* the equipment that is needed."

NOTES

[1] *http://insight.eun.org/ww/en/pub/insight/misc/country_report.cfm.*

[2] In addition to the two reviews mentioned earlier, this case draws on information from the Korean Education and Research Information Service (KERIS) website: *http://english.keris.or.kr/.*

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ANNEX C. COMPARATIVE INDICATORS OF ICT USE IN ITALIAN SCHOOLS

Table C.1. Comparative indicators on country ICT infrastructure

	source	year	Italy	Denmark	Finland	France	Germany	Japan	Korea	Norway	Singa-pore	Spain	Switzer-land	United Kingdom	United States	OECD average	EU27 average
Broadband coverage - Percentage of population living in areas served by either DSL or cable modem networks.	(1)	2010	96.0	100.0	95.7	100.0	98.0	m	m	m	m	99.0	m	100.0	m	m	95.3
Broadband penetration -Number of fixed broadband subscriptions (lines) per 100 people. Situation at end of year.	(2)	2011	22.4	37.9	29.6	35.9	33.3	27.4	35.4	35.7	m	24.5	39.9	33.3	27.7	25.6	26.6
Broadband take-up - Percentage of households having a broadband connection	(2)	2011	48.9	80.1	75.8	66.8	75.2	63.4	97.5	82.6	m	57.4	70.8	69.5	68.2	62.9	61.4
Home computer access - Percentage of households with access to a home computer	(2)	2011	64.8	88.0	82.0	76.4	85.7	83.4	81.8	90.9	m	68.7	81.4	82.6	77.0	73.9	74.4
Internet access - Percentage of households with access to the Internet at home	(1)	2011	61.6	90.1	84.2	75.9	83.3	m	m	92.2	m	63.9	m	82.7	m	m	73.2

Source: (1): EU digital scoreboard; (2): OECD broadband statistics. *Note:* OECD and EU27 averages are computed on all countries with data available: countries included in these averages can therefore vary depending on the data-source.

Table C.2. Comparative indicators on school ICT infrastructure

	source	year	Italy	Denmark	Finland	France	Germany	Japan	Korea	Norway	Singapore	Spain	Switzer-land	United Kingdom	United States	OECD average	EU27 average
			mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se
Computers/Student ratio for 9th graders (or modal grade for 15-year old students): number of school computers used for educational purposes per 100 students	(3)	2009	42.8 (1.0)	83.0 (4.0)	43.9 (2.0)	m	50.4 (2.0)	46.0 (2.5)	42.5 (2.4)	m	62.5 (0.4)	58.1 (1.7)	55.8 (2.0)	88.6 (3.2)	72.8 (4.1)	55.8 (0.4)	54.1 (0.5)
Percent of 4th grade students in schools with less than three students per computer	(9)	2011	20 (3.0)	87 (2.2)	55 (4.3)	34 (4.2)	21 (2.5)	48 (3.3)	22 (3.5)	58 (5.1)	51 0.0	50 (3.2)	m	89 (3.0)	67 (2.9)	46 (0.7)	40 (0.7)
Percent of 8th grade students in schools with less than three students per computer	(5)	2011	16 (2.8)	m	47 (3.8)	m	m	31 (2.4)	6 (2.3)	73 (4.2)	68 0.0	m	m	99 (0.9)	58 (2.1)	52 (0.8)	58 (1.3)
Internet penetration (schools) - Percentage of computers connected to the Internet/World Wide Web among school computers available to 9th graders (or modal grade for 15-year old students)	(3)	2009	86.5 (1.1)	99.7 (0.1)	98.9 (0.4)	m	96.4 (1.0)	92.3 (1.6)	98.5 (0.6)	m	97.8 (0.1)	95.8 (1.0)	95.1 (1.5)	92.7 (1.8)	99.2 (0.3)	92.5 (0.2)	95.1 (0.2)
Computer access at school - Percentage of 15-year-old students attending schools where desktop or laptop computers are available - student reporting	(4)	2009	84.1 (0.6)	99.4 (0.1)	96.7 (0.4)	m	95.2 (0.6)	88.7 (0.8)	90.0 (0.6)	m	97.3 (0.2)	89.7 (0.6)	93.8 (0.6)	m	m	93.2 (0.1)	93.4 (0.1)
Laptop access at school - Percentage of 15-year-old students attending schools where portable laptops or notebooks are available - student reporting	(4)	2009	15.3 (0.4)	86.2 (1.4)	27.3 (2.1)	m	35.4 (1.8)	31.4 (1.3)	44.1 (1.9)	m	45.8 (0.6)	23.9 (1.2)	45.4 (1.8)	m	m	34.5 (0.3)	30.6 (0.3)
Internet access at school - Percentage of 15-year-old students attending schools where an internet connection is available - student reporting	(4)	2009	72.5 (0.7)	99.1 (0.2)	97.0 (0.4)	m	94.4 (0.6)	83.8 (0.9)	91.4 (0.6)	m	96.5 (0.3)	90.2 (0.6)	94.2 (0.7)	m	m	92.6 (0.1)	93.3 (0.1)

Source: (3,4): OECD PISA 2009 Database; (3): school questionnaire; (4): student ICT familiarity questionnaire. (5) IEA TIMSS 2011 Database. (9) IEA PIRLS 2011 Database (TIMSS data from the same year are used where PIRLS data are not available). *Note:* TIMSS and PIRLS data for the United Kingdom refer to England only. OECD and EU27 averages are computed on all countries with data available: countries included in these averages can therefore vary depending on the data-source.

Table C.3. Comparative indicators on computer use in schools

	source	year	Italy	Denmark	Finland	France	Germany	Japan	Korea	Norway	Singapore	Spain	Switzer-land	United Kingdom	United States	OECD average	EU27 average
			mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se
Computer use in school (4th grade) - Percentage of fourth grade students using computers in school	(5)	2007	42.4 (1.4)	77.9 (1.3)	m	m	33.2 (1.6)	72.8 (1.3)	m	62.5 (1.8)	74.8 (1.0)	m	m	85.1 (0.9)	67.6 (0.9)	59.4 (0.3)	46.9 (0.4)
Computer use in school (8th grade) - Percentage of eighth grade students using computers in school	(5)	2007	55.8 (1.9)	m	m	m	m	74.7 (1.4)	32.0 (1.5)	68.6 (1.2)	72.0 (0.9)	70.5 (2.1)	m	79.1 (1.0)	74.8 (0.9)	67.5 (0.3)	64.8 (0.4)
Computer use in school (15-y-olds) - Percentage of 15-year-old students using school desktop computers - student reporting	(4)	2009	63.9 (0.8)	93.1 (0.5)	87.5 (0.8)	m	64.8 (1.5)	59.3 (2.3)	62.8 (1.6)	m	62.7 (0.6)	65.5 (1.0)	75.8 (1.2)	m	m	71.5 (0.2)	70.4 (0.3)
Laptop use in school (15-y-olds) - Percentage of 15-year-old students using school laptops or notebooks - student reporting	(4)	2009	5.3 (0.3)	72.7 (2.0)	17.1 (1.8)	m	14.2 (1.2)	12.0 (1.2)	19.9 (1.3)	m	17.0 (0.4)	10.1 (0.9)	28.1 (1.7)	m	m	18.4 (0.2)	14.7 (0.3)
Internet use in school (15-y-olds) - Percentage of 15-year-old students using school internet connections - student reporting	(4)	2009	45.6 (0.9)	96.0 (0.3)	88.2 (0.8)	m	63.4 (1.4)	47.2 (1.9)	65.4 (1.5)	m	61.8 (0.6)	65.1 (1.0)	75.8 (1.3)	m	m	70.8 (0.2)	70.4 (0.3)
Computer use in class (4th grade, reading) - Percentage of fourth-grade students who have computer(s) available to use during their reading lessons	(9)	2011	24 (2.9)	87 (2.0)	64 (3.1)	11 (2.0)	73 (2.8)	m	m	88 (2.5)	64 (2.8)	20 (2.9)	m	47 (4.0)	74 (2.2)	49 (0.6)	45 (0.7)
Computer use in class (4th grade, maths) - Percentage of fourth-grade students who have computer(s) available to use during their mathematics lessons	(5)	2011	25 (2.9)	70 (3.4)	59 (3.1)	m	58 (3.1)	58 (3.5)	31 (3.7)	77 (3.6)	65 (2.6)	36 (3.6)	m	71 (4.2)	63 (2.2)	53 (0.7)	50 (0.8)
Computer use in class (4th grade, science) - Percentage of fourth-grade students who have computer(s) available to use during their science lessons	(5)	2011	31 (3.2)	81 (2.6)	66 (3.1)	m	61 (3.5)	74 (3.7)	35 (3.6)	72 (3.9)	62 (2.5)	40 (3.8)	m	74 (4.3)	65 (2.6)	58 (0.7)	56 (0.8)
Computer use in class (8th grade, maths) - Percentage of eighth-grade students who have computer(s) available to use during their mathematics lessons	(5)	2011	31 (3.9)	m	43 (3.8)	m	m	58 (4.2)	56 (3.1)	76 (3.5)	56 (2.4)	m	m	51 (4.3)	44 (2.5)	45 (0.9)	40 (1.4)
Computer use in class (8th grade, science) - Percentage of eighth-grade students who have computer(s) available to use during their science lessons	(5)	2011	36 (3.2)	m	59 (2.5)	m	m	50 (4.3)	68 (3.5)	77 (3.6)	56 (2.5)	m	m	63 (3.3)	67 (2.7)	57 (0.9)	53 (1.0)
Computer use in class (15-y-olds, language of instruction) - Percentage of 15-year old students using computers during language of instruction classes, 2009	(4)	2009	11.5 (0.5)	77.0 (1.2)	32.8 (1.9)	m	16.9 (1.0)	1.0 (0.2)	27.4 (1.7)	m	24.7 (0.6)	11.7 (0.9)	32.9 (1.0)	m	m	26.1 (0.2)	21.6 (0.2)
Computer use in class (15-y-olds, maths) - Percentage of 15-year old students using computers during mathematics classes, 2009	(4)	2009	27.4 (1.0)	39.9 (1.3)	18.2 (1.4)	m	13.9 (0.9)	1.4 (0.3)	8.3 (0.9)	m	18.1 (0.6)	10.4 (1.1)	16.4 (0.8)	m	m	15.9 (0.2)	14.5 (0.2)
Computer use in class (15-y-olds, science) - Percentage of 15-year old students using computers during science classes, 2009	(4)	2009	12.8 (0.5)	50.7 (1.5)	29.6 (1.6)	m	24.6 (1.3)	1.6 (0.5)	30.8 (1.9)	m	16.7 (0.6)	15.8 (0.9)	30.1 (1.2)	m	m	24.3 (0.2)	22.1 (0.3)
Computer use in class (15-y-olds, foreign language) - Percentage of 15-year old students using computers during foreign language classes, 2009	(4)	2009	25.3 (0.9)	60.9 (1.4)	41.2 (2.0)	m	17.9 (1.0)	4.2 (1.0)	41.3 (1.8)	m	11.1 (0.5)	18.5 (1.2)	32.3 (1.2)	m	m	25.8 (0.2)	25.2 (0.3)
Computer use in class for search (4th grade, reading) - Percentage of students in the fourth-grade using a computer in their reading class for looking up ideas and information at least monthly, as reported by their teacher	(9)	2011	14 (2.4)	76 (2.6)	59 (3.6)	10 (1.7)	54 (3.2)	m	m	79 (3.2)	58 (2.7)	17 (2.8)	m	43 (4.2)	61 (2.4)	43 (0.6)	39 (0.7)

	source	year	Italy	Denmark	Finland	France	Germany	Japan	Korea	Norway	Singapore	Spain	Switzer-land	United Kingdom	United States	OECD average	EU27 average
			mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se
Computer use in class for search (8th grade, science) - Percentage of students in the eighth-grade using a computer in their science class for looking up ideas and information at least monthly, as reported by their teacher	(5)	2011	30 (3.0)	m	49 (2.7)	m	m	15 (3.1)	52 (3.4)	72 (3.9)	42 (2.5)	m	m	57 (3.1)	59 (2.7)	48 (0.9)	47 (1.0)
Computer use in class for reading practice (4th grade) - Percentage of students in the fourth-grade using a computer in their reading class for reading at least monthly, as reported by their teacher	(9)	2011	15 (2.5)	65 (2.7)	41 (3.3)	5 (1.2)	42 (3.3)	m	m	54 (4.9)	51 (2.8)	12 (2.4)	m	34 (4.5)	53 (2.3)	35 (0.7)	32 (0.7)
Computer use in class for mathematics practice (8th grade) - Percentage of students in the eighth-grade using a computer in their mathematics class for practiciing skills and procedures at least monthly, as reported by their teacher	(5)	2011	23 (3.4)	m	27 (3.4)	m	m	1 (0.8)	28 (3.0)	53 (4.3)	34 (2.4)	m	m	38 (4.1)	27 (2.4)	28 (0.8)	27 (1.2)
Computer use in class for analysing data (8th grade, maths) - Percentage of students in the eighth-grade using a computer in their mathematics class for processing and analysing data at least monthly, as reported by their teacher	(5)	2011	20 (3.1)	m	14 (3.0)	m	m	6 (1.9)	25 (3.0)	58 (3.8)	24 (2.2)	m	m	24 (4.0)	21 (2.4)	23 (0.8)	19 (1.1)
Computer use in class for simulating phenomena (8th grade, science) - Percentage of students in the eighth-grade using a computer in their science class for studying natural phenomena through simulations at least monthly, as reported by their teacher	(5)	2011	14 (2.4)	m	20 (2.3)	m	m	13 (2.8)	49 (3.7)	42 (4.4)	31 (2.7)	m	m	37 (2.9)	44 (2.4)	31 (0.8)	27 (0.9)
Computer use in school for practice (15-y-olds) - Percentage of 15-year old students using computers at school to do practice and drilling	(4)	2009	51.6 (0.7)	43.6 (1.0)	58.0 (1.7)	m	26.5 (1.0)	3.9 (0.4)	15.4 (0.8)	m	30.5 (0.7)	53.7 (1.0)	50.3 (1.2)	m	m	35.4 (0.2)	37.5 (0.2)
Computer use in school for search (15-y-olds) - Percentage of 15-year old students using computers at school to browse the Internet for schoolwork	(4)	2009	84.1 (0.6)	99.4 (0.1)	96.7 (0.4)	m	95.2 (0.6)	88.7 (0.8)	90.0 (0.6)	m	97.3 (0.2)	89.7 (0.6)	93.8 (0.6)	m	m	93.2 (0.1)	93.4 (0.1)
Computer use for homework (15-y-olds) - Percentage of 15-year old students using computers at home for doing homework on the computer	(4)	2009	68.3 (0.5)	96.1 (0.4)	59.8 (1.0)	m	78.5 (0.7)	18.9 (1.0)	92.2 (0.7)	m	87.6 (0.5)	70.2 (0.6)	79.2 (0.8)	m	m	80.2 (0.1)	79.5 (0.2)

Source: (4) OECD PISA 2009 Database, student ICT familiarity questionnaire. (5) IEA TIMSS 2011 Database. (9) IEA PIRLS 2011 Database. *Note:* TIMSS and PIRLS data for the United Kingdom refer to England only. OECD and EU27 averages are computed on all countries with data available: countries included in these averages can therefore vary depending on the data-source.

Table C.4. Comparative indicators on teachers' ICT skills and professional development

	source	year	Italy	Denmark	Finland	France	Germany	Japan	Korea	Norway	Singapore	Spain	Switzer-land	United Kingdom	United States	OECD average	EU27 average
			mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se
Old teachers (primary) - Percentage of primary teachers above 50 years old	(6)	2010	45.0	37.1	28.6	22.3	47.8	28.4	16.0	35.1	m	31.1	34.5	19.4	32.4	29.9	30.0
Old teachers (lower secondary) - Percentage of lower secondary teachers above 50 years old	(6)	2010	59.8	37.1	29.8	29.7	51.8	22.0	16.8	35.1	m	29.0	35.5	25.0	31.7	33.2	34.3
Old teachers (upper secondary) - Percentage of upper secondary teachers above 50 years old	(6)	2010	58.9	m	42.6	34.9	47.1	31.0	21.7	48.6	m	29.7	37.0	28.9	35.5	36.8	37.4
Young teachers (primary) - Percentage of primary teachers below 30 years old	(6)	2010	0.5	8.6	10.0	13.0	7.4	13.1	22.5	12.2	m	14.0	17.3	31.7	18.1	14.0	13.1
Young teachers (lower secondary) - Percentage of lower secondary teachers below 30 years old	(6)	2010	0.5	8.6	11.2	10.8	4.8	10.8	14.8	12.2	m	6.2	12.3	22.7	18.4	11.6	10.8
Young teachers (upper secondary) - Percentage of upper secondary teachers below 30 years old	(6)	2010	0.4	m	5.1	5.6	3.1	8.0	13.1	4.9	m	5.9	6.9	19.1	15.6	9.4	8.7
ICT for teaching PD (4th grade, maths) - Percentage of students in the fourth grade whose teachers report having participated in professional development on integrating ICT in mathematics teaching in the past two years, 2007	(5)	2007	33 (3.2)	21 (3.0)	m	m	7 (1.5)	19 (2.8)	m	12 (2.8)	51 (2.9)	m	m	44 (4.1)	39 (2.6)	24 (0.7)	26 (0.8)
ICT for teaching PD (4th grade, science) - Percentage of students in the fourth grade whose teachers report having participated in professional development on integrating ICT in science teaching in the past two years, 2007	(5)	2007	23 (3.3)	6 (2.0)	m	m	45 (4.2)	53 (4.3)	m	19 (4.6)	45 (3.6)	m	m	16 (3.2)	7 (2.9)	22 (0.6)	23 (0.8)
ICT for teaching PD (8th grade, maths) - Percentage of students in the eighth grades whose teachers report having participated in professional development on integrating ICT in mathematics teaching in the past two years, 2007	(5)	2007	43 (3.1)	m	m	m	m	27 (3.3)	31 (3.2)	35 (3.7)	74 (2.0)	32 (4.5)	m	62 (4.2)	61 (3.0)	40 (0.8)	52 (1.0)
ICT for teaching PD (8th grade, science) - Percentage of students in the eighth grades whose teachers report having participated in professional development on integrating ICT in science teaching in the past two years, 2007	(5)	2007	25 (2.9)	m	m	m	m	31 (3.5)	29 (3.4)	15 (2.7)	70 (2.2)	41 (5.0)	m	44 (3.0)	70 (3.1)	40 (0.8)	48 (0.7)
Development needs: ICT for teaching (ISCED 2) - Percentage of teachers reporting a high need for professional development in ICT skills for teaching	(7)	2008	25.8 (0.8)	20.1 (1.7)	m	m	m	m	17.7 (0.7)	28.1 (1.2)	m	26.2 (1.1)	m	m	m	22.3 (0.2)	24.5 (0.3)
Development needs: special needs (ISCED 2) - Percentage of teachers reporting a high need for professional development in teaching students with special learning needs	(7)	2008	35.3 (1.0)	24.6 (1.4)	m	m	m	m	25.6 (0.9)	29.2 (1.0)	m	35.8 (1.0)	m	m	m	30.4 (0.3)	31.4 (0.3)
Development needs: subject content knowledge (ISCED 2) - Percentage of teachers reporting a high need for professional development in knowledge and understanding of my main subject field(s)	(7)	2008	34.0 (0.7)	4.6 (0.5)	m	m	m	m	38.3 (1.0)	8.6 (0.7)	m	5.0 (0.5)	m	m	m	13.7 (0.2)	15.7 (0.2)

Source: (5) IEA TIMSS 2007 Database. (6) OECD (2012), Education at a Glance. (7) OECD, TALIS 2008 Database. *Note:* TIMSS data for the United Kingdom refer to England only; TIMSS data for Spain refer to the Basque country only. OECD and EU27 averages are computed on all countries with data available: countries included in these averages can therefore vary depending on the data-source.

Table C.5. Comparative indicators on digital skills and ICT familiarity

	source	year	Italy	Denmark	Finland	France	Germany	Japan	Korea	Norway	Singapore	Spain	Switzer-land	United Kingdom	United States	OECD average	EU27 average
			mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se
Internet use (adults, regular) - Percentage of population who are regular internet users (at least once a week)	(1)	2011	50.7	87.5	85.6	74.3	76.5	m	m	91.1	m	61.8	m	80.8	m	m	67.5
Internet use (adults, never) - Percentage of population who have never used the internet	(1)	2011	38.6	7.2	8.9	17.8	15.8	m	m	4.6	m	29.2	m	11.2	m	m	24.3
Internet use (adults, banking) - Percentage of population using online banking	(1)	2011	19.7	75.0	79.2	50.9	45.3	m	m	85.1	m	28.2	m	45.5	m	m	36.5
Internet use (adults, e-gov) - Percentage of population interacting online with public authorities, last 3 months	(8)	2010	17	72	58	37	37	m	60	68	m	32	m	40	m	42	40
Internet use (adults, e-gov) - of population sending filled forms to public authorities, over the internet, last 3 months	(1)	2010	17.4	72.0	58.0	35.6	37.1	m	m	68.3	m	32.3	m	40.2	m	m	31.5
Internet use (15-y-olds, entertainment) - Percentage of 15 year old students who use computers at home to browse the internet for fun	(4)	2009	89.1 (0.3)	98.0 (0.2)	98.2 (0.2)	m	95.1 (0.4)	82.4 (0.7)	93.4 (0.4)	m	97.1 (0.2)	91.5 (0.3)	96.5 (0.2)	m	m	92.3 (0.1)	93.0 (0.1)
Internet use (15-y-olds, blog) - Percentage of 15 year old students who use computers at home to publish and maintain a personal website, weblog or blog	(4)	2009	55.3 (0.4)	40.8 (0.9)	25.6 (0.6)	m	33.9 (0.9)	25.5 (0.7)	58.6 (0.9)	m	56.7 (0.7)	55.5 (0.7)	47.4 (0.9)	m	m	43.7 (0.2)	45.5 (0.2)
Computer skills (15-y-olds) - Percentage of 15 year old students who can very well use a spreadsheet by themselves to plot a graph (self-assessment)	(4)	2009	50.3 (0.5)	53.4 (1.1)	31.3 (0.8)	m	57.4 (1.0)	30.6 (0.9)	34.2 (1.0)	m	28.4 (0.6)	58.1 (0.7)	52.5 (1.0)	m	m	52.0 (0.2)	56.2 (0.2)

Source: (1): EU digital scoreboard; (4): OECD PISA 2009 Database, student ICT familiarity questionnaire. (8): OECD (2011), Government at a Glance. *Note:* OECD and EU27 averages are computed on all countries with data available: countries included in these averages can therefore vary depending on the data-source.

Table C.6. Average performance in international assessments of learning outcomes

	year	Italy	Denmark	Finland	France	Germany	Japan	Korea	Norway	Singapore	Spain	Switzerland	United Kingdom	United States	OECD average	EU27 average
		mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se	mean se
PISA reading score	2009	486 (1.6)	495 (2.1)	536 (2.3)	496 (3.4)	497 (2.7)	520 (3.5)	539 (3.5)	503 (2.6)	526 (1.1)	481 (2.0)	501 (2.4)	494 (2.3)	500 (3.7)	493 (0.5)	486 (0.6)
PISA mathematics score	2009	483 (1.9)	503 (2.6)	541 (2.2)	497 (3.1)	513 (2.9)	529 (3.3)	546 (4.0)	498 (2.4)	562 (1.4)	483 (2.1)	534 (3.3)	492 (2.4)	487 (3.6)	496 (0.5)	491 (0.6)
PISA science score	2009	489 (1.8)	499 (2.5)	554 (2.3)	498 (3.6)	520 (2.8)	539 (3.4)	538 (3.4)	500 (2.6)	542 (1.4)	488 (2.1)	517 (2.8)	514 (2.5)	502 (3.6)	501 (0.5)	497 (0.6)
TIMSS 4th grade science	2007	535 (3.2)	517 (2.9)	m	m	528 (2.4)	548 (2.1)	m	477 (3.5)	587 (4.1)	m	m	542 (2.9)	539 (2.7)	523 (0.7)	525 (0.8)
TIMSS 4th grade maths	2007	507 (3.1)	523 (2.4)	m	m	525 (2.3)	568 (2.1)	m	473 (2.5)	599 (3.7)	m	m	541 (2.9)	529 (2.4)	512 (0.6)	514 (0.7)
TIMSS 8th grade science	2007	495 (2.8)	m	m	m	m	554 (1.9)	553 (2.0)	487 (2.2)	567 (4.4)	498 (3.0)	m	542 (4.5)	520 (2.9)	514 (0.7)	500 (0.9)
TIMSS 8th grade maths	2007	480 (3.0)	m	m	m	m	570 (2.4)	597 (2.7)	469 (2.0)	593 (3.8)	499 (3.0)	m	513 (4.8)	508 (2.8)	503 (0.8)	490 (0.9)
PIRLS 4th grade reading	2006	551 (2.9)	546 (2.3)	m	522 (2.1)	548 (2.2)	m	m	498 (2.6)	558 (2.9)	513 (2.5)	m	539 (2.6)	540 (3.5)	535 (0.5)	534 (0.6)

Source: OECD PISA Database, IEA TIMSS and PIRLS 2011 Database. *Note:* TIMSS data for the United Kingdom refer to England only; TIMSS data for Spain refer to the Basque country only. OECD and EU27 averages are computed on all countries with data available: countries included in these averages can therefore vary depending on the data-source.

ANNEX D. VISIT PROGRAMME (5-7 NOVEMBER 2012)

Monday, 5 November 2012 (Rome)

- **9am**: Visit to the School "Convitto Nazionale Vittorio Emanuele II", Rome. Meetings with the leadership team (Emilio Fatovic, Eleonora Sanna, Giovanna Angelosante, Tommaso Villani, Antonio Capizzoto), a group of teachers, and a group of students.

- **12pm**: Meeting with the Regional School Office Lazio (USR Lazio): Angelo Lacovara, Claudio Proia.

- **2.30pm**: Seminar with University researchers and ministry consultants: Vittorio Campione, Francesco Antinucci, Sebastiano Bagnara, Daniele Barca, Rosa Bottino, Giusy Cannella, Donatella D'Amico, Rino Falcone, Paolo Maria Ferri, Roberto Maragliano, Elena Mosa, Aurelio Simone, Leonardo Tosi.

- **4pm**: Meeting with Teacher and Head Teacher professional associations: ADI (Alessandra Cenerini), ANDIS (Domenico Ciccone, Alessandra Silvestri), APEF (Paola Tonna), DIESSE (Daniela Notarbartolo), DISAL (Filomena Zamboli), FNISM (Gigliola Corduas), MCE (Domenico Russo), UCIIM (Giovanni Villarossa, Rosalba Fiducia), PROTEO fare sapere (Isabella Filippi, Gennaro Lopez), AIMC (Giuseppe Desideri, Elenora Mosti).

- **5pm**: Meeting with Publishers' and IT industries' organisations: AIE (Giorgio Palumbo, Gianni Cicognani, Massimilaiano Galioni, P. Attanasio) and Confindustria Digitale (Roberto Bedani, Roberto Triola, Franco Patini).

- **6pm**: Meeting with associations of provinces and communes: UPI (Gaetano Palombelli and Nicola Melideo) and ANCI (Simone Guerra).

Tuesday, 6 November 2012 (Rome)

- **9am**: Visit to the School "Istituto Comprensivo Via Luchino dal Verme", Rome. Meetings with the leadership team (Noemi Fiorini), a group of teachers, and parents' representatives.

- **12pm**: Ministry of Education, Heads of the Education Department and of the Programming Department (Dipartimento per la Programmazione: Giovanni Biondi, Dipartimento per l'Istruzione: Lucrezia Stellacci).

- **12.30pm**: Ministry of Education, innovation advisors to the Minister of Education: Donatella Solda-Kutzmann, Damien Lanfrey, Lorenzo Benussi.

- **2.30pm**: Ministry of Education, curriculum, teachers, and information systems: Carmela Palumbo (Direttore Generale per gli Ordinamenti), Luciano Chiappetta (Direttore Generale per il Personale scolastico), Emanuele Fidora (Direttore Generale per i Sistemi informativi).

- **3pm**: Meeting with the national forum of parents' associations: A.Ge. Associazione Genitori Italiani (Gianni Nicolì), AGeSC. Associazione Genitori Scuole Cattoliche (Roberto Gontero), C.G.D. Coordinamento Genitori Democratici, MO.I.GE.Movimento Italiano Genitori, FAES Famiglia e Scuola (Claudio Marcellino, Marco Ferraresi).

- **4.30pm**: Meeting with the President of the Senate Commission for Culture and Education, Guido Possa.

Wednesday, 7 November 2012 (Florence)

- **9am**: Visit to the School "Istituto Comprensivo Baccio da Montelupo", Montelupo Fiorentino (Firenze). Meetings with the leadership team (Gloria Bernardi, Antonella Nunziati, Patrizia Melani), a group of teachers (Patrizia Melani, Laura Salvadori, Maria Cristina Cioni, Fabiana Pieraccini, Alessandra Cenci, Carla Baronti, Angelo Lippiello, Cristina Romanelli, Rita Pasqualetti, Lucia Girolamo, Michela Palmieri) and the parents' representative (Francesco Polverini).

- **12pm**: Meeting with Regional School Office Toscana (USR TOSCANA) and with the Vice President of Regione Toscana: Angela Palamone (Direttore Generale USR Toscana), Stella Targetti (vice-presidente e assessore alla scuola, università e ricerca, Regione Toscana), Marta Rapallini, Elio Satti.

- **2.30pm**: Web conference with the Institute for the evaluation of the school system (INVALSI): Paolo Sestito (Commissario Straordinario INVALSI).

- **3pm**: Meeting with INDIRE: Giusy Cannella, Elena Mosa, Leonardo Tosi, Samuele Borri, Elisabetta Mughini.

- **4.30pm**: Web conference with external evaluators for cl@sse 2.0: Andrea Gavosto and Daniele Checchi (Fondazione Giovanni Agnelli - in web conference da Roma).

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Looney, J. (2009), "Assessment and Innovation in Education", *OECD Education Working Papers*, No. 24, OECD Publishing, *http://dx.doi.org/10.1787/222814543073*.

Lubienski, C. (2009), "Do Quasi-markets Foster Innovation in Education?: A Comparative Perspective", *OECD Education Working Papers*, No. 25, OECD Publishing, *http://dx.doi.org/10.1787/221583463325*.

Kärkkäinen, K. (2012), "Bringing About Curriculum Innovations: Implicit Approaches in the OECD Area", *OECD Education Working Papers*, No. 82, OECD Publishing, *http://dx.doi.org/10.1787/5k95qw8xzl8s-en*.

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