D2.3 Report on the Use of Tools and Technology to Support Teaching and Assessment

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Deliverable 3: General introduction

This document is a report aimed at surveying the technology currently available in classrooms to support teaching and assessment, with a specific focus on formative assessment in mathematics and science.

In the following section examples of digital technologies useful in teaching and assessment will be analysed (D2.3.1), focusing in particular on the role they could play in fostering formative assessment. In the second section (D2.3.2) an overview of significant tools, programs, initiatives to support teaching and assessment through digital technologies within the FaSMEd countries will be provided. The third section (D2.3.3) will be devoted to an overview of further international surveys and projects focused on the use of digital technologies in teaching and assessment.

The collection of data about the use of digital technologies in teaching and assessment and of significant programs and initiatives developed within the FaSMEd countries have been developed through a questionnaire (presented in detail in the introduction to D2.1). The questionnaire was meant to collect data and information from each country about the approach to low achievers and related educative approaches and tools.

The questions posed to the partners are:

- How is 'low achievement in mathematics and science' interpreted in your country? How are low achievers considered in teaching practices in your country? How are they helped?
- How are these students identified and at what age? What are the consequent interventions?
- Are there any tools and technology available to support teaching and assessment in mathematics and science?
- Have there been any local, regional or national studies or initiatives in your country concerning low achievement in mathematics and /or science?
- What is the general view of formative assessment in your country?
- Have there been any local, regional or National studies or initiatives in your country concerning formative assessment with and without technological tools?

The data collected through the questionnaire have been integrated with other data, derived from different sources:

a) The Eurydice report *"Key Data on Learning and Innovation through ICT at school in Europe"* (2011);

b) The document "*Survey of Schools: ICT in Education. Benchmarking Access, Use and Attitudes to Technology in Europe's Schools*" (2013), commissioned by the European Commission;

c) The Country reports related to the document "*ICT in Education*" (available for France, Germany, Ireland, Italy, Netherlands, Norway, UK);

d) The section devoted to "Innovation projects", within the website of *European Schoolnet* (http://www.eun.org);

e) The website of the international project iTEC (Innovative Technologies for Engaging Classrooms, http://itec.eun.org);

f) The National overviews proposed in the website of EdReNe – Educational Repositories Network (http://edrene.org/);

g) A range of research papers.

D2.3.1 Examples of digital technologies for teaching and assessment

This section is devoted to the analysis of the different ways in which technology can support teaching and assessment, referring to significant research on this theme. The analysis will be developed outlining the potentials of widespread digital technologies as tools to foster formative assessment and the challenges for teachers.

Research has highlighted the role that digital technology can play in fostering formative assessment. Quellmalz (2013), for example, has stressed the role played by the use of technology: (a) *for resources collection*, because it can both make available cognitively principled assessment tasks to embed in curricula and facilitate the alignment between the lesson goals and the standards by offering online databases that link curriculum, district, state and national standards; (b) *for test assembly, delivery and scoring*, because it can make available to teachers pools of assessment tasks and items that can be embedded within lessons; (c) *to enable assessment of those aspects of cognition and performance that are complex and dynamic and that were previously impossible to assess directly*.

Further reasons for using computers and technology as an integral part of the learning programme have been suggested:

- they are *interactive*, making tasks more accessible for students (Van den Heuvel-Panhuizen et al., 2011) and enabling them to explore situations by changing something on the screen and observing the effects, providing *dynamic* responses (Swan, 2005, Quellmalz et al., 2012);
- they *provide individualized instant feedback and coaching* because learners can immediately see the consequences of the decisions they make (Swan, 2005, Quellmalz et al., 2012, Looney, 2010);
- they create *rich, complex and authentic contexts for learning* (Quellmalz et al. 2012), enabling the use of high-demanding tasks (Van den Heuvel-Panhuizen et al., 2011);
- they reveal students' thinking and solution processes (Van den Heuvel-Panhuizen et al. 2011), enabling the *tracking of student learning* in different contexts and over time (Quellmalz et al. 2012, Looney 2010).

All these features make digital technologies particularly useful for formative assessment, because they highlight how digital technologies could incorporate different ways to assess student performance.

Two main ranges of technologies have been developed to integrate technological development and formative assessment and, for this reason, have been the object of research in the last years: the Computer aided assessment and the Connected Classroom technologies.

Computer aided assessment (CAA) is widespread especially within higher education and it is used as a diagnostic, formative and summative tool (Jenkins, 2004). Referring to formative assessment (FA), Jenkins observes that, although a multiple-choice questions approach exploits some of the strengths of using computers, focusing only on multiple choice-questions limits the possibilities of use of ICT. He therefore suggests looking at web technologies to promote the use of different assessment methods within a range of approaches, including peer-assessment, self-assessment, and group-based assessment. In this way CAA can encourage collaborative and reflective styles of learning and could also become adaptive, in that the outcomes of an assessment can be used to determine further questions or information that the student needs to address. This is in tune with Bernholt et al.'s (2013) observation about the key areas relevant for the design of e-assessments: self-assessment, peer assessment, diagnostic assessment, adaptive assessments and interaction between the teacher, learner and computer.

Charman (1999) has identified different advantages of using CAA for FA in higher education. Among them: repeatability; immediacy of response to the student; immediacy of assessment results to teachers for monitoring and adaptation; increasing the diversity of assessment; potential for assessments to be used at the most appropriate time; flexibility of access; student interest and motivation; student-centred skills and learning.

Wang (2008) suggests a way of using CAA as a formative tool also with young students, presenting the design of a Web-based quiz-game-like formative assessment (GAM-WATA) based on seven key strategies aimed at activating both a challenge mechanism and a game mechanism: the strategies 'repeat the test', 'timely feedback', 'query scores' enable to track learning status anytime and anywhere; the 'ask questions' strategy encourages students to discuss the questions with peers or teachers; 'all pass and then reward' and 'monitor answering history' let students query their own answering history after all items have been passed; finally 'Ask-Hint' strategy provides the info about how their peers answer each question for the less-competent students.

Wang's analysis shows that if the administering of FA only involves changing a paper-and-pencil test into a web-based test without offering assessment strategies, this change will not necessarily improve the effectiveness of FA. Using more than one strategy in a web-based FA system to provide feedback and enhance the human–computer interaction, instead, would have a positive influence on the effectiveness of the system.

The second range of technologies aimed at integrating technological development and formative assessment are the ***connected classroom technology***. This term refers to a networked system of personal computers or handheld devices specifically designed for classroom use in interactive teaching and learning (Irving, 2006). These technologies, defined WILDs (wireless internet learning devices) by Roschelle and Pea (2002), include *classroom response systems*, *networked graphing calculators* and *participatory simulations*. Connected classroom technologies are considered effective in enabling forms of participation in classrooms in which elements of online learning are integrated fully into face-to-face instruction (DeBarger et al., 2010).

A first example of these technologies is the so-called *Classroom Response System* (CRS), that consists of a set of input devices for students, communicating with the software running on the instructor's computer, enabling the instructor to pose questions to students and take a follow-up poll (Beatty & Gerace, 2009, Looney, 2010). Additional names have been given to this class of systems: clickers, classroom communication system (CCS), audience response system (ARS), voting machine system, audience feedback system, etc. Roschelle et al. (2004) have introduced the term CATAALYST to refer to these systems, as an acronym for "Classroom Aggregation Technology for Activating and Assessing Your Students' Thinking". The devices usually allow students to respond to yes/no or multiple-choice questions, but some of them also accept free text or numeric answers. After the instructor has posed a question, typically students beam answers to a receiving station with an accompanying anonymous display of histograms of students' answers. A subsequent public examination of the solutions and of the proposed alternative conceptions helps students understand their role as critical listeners and thinkers in the classroom (Irving, 2006) and guide teachers to adapt instruction depending on the results of the poll (Roschelle et al., 2007). Beatty and Gerace (2009) observe that one crucial feature of CRSs is that they simultaneously provide anonymity and accountability, support collecting answers from all students in a class, rather than just the few who speak up or are called upon and enable recording the data of students' individual and collective responses for subsequent analysis.

Another example of connected classroom technologies are the *Networked graphing calculator systems*, which enable information to be aggregated and mutually exchanged and accessed, as well as being displayed visually for all to see. Among them is the TI-Navigator, which enables teachers to select one of the handheld screens to be shared, to send immediate polls to the students, to collect students' answers and add them to the class portfolio. Such support could foster the development of a collaborative classroom environment by enhancing student interactions, focusing students' attention on multiple responses, and providing opportunities for students to peer- and self-assess student work (Clark-Wilson, 2010). Clark-Wilson highlights the opportunities, given to teachers and students by TI-Navigator, to engage in a range of FA practices: providing teachers with additional insight into their students' sense-making processes; promoting purposeful classroom discourse, prompted by shared responses and screens; developing strategies for students' peer assessment and self-assessment. Robutti (2010) stresses that this connectivity software enables the class to work together, share the products of problem-solving strategies, discuss on a theme and give or receive feedback in real time. She highlights that an important feature of this kind of activity is that the class discussion can be deeply intertwined with the group work, because at any moment the public screen gives information on what students do on their private screens.

A third example of connected classroom technologies are *Participatory simulations*, which involve graphing calculators that are connected to hubs that have a wireless connection to a computer that acts as a central server. Students are asked to "act out the roles of individual system elements and then see how the behaviour of the system as a whole can emerge from these individual behaviours. The emergent behaviour of the system and its relation to individual participant actions and strategies can then become the object of collective discussion and analysis" (Wilensky & Stroup 2000, p.2). Ares (2007) observes that these systems enable students to deal with multiple modes of contribution (language, text, physical and electronic gestures), engage with multiple representations of phenomena (texts, graphs, visual displays of emergent systems, language), and be involved in inquiry-oriented discussions.

A final example of connected classroom technology developed recently is *Group Scribbles*, a software platform designed by Roschelle et al. (2007) to support teachers in inventing and enacting new forms of collaboration and coordination in their classroom and "maximize the power of ink, improvisation, and interactive engagement in a wireless, tablet-based learning environment" (p. 39). The Scribble Sheets are small squares of virtual paper through which students can express their thoughts via a quick sketch or a few words, which can be posted to public boards, visible to all participants, or to a private board on which to create and arrange Scribble Sheets. According to Roschelle et al. (2007), FA and adaptive instruction are possible throughout the lesson with Group Scribbles because both the teachers and students receive rich and continuous feedback on what students know and have the possibility to act more like a community than they would in a conventional classroom.

Summing up, the innovative features of connected classroom technologies that make them effective tools to develop FA are the following:

(1) they give immediate information to teachers, enabling them to monitor students' incremental progress and keep them oriented on the path to deep conceptual understanding, providing appropriate remediation to address student needs (Irving 2006, Shirley et al. 2011);

(2) they support positive student's thinking habits, such as arguing for their point of view (Roschelle et al. 2007), seeking alternative representations for problems, comparing and contrasting different solution strategies, explaining and describing problem solving strategies (Irving 2006);

(3) they create immersive learning environments that highlight problem-solving processes and make student thinking more visible (Looney 2010);

(4) they enable most or all of the students to contribute to the activities and work toward the classroom performance, taking a more active role in the discussions (Shirley et al. 2011, Roschelle & Pea, 2002);

(5) displaying the aggregated student results, they can give powerful clues to what students are doing, thinking, and understanding (Roschelle et al., 2004) and enable teachers to "take the pulse" of learning progress for the classroom as a whole (Roschelle & Pea, 2002);

(6) they provide students with immediate private feedback, encouraging them to reflect and monitor their own progress (Roschelle et al. 2007, Looney, 2010);

(7) they provide opportunities for independent and collaborative learning (Looney, 2010), fostering classroom discourse (Abrahamson et al., 2002; Dufresne et al., 2000; Shirley et al., 2011; Roschelle et al., 2007);

(8) they offer potentially important avenues for enlarging the types of cultural practices used as resources for learning and foster students' dynamic engagement in conceptual, collective activities which are more akin to practices of professional communities, making them become knowledge producers rather that consumers (Ares, 2008);

(9) they enable the instructor to carry out a multi-level analysis of patterns of interactions and outcomes thanks to their potential to instrument the learning space to collect the content of students' interaction over longer timespans and over multiple sets of classroom participants (Roschelle & Pea, 2002).

Notwithstanding the potential of these tools, many researchers have stressed that the effectiveness of connected classroom technology depends on the skill of the instructor (Irving, 2006) and on his/her ability to incorporate procedures such as tracking students' progress, keeping students motivated and enhancing reflection with technologies (DeBarger et al., 2010).

Different studies have highlighted that connected classrooms technologies (CCT) have increased the complexity of the teacher's role with respect to 'orchestrating' the lesson (Clark-Wilson 2010, Roschelle & Pea 2002). As a "conductor-of-performances", in fact, he/she has responsibility for choosing and sequencing the material to be performed, interpreting the performance, and guiding it toward its desired forms (Roschelle & Pea, 2002). Therefore, in order to bring about improvements to student participation in class and achievement, technology must be used in conjunction with particular kinds of teaching strategies (Penuel et al., 2007, DeBarger et al., 2010).

Some studies have stressed that it takes a considerable amount of time for teachers to change their beliefs about teaching and learning, classroom culture and the teacher's role (Foshayla et al., 2012) and their ways of being so that FA with technology becomes an integral part of their practice (Feldman & Capobianco, 2008). It is, in fact, possible to be expert in various combinations of the technologies without having expertise in FA (Feldman & Capobianco, 2008).

Foshayla et al. (2012) introduce a three-level developmental progression for teachers' full transition to the highest level of expertise: (1) the *Immediate level*, which describes many teachers at the beginning of their use of technology for FA, who usually examine students' feedback after class and take decisions about "what to do next" from day to day, informed by this feedback; (2) the *Expert level*, typical of teachers who feel comfortable with the mechanism of obtaining frequent student data and are able to use these data to make "real time" decisions about skill steps or concepts needing re-teaching; and (3) the *Master level*, which is characterized by the teacher's command of the full range of advanced interactive capabilities that technology offers, and his/her ability to use them in an innovative way in classroom teaching to deepen student understanding and to differentiate instruction to support all learners.

Penuel et al. (2007) have identified similar profiles of teachers' use of classroom performance systems related to the frequency of use and the breadth of instructional strategies employed: (1) *Infrequent user*, who rarely uses CPS and tends not to use the full range of capabilities of the system; (2) *Teaching self-evaluator*, who often uses the CPS, but usually only for summative assessment purposes, to gain feedback on the effectiveness of his/her own teaching; (3) *Broad but infrequent* *user*, who uses the CPS less frequently than self-evaluators, but for both formative and summative assessment purposes, to adjust instruction and to make judgments about what their students had learned; (4) *Broad and frequent user*, who uses the CPS frequently and for a wide range of purposes, often involving students in peer and whole-class discussions.

Shirley et al. (2011) have analysed the costs and benefits of implementing CCT in middle and high school mathematics and science classrooms. With regard to the teachers' difficult evolution toward the highest level of expertise in the use of technology, these authors highlight that all the teachers experience initial challenges in setting up computer equipment and that initially the lack of familiarity with the technology sometimes could even impede instruction. Many of the costs associated with this implementation are therefore connected to factors related to instrumentality.

Therefore teachers need support for the design of these strategies (DeBarger et al., 2010). DeBarger et al. (2010) propose a frame aimed at providing teachers with different possible sequences of movement across public and private workspaces and between computer-mediated and face-to-face communication to make student thinking transparent (*IFAs - Interactive formative assessments*). Specifically, they have identified a collection of seven (science) teaching routines that describe a sequence of instructional moves for creating a particular kind of interactive FA opportunity: concept mapping, test design, data creating and sharing, question posing and categorizing, constructing a model, interpreting and using a model, designing tests, predicting with reasons.

Similarly, Beatty and Gerace (2009) developed *technology-enhanced formative assessment (TEFA)*, a pedagogical approach for teaching science and mathematics with the aid of a classroom response system (CRS). To help teachers implement FA, the TEFA approach introduces an iterative cycle of question posing, answering, and discussing, which forms a scaffold for structuring whole-class interaction. The essential phases of the cycle are: 1) pose a challenging question or problem to the students; 2) have students wrestle with the question and decide upon a response; 3) use a CRS to collect responses and display a chart of the aggregated responses; 4) elicit from students as many different reasons and justifications for the chosen responses as possible; 5) develop a student-dominated discussion of the assumptions, perceptions, ideas, and arguments involved; 6) Provide a summary, micro-lecture, meta-level comments.

D2.3.2 Tools/programs/initiatives to support teaching and assessment through digital technologies in the FaSMEd countries

Introduction: the use of ICT in the European education systems

In the Eurydice report "*Key Data on Learning and Innovation through ICT at School in Europe*" (2011), it is stressed that innovative teaching methods that may be enhanced through the use of ICT can increase student engagement and improve their results. For this reason, a great majority of European countries recommend or suggest, at both primary and secondary level, several innovative pedagogical approaches that could involve the use of ICT, such as: (a) project-based learning activities that engage students in open-ended, long term questions or problems; (b) individualised learning, by which teachers make it possible for individual students to work at their own pace; (c) scientific investigations.

The same report states that the majority of countries in Europe promote the use of a large range of ICT tools for teaching and learning:

- hardware, such as computers, projectors or beamers, DVD, video, TV, cameras, smartboards, and virtual learning environments which integrate a range of ICT infrastructure to create a personalised online learning space;
- ICT software, such as tutorials, general office applications, multimedia applications, digital learning games, communication software such as email, chat or discussion forums, and digital resources.

Across Europe, official steering documents suggest the use of ICT not only for teachers teaching different subjects in school, but also to help students with their learning activities in and out of school. In particular, the use of ICT in education is also conceived as a way of promoting equity.

Some countries specify the subjects that should involve a more intensive use of ICT, but, in some cases, only a few recommendations on students' use of ICT are provided. The report also highlights that, in mathematics, usually ICT are used for skills practice, while in science they are used more often for looking up information or, rarely, for conducting experiments or simulations of natural phenomena. On average, more than one third of students use computers for mathematics and science schoolwork at least once a month and the proportions of students using a computer for mathematics and science schoolwork, respectively, are similar.

With regards to students' assessment, the report highlights three approaches used in European countries that can benefit from ICT: (1) *self-assessment*, that could be supported by ICT by providing students with immediate feedback on their performance and by allowing the sharing of information; (2) *the assessment focused on learning outcomes* (rather than on teaching objectives), that could be facilitated through ICT and carried out by both the teacher and other students; (3) *e-Portfolios*, electronic collections of users' achievements which permit an assessment of their competences.

The report states that a wide variation exists between countries with respect to central recommendations on the use of these new approaches to pupil assessment. In particular it denounces that, while self-assessment and assessment based on learning outcomes have been widely adopted within European countries, e-portfolios are not yet widely used for pupil assessment. Moreover, it shows that, although the use of these new approaches to pupil assessment is becoming increasingly widespread, the question arises whether and how ICT is used in this context.

The document "*Survey of Schools: ICT in Education. Benchmarking Access, Use and Attitudes to Technology in Europe's Schools*" (2013), which was commissioned in 2011 by the European Commission to benchmark access, use and attitudes to ICT in schools in 31 countries (EU27, Croatia, Iceland, Norway and Turkey), points to a number of policy actions to ensure an optimal use of financial resources to foster effective use of ICT in schools:

(1) to strengthen public action at institutional, local, regional, national and European levels to boost ICT use at school so as to reduce the gap between ICT use out and within school, giving greater opportunities to about 30% of 16-year-old students lacking adequate home access to ICT;

(2) to transform positive attitudes and sufficiency in ICT provision into effective and sustained classroom practice;

(3) to provide teachers with technical and pedagogical support in the use of ICT, introducing ICT coordinators in schools, increasing the training provided to teachers of all disciplines and promoting online platforms and the opportunities to foster online professional collaboration between teachers;

(4) to harness high levels of use of personally–owned mobile phones because of the role they play, according to students, in supporting their learning.

The following sections will be devoted to an overview of the use of ICT in the FaSMEd countries' education systems, with a specific focus on the projects and initiatives developed to raise students' achievement through the use of digital technologies.

The use of ICT in the English Education System and the Projects/Initiatives involving the use of digital technologies to raise students' achievement in England

The development of tools and technology to support teaching and assessment in mathematics and science in the UK has a long history of development from both industry and public funds. Government support in England included the establishment of the National Council for Educational Technology (NCET) in 1993, which subsequently became the *British Educational Communication and Technology Agency (Becta)* in 1997 – this closed in 2011.

Becta (becta.org.uk/) provided rigorous research and evaluation to evaluate the impact of technology on the education and skills system. It provided expert, independent advice to:

- help schools make informed choices about technology and plan, buy and use it effectively;
- help learners and their families access technology, become involved in learning and stay safe online;
- ensure government policy took full account of the opportunities and challenges technology brings.

Becta provided practical tools for schools to save time and money, improve teaching and learning and share best practice. The resources developed by Becta are still available in the UK government online archive.

As regards the digital technologies that are most widespread in the schools, projective technology is frequently found in most secondary and primary classrooms in England. This is usually in the control of the teacher with pupils having less personal access ICT. Some schools are experimenting with tablets and other forms of hand held technologies – some also have 'voting' technologies. A small number of mathematics departments use graphing calculators. 'Four function' calculators are widely available, however, government guidance discourages their use in primary schools and secondary schools rarely have a coherent policy about their use in mathematics and science.

Online resources are widely used in teaching and sometimes in assessment and schools access a variety of subscription sites that provide 'scripted' lessons. A large number of schools subscribe to a range of online resources for mathematics and science which give teachers access to more or less ‘scripted’ lessons and these also frequently provide assessment materials online which pupils can access from home. The *BBC* also has an extensive library of educational online materials (http://www.bbc.co.uk/education), although its expansion of these was stopped when industry protested about unfair subsidised competition.

Many projects and initiatives have been developed to foster the use of ICT in teaching and assessment.

The *Technology Enhanced Learning* (TEL) research programme (http://tel.ioe.ac.uk/about-3/) aims to improve the quality of formal and informal learning, and to make accessible forms of knowledge that were simply inaccessible before. Since research does not translate easily into practice, the TEL programme seeks to distil themes from across different projects into more generalisable findings, trying to identify ways in which technology can be designed and built so that it improves learning.

Five key research themes have been developed within the programme:

a) Research Community, to help the UK research community to rise to the interdisciplinary challenges of TEL research;
b) Flexibility, to enable the provision of education and skills to be deployed in more open, variable, and accessible ways, so that learning opportunities are available in a more seamless environment that can link classroom, home, workplace, and community.
c) Inclusion, to improve the reach of education and lifelong learning to groups and individuals who are not best served by mainstream methods;
d) Personalisation, to transform the quality of learning, teaching and assessment by exploiting the responsive and adaptive capabilities of advanced digital technologies to achieve a better match with learners’ needs, dispositions and identities;
e) Productivity, to achieve higher quality and more effective learning in affordable and acceptable ways.

These are some of the development projects carried out within the TEL programme:

a) Transforming perspectives: technology to support the teaching and learning of threshold concepts (Carmichael, Johnstone & Robinson, 2006-07)
b) Supporting sign language users through technology enhanced learning (Glauert, 2006-2007)
c) Authoring as acting: exploring embodied interaction in game authoring environments for children (Good, du Boulay, Mares & Robinson, 2006-2007)
d) Workplace personalised learning environments for the development of employees' technical communicative skills (Hoyles, Brown, Magoulas, Poulovassillis & Noss, 2006-2007)
e) Merging cognition and technology to enhance learning in the field (Martin, Dror & Clark, 2006-2007)
f) Exploring e-learning and communication tools for improving children's language usage in social interactions: EchoeS (Porayska-Pomsta, Pain, Good, Walker, Keay-Bright & Lemon, 2006-2007)
g) Personalisation of learning: constructing an interdisciplinary research space (Solomon, 2006-2007)

Different associations and organization have been established to foster a positive impact of technology on the education system:

(1) *Naace*, the national association aimed at promoting learning with technology in a connected world (www.naace.co.uk/). It represents a community of schools, teachers, those who work in schools and the Education Technology industry;

(2) *ALT*, the UK's leading membership organisation in the learning technology field, whose purpose is to ensure that use of learning technology is effective and efficient, informed by research and practice, and grounded in an understanding of the underlying technologies (www.alt.ac.uk/);

(3) *Futurelab*, funded by the Department for Education with the aim of inspiring, challenging and engaging all young people in rich and rewarding learning experiences through new approaches to learning and the innovative use of technology;

(4) *The National Centre for the Excellence in the Teaching of Mathematics*, which proposes a wide range of online resources for teachers and has established an ICT group to identify actions and key-points to respond to the difficulties met by teachers in supporting the use of ICT by learners during the mathematics lessons.

The use of ICT in the French Education System and the Projects/Initiatives involving the use of digital technologies to raise students' achievement in France

The French Ministry of National Education has oversight of all aspects of the French educational system. It is responsible for providing a National Curriculum. However, this power is devolved in many significant ways through 30 educational units called académies. These regulate and establish national educational policy. This decentralisation of power is a long-standing feature of the French educational system. As a result, schools and teachers are free of choosing their pedagogical approaches in accordance with the national curriculum.

The Department of Information and Communication Technology in Education (DGESCO-A3) is responsible for coordinating ICT development in education. The department's mission covers the following main areas:

- Encouraging teaching practices using ICT;
- Developing school equipment;
- Creating networks;
- Teacher training (both initial teacher education and continuing professional development);
- Supporting the production and distribution of multimedia resources;
- The product and services industry.

The académies (the regional structures of the Ministry of Education) are responsible for implementing national directives and polices. This includes the development of ICT. The overall ICT policy in France covers the following key areas:

- Proposing and implementing measures for increasing the use of the internet and ICT;
- Providing training for families, children and others in the use of ICT;
- Preparing and implementing guidelines for the development of ICT for educational purposes in schools and higher education;
- Monitoring the use of ICT in these contexts;
- Supporting the production of digital resources;
- Establishing partnerships and agreements with regional authorities and companies.

The DGESCO-A3 is part of the Ministry of Education. It is currently running a number of programmes that have bearing on the iTEC programme (see section D3.3):

- The '*Infrastructure and Services*' programme, in particular, aims to provide the educational community with the infrastructures and services necessary to support the development of good practice with ICT. There is a particular focus within this programme, as well as in the 'ICT

Uses in Education' programme (see below), on how teachers and students can benefit from the use of ICT in their work.

- The *'Digital Resources for Teaching and Learning in Schools and in Higher Education'* programme supports the creation and distribution of high quality digital educational contents for pupils and teachers.
- The *'ICT Uses in Education'* programme focuses on how ICT is adapted to particular school subjects at the various educational levels. It encourages various groups to produce and share the educational uses of ICT and digital learning resources.
- The *'ICT Training and Support'* programme has systematised the training and support of staff working within the educational sector as they develop their skills with ICT (this includes teaching and non-teaching staff). It also has supported the adoption of the ICT and Internet Proficiency Certificate within schools. This programme is currently conducted by the French Ministry of Higher Education and Research.

Examples of specific projects developed in the context of these programmes are:

- The *'1000 visioconférences pour l'école'* (2008 ongoing) project, a plan to support and develop foreign language learning in primary schools. It has equipped 1000 primary schools with video-conferencing in order enable primary pupils to get in touch with native speaking peers in other countries;
- *PRIMTICE* (2004 – ongoing), a directory of several hundred teaching scenarios involving the use of ICT. The PRIMTICE portal (http://primtice.education.fr) opened in 2009 and identifies, presents and advertises digital resources and pedagogical usage scenarios for primary educators;
- *EDUBASES* (2002 – ongoing), a collection of directories of several hundred teaching scenarios involving the use of ICT (http://eduscol.education.fr/cid57544/edu-bases-des-usages-repertories-pour-les-enseignants.html). It covers all disciplines and school grades from secondary school. EDUbases are collections of resources created by teachers for teachers.

Other tools and materials to support teachers in their mathematics and science classrooms are mainly produced by teams of teachers at a local level and made available through institutional or personal websites. Examples of websites are:

- The website "Psychologie, éducation & enseignement spécialisé" (by Daniel Calin), aimed at publishing reflections on psychological and pedagogical aspects of specialised teaching and resources designed for students with special needs (http://dcalin.fr/sites/rased.html);
- The website "Site coopératif d'un instit. du Territoire de Belfort", which proposes examples of individualised help in mathematics (http://sylvain.obholtz.free.fr/crbst_106.html);
- The website "Aide aux élèves en difficulté", of the Académie de Versailles, which presents different software that can be used with low attainers and proposes possible activities for students, giving technical and pedagogical indications (http://www.eed.ac-versailles.fr/spip.php?rubrique58);
- The website *"Mathématique et sciences en lycée professionnel"*, created by teachers of the Académie de Lille, which offers downloadable math formative assessment materials involving the use of ICT (http://maths-sciences.discipline.ac-lille.fr/maths/page-accueil-maths/1/2/exemples-devaluations-formatives-de-mathematiques).

Various projects concerning innovations through the use of technology have been developed in France at a local level. Examples are:

- The project "*MATHEMATIQUES ET TICE Intégrer des boitiers de vote dans l'évaluation des élèves durant les séances de mathématiques"*, developed by the College Asselin de Beauville, with the aim of promoting the use of the vote-response system Activexpression during Mathematics lessons to regularly and instantly evaluate (in a summative and/or formative way) all students (http://eduscol.education.fr/experitheque/consultFicheIndex.php?idFiche=8028);
- The project "*Utilisation de la tablette numérique pour apprendre autrement en EPS: l'évaluation formative par compétences*", developed by the Lycée professionnel Charles Stoessel, which fosters the use of tablets in a perspective of formative assessment to instantly collect the results of different forms of assessment.

In the EdReNe website "Current state of educational repositories – national overview", it is reported that in France several stakeholders are involved in the development of learning object repositories: the ministry of education, the national agency of ICTE, universities, professional training institutions and publishers. Examples of these repositories are:

- *Sialle*, an open source educational software information online service, which encourage teachers to submit their comments/feedback about the software (http://www.sialle.education.fr);
- *PrimTICE*, a directory of teaching scenarios involving the use of ICT in primary education, which identifies, presents and advertises digital resources;
- *Edubases*, a collection of directories of teaching scenarios involving the use of ICT, which covers all disciplines and school grades from secondary school.

The use of ICT in the German Education System and the Projects/Initiatives involving the use of digital technologies to raise students' achievement in Germany

The use of tools and technology in mathematics to support the learning process is strongly recommended in the German National Education Standards. In some states it is possible to find this recommendation in the curricula – in other states it is even a duty to use digital tools, for example graphic calculators or even computer algebra is compulsory for the final examination. Nevertheless, independent of recommendation or duty, the concrete use and integration of technology in the classroom differs a lot from school to school and even from teacher to teacher.

It is most common for students to use scientific calculators from grade 6. In relation to graphic calculators, Germany does not have a long tradition and is still not used in a lot of schools (Barzel, 2006). If graphic calculators are used, they are introduced in grade 9, mainly in the gymnasium. More often teachers use the computer lab of their school, but only occasionally in single mathematics and science lessons (usually a spread sheet like Excel or a geometry software like GeoGebra).

Significant projects and initiatives have been developed in Germany to foster and improve the use of ICT in teaching.

Since 1996, for example, a growing teacher network focusing on the use of handheld technology for maths and science has been developed: *T3-Teachers Teaching with Technology*. The network was created on the basis of a sponsor agreement between the University of Duisburg-Essen and Texas Instruments (www.t3deutschland.de). Materials for teaching and training are developed within the project on how to integrate graph-plotting tools, computer algebra, spread sheets, geometry packages and statistic software (such as Fathom). These tools are only used on a secondary level. Beside these digital tools, a lot of digital learning environments with just a specific aim are used occasionally for single topics (such as applets, interactive worksheets). The digital tools are mainly used on one side as learning tools for exploration and discovery and on the other side for applying mathematics (Barzel & Greefrath, 2014).

As regards the teaching of science, teachers use computers above all outside of school to prepare their lessons. The first studies about the use of technology during school lessons in Germany took place from the year 2001 onwards.

Another programme aimed at advancing the integration of ICT into German schools is *SEMIK (Systematic Integration of Media and ICT in Teaching and Learning)*. It is a five-year program (1998-2003) initiated by the Federal-States Commission and of the German Ministry for Education and Research (http://dbbm.fwu.de/semik/7_programm_info_englisch/index.html). The programme consists of five focal points: (1) teacher education and training, (2) school development, (3) development of instructional concepts, (4) development of curricula and (5) preparation of technical tools.

There are three general principles that constitute the framework of the SEMIK program:

1) Schools need to prepare their students for an increasingly knowledge-based society, therefore, students need to acquire a sound foundation of basic knowledge as a basis for life-long learning and they need to acquire skills and competencies to access information from various sources and use it in a responsible way.

2) The integration of new media into the classroom takes place according to a problem-based didactical approach, therefore the programme intends to create realistic learning environments that allow for active, self-guided and collaborative learning. An emphasis is put on a balanced use of constructive learning and instructional support.

3) The integration of new media brings about a systemic change to the instructional culture of the school, therefore professional development and teacher training, co-operation among teachers and organizational development within schools are additional important goals of the project.

The SEMIK project integrates a variety of different approaches to strengthen the use of information technology in German schools. It consists of schools' individual projects carried out in the 16 federal states. The projects are funded only if they yield results and practices transferable to other schools. Thus, the program hopes to create synergies among schools and to initiate a co-operation between schools that will have a long-lasting effect.

Through the *SEMIK program* the teachers' attitudes towards the use of ICT were analysed (Ehmke et al., 2004). This analysis enabled to identify four different categories of teachers, in relation to their feeling of being responsible for using ICT at school: enthusiasts (19%), pragmatists (16%), interested laymen (24%), and refusers of innovation (24%). The rest (about 16%) are prevented from using media in school.

Another study, developed by Pietzner (2009) in Lower Saxony and Northrhine-Westfalia, focused on the use of ICT specifically in science classes. The teachers involved (about 1200) were asked to answer to a questionnaire aimed at highlighting the following aspects: How do science teachers use the computer in biology, chemistry and physics? What reasons do science teachers give for not using the computer? Are there differences concerning the computer-related attitude and computer anxiety of teachers between "users" and "avoiders"?

The collected data demonstrated that the main focus of ICT use in science classes is the search of information. Computers are also used to propose animations and simulations during the lessons. A different use of computers was highlighted through the comparison between general schools or Realschulen, where computers are mainly used to search information through the internet, to construct Mind and Concept maps or to individually support students, and gymnasiums or comprehensive schools, where computers are usually used to develop whole class activities.

Three mains reasons were named by science teachers to motivate why they do not use the computer in class: the absence of hard-software, the belief that the current topic does not allow computer usage, and a lack of certainty in using the computer, often connected to a computer anxiety. It was also highlighted that women use the computer in science class less than their male colleagues (Pietzner, 2009).

Another programme that promoted specific projects aimed at bringing digital technologies into the classroom was *D21* (*Innovation and jobs in the information society of the 21st century*). The program, started in 1999, provided schools with computers, media laboratories and internet access. Three main internet teaching projects were developed: (1) The first involved the establishment of virtual cooperation among Fachhochsculen; (2) The second concerned the development of multimedia support for courses in chemistry; (3) The third promoted technical and organizational approaches to telelearning.

D21 acts as a coordinator for several smaller sub-projects, while giving advice and support to others. For example, the project "*Testing A Futuristic Classroom*", part of the D21 initiative, was developed to investigate the 'classroom of the future'. Through agreements with major technology firms, the project has put together a demonstration classroom made up of 17 PCs, a server, laser printer, scanner, and other facilities. The project "*Raising issues*", considered one of the main successes of the D21 initiative, was aimed at bringing together key players to discuss important issues surrounding the use of information technologies in schools. Another project, "*Ambassador For IT*" was developed to encourage the collaboration between D21 and schools, sending expert 'Ambassadors' from D21 into local schools and colleges to inform the staff about the possibilities of using ICT and, therefore, reduce the 'fear factor' in new ICT plans.

The activities of D21 are varied, and new projects are constantly being added.

Another relevant German initiative was *InfoSCHUL* ("*Nutzung elektronischer und multimedialer Informationsquellen in SCHULen*" - Usage of electronic and multimedia information Sources in schools). This program, launched at the beginning of the school term 1997/98, represented a special supportive measure within the framework of the initiative "Schulen ans Netz" of the German Federal Ministry for Education und Research (BMBF) and Deutsche Telekom AG. It addressed the development and testing of learning concepts that integrate the use of electronic and multimedia materials, supporting projects which demonstrate how electronic and multimedia information sources can be used during subject lessons or for the independent application by pupils. The participants were working groups and special classes in the German Sekundarstufe II (secondary phase) of school.

The use of ICT in the Irish Education System and the Projects/Initiatives involving the use of digital technologies to raise students' achievement in Ireland

In Ireland, although almost all primary schools and the majority of post-primary schools are locally owned and managed, schools have relatively limited autonomy especially in relation to curriculum and the pedagogical methods employed.

As regards the use of ICT, the Eurydice's *Key Data on Learning and Innovation through ICT at school in Europe* highlights that national strategies have been developed to cover training measures in all areas as well as research on the use of ICT in schools and in e-learning. At both primary and secondary education level, recommendations and support are provided in the hardware areas and in the software categories. The official steering documents require primary and secondary school teachers to use ICT in all subjects, while students are expected to use ICT in class and also for complementary activities. No central recommendations are given on the use of ICT in student assessment.

The country profile of the document "*Survey of school: ICT in education*" (European Schoolnet, 2012), highlights that in Ireland the use of ICT by teachers is much higher at all grades than the EU average, particularly at grades 4, 8 and 11. This is a consequence of the fact that Irish teachers' confidence in their operational skills with ICT is higher than the EU mean at all grades. Irish schools are therefore included, by the survey, within the 'digitally supportive schools", that is the schools that develop strong concrete support measures for teachers to use ICT in teaching and learning. On the contrary, the percentages of students having high ICT access and use at school and at home are lower than the EU average.

In recent years there has been an emphasis on the use of tablets in Irish post primary schools. The use of tablets in the classroom has a positive impact on schools, particularly in terms of student engagement and motivation.

The study "*The Use of Tablet Devices in ACCS Schools*", by Hallissy, Gallagher, Ryan and Hurley (2013) was commissioned by the Association of Community & Comprehensive Schools (ACCS) to research the impact of tablet devices across their network of ninety-three schools nationally.

The study highlights that most ACCS schools currently have not embarked on deploying tablet devices and only a small number of pioneering schools have deployed tablet devices.

The schools that are implementing tablet programmes reported numerous positive outcomes arising from the introduction of the tablet devices: an increased enthusiasm among students, higher levels of independent learning, increased communication and collaboration among students. Teachers, too, have found that the devices have re-invigorated their teaching and helped them to re-assess how they design their learning environments.

The report has found that schools are currently at the initial stages of transforming their teaching, learning and assessment practices in light of the arrival of these digital tools. It suggests that the digital technologies' potential to transform student learning implies that teachers should re-design their classroom activities and their roles within them. As regards this aspect, teachers are still coming to terms with the presence of these devices in their classrooms and have highlighted the need for additional subject-department continual professional development.

Stressing the importance of planning for learning, Hallissy et al. (2013) suggest 'Practical Guidelines for Schools' in relation to the implementation of one-to-one programme. The guidelines include some useful tools that are available to teachers:

(a) the NCTE Handbook "*Planning and implementing e-learning in your school"* (2009);

(b) the book "*Redesigning Education: Meeting the Challenges of the 21st Century*" (Hallissy et al.), published by Microsoft Ireland;

(c) the book "21 Steps to 1-to-1 Success"

(http://education.qld.gov.au/smartclassrooms/documents/strategy/pdf/scbyte-21steps.pdf);

(d) the "ITL Planning Resource" (Microsoft Partners in Learning, 2010, www.is-toolkit.com).

Another report that has highlighted the positive impacts of the introduction of technologies in the classroom is the one carried out by Galvin, Coates and Murray (2010) for the South Dublin County Council on the local initiative *CONNECT School Project*. Galvin and his colleagues report significant improvement in students' results, particularly among weaker students, as a result of the use of laptops in the school. An increase in numbers of students choosing higher and further education than was typical of the school was also noted, while teachers experienced positive change in the learning environment, greater diversity in their teaching strategies and improvements to the motivation of students. However the report also notes the "paucity of these resources elsewhere in the education system" (p. V).

National initiatives have been developed to foster the use of ICT in teaching and learning.

The "*Dissolving Boundaries*" programme (www.dissolvingboundaries.org), for example, used ICT to facilitate cross-cultural educational links between schools in the North and South of Ireland. It was established in 2000 and managed in the Republic of Ireland by the Education Department, National University of Ireland, Maynooth and in Northern Ireland by the School of Education, University of Ulster, Coleraine.

One of the main aims of this programme, which involved over 100 partnerships from primary, special and post primary schools, was to engage pupils in collaborative, curricular-based activities.

The teachers involved in "Dissolving Boundaries" were trained in all aspects of the technology used in the programme.

Another initiative characterised by the aim of providing high quality professional development and support for teachers and schools to improve education is *PDST* (*Professional Development Service for Teachers*). PDST (http://www.pdst.ie/postprimary) was established in 2010 as a new, generic, integrated and cross-sectoral support service for schools.

A range of professional development initiatives was provided to teachers to support their learning, collaboration and reflection on their practice. A great emphasis was given to learning and teaching methodologies and ICT. *PDST Technology in Education* is, in particular, a programme aimed at promoting and supporting the integration of a high quality ICT infrastructure into learning and teaching for schools. On the website of the programme, there is a specific section devoted to a range of different good practice examples which can help teachers in progressing the use and integration of ICT in learning and teaching. The examples are built upon the experiences in Irish classrooms and other countries. Another initiative led by PDST is *Digital Schools*, aimed at promoting, recognizing and encouraging excellence in the integration of ICT in learning and teaching in primary schools (it is now managed by Dublin West Education Centre). The schools that successfully complete the programme will receive a nationally recognised award, free hardware and software and ongoing practical support and resources.

Bridge 21 is another programme focused on supporting an innovative learning environment within schools (http://www.bridge21.ie/). The programme, based in Trinity College (Dublin), was designed to offer a new model of learning for use in secondary schools, which is team-based, technology mediated, project based and cross- curricular. In particular, the *Bridge21 Transition Year programme*, aimed at developing a team-based experience for young people to explore learning through technology.

Other initiatives aim at providing access to educational information and curriculum and training materials for teachers through web portals. *Scoilnet*, for example, focuses on spreading curriculum-relevant learning resources that support the integration of ICT in learning and teaching. Users can search for teaching and learning resources by curriculum, subject, strand and topic. The resource finder currently contains more than 11,000 resources, which have been reviewed, described and categorised by Irish teachers. A similar initiative was developed through the *NDLR* (*National Digital Learning Repository*) project, which was funded by the Higher Education Authority and involves all Irish Universities, Institutes of Technology and their affiliated colleges. The NDLR is an online resource bank to support collaboration and sharing of teaching and learning resources.

There are also projects focused on specific categories of students or specific subjects. *Mission V* aims at engaging children in their learning, particularly those who are at risk of significantly underachieving (http://missionv.ie/). This project seeks improvement in educational standards by facilitating a greater level of engagement with the curriculum, particularly with regards to STEM

(Science, Technology, Education, and Maths). With the aim of involving students in a new kind of game-based learning, Mission V is building a platform, where students can use geometric building tools to collaboratively construct 3D models of real world or fantasy structures (e.g. atoms, museums, physics experiments) and generate a fully interactive world.

Science Unleashed is another initiative specifically focused on the teaching of science. It is part of a collaborative project between RTE and the National Centre for Technology in Education: *IMMERSE* (Innovative Multimedia Educational Resources for Students and Educators), which has set out to develop innovative, interactive, curriculum-relevant resources for students and teachers in the Irish education system. *Science Unleashed* aims at second-level students studying the revised Junior Cycle science curriculum and comprises 15 videos and an interactive website with notes, interactive games, quizzes and weblinks on a wide range of science topics.

The use of ICT in the Italian Education System and the Projects/Initiatives involving the use of digital technologies to raise students' achievement in Italy

The Ministry of Education, University and Research (MIUR), which is the principal administrative body in Italy, and other local governmental bodies, such as the regional and provincial education officers, are the main referees for the school use of ICT in teaching and learning. However, recently, schools have increased a considerable degree of autonomy in how they organise tuition and conduct the teaching and learning processes.

The country profile of the document "*Survey of school: ICT in education*" (European Schoolnet, 2012), highlights that in Italy the infrastructure conditions needed to underpin teaching and learning with ICT are not in place in all schools, with relatively high ratios of students to computers and over three times the EU percentage of students in schools without broadband. In spite of this, teachers' use of ICT at grades 4 and 8 is close to the EU average.

The Eurydice's *Key Data on Learning and Innovation through ICT at school in Europe* shows that, according to Italian official steering documents, students and teachers at all levels are expected to use ICT in all subjects for complementary activities and also in class at secondary education level, although there are no central recommendations on the use of ICT in student assessment. In both primary and secondary schools ICT is taught as a general tool for other subjects/or as a tool for specific tasks in other subjects.

Different national strategies covering training and research measures for ICT in schools have been developed in Italy.

The National Project "*Scuola digitale*" (Digital School), for example, was carried out to foster the implementation of innovative models of instruction, which involve a constant and wide use of digital technologies in the teaching practice. *ARDESIA TECH* is an example of a research project developed within "*Scuola digitale*" (http://www.scuola-digitale.it/ardesia-tech/il-progetto/sperimentazione/#sthash.mRXx91Fh.dpuf). The project was promoted by INDIRE (National Institute for Documentation, Innovation and Educational Research) and involved many scientific and technological partners. Its aim was to experiment, in three classes of a primary school, an innovative learning setting constituted by an interactive whiteboard, one notebook for each teacher (to plan and implement class activities and didactical resources), one touch screen notebook for each student (for both class activities and homework) and an interactive desk for group activities. The central research questions were how a technology-based class could be implemented and what are the relationships between the methodological choices, the introduced didactics and the digital tools used in this kind of innovative learning setting.

Within "Scuola digitale", two main initiatives have been developed. The first one, *Cl@ssi 2.0*, is aimed at investigating in what ways and how much the constant and widespread use of digital technologies in everyday school practice could transform the learning environment, impacting on students' performance and skills. This investigation has been carried out through the experimentation of a range of innovative learning environments at the lower secondary school level. The focus of the project is not technology itself, but the dynamics of innovation that technology could activate.

The second initiative, “*Scuola digitale-LIM*”, has been undertaking a large implementation of interactive whiteboard technologies in lower secondary schools, which were supplied with 18,000 interactive whiteboards in 2009. An additional 10,000 boards were distributed to primary and upper secondary schools by the end of 2011. In order to foster a proficient use of interactive whiteboards in the classes, an in-service teacher training-program, which involved 75,000 teachers, was implemented by the National Agency for the Support of School Autonomy. The training-program, aimed at supporting teachers in the planning and implementation of didactical activities involving the use of interactive whiteboards, was developed from 2009 to 2012, involving primary, lower secondary and upper secondary school teachers. During the training activities, stimuli were given to foster the teachers’ critical reflections on the impact of interactive whiteboards in transforming the learning environment.

Another national program that activated eLearning initiatives for teachers and other members of school staff was the *ForTic* Program (“Piano nazionale di Formazione degli insegnanti sulle Tecnologie dell'Informazione e della Comunicazione” – National plan for the training of teachers on ICT). The program, which ran from 2005 to 2008, activates the development of a web portal that offered technological training through a blended learning approach. The aims of the program were: (a) to improve teaching and learning processes in specific ICT subjects and through general ICT-related skills; (b) to empower students in gaining practical understanding of different ICT tools, styles of learning, communication and dissemination of information; (c) to enhance teachers' professional capabilities by training them in the use and application of ICT as part of their administrative role and within their pedagogical approaches. Three main training paths were activated: (1) the first one was for teachers with insufficient competences in the use of ICT; (2) the second path was aimed at creating specific figures of consultant-teachers, experts about the methodologies for the use of ICT and the available didactical resources; (3) the third path was aimed at providing some teachers with the necessary competences to become ‘champions’ for the technological infrastructures of a school or of a cluster of schools.

With a similar aim of offering support and guidance for teachers to integrate software and multimedia into the teaching/learning process, an online service was established in 1999 by the Italian Research Council’s Institute for Education Technology (ITD-CNR): *ESSEDIQUADRO* (http://sd2.itd.ge.cnr.it/guidaeng/index.htm). This searchable catalogue lists educational software for all school levels and disciplines, with particular attention to special education needs, and provides comprehensive information on educational software products from both Italy and abroad. Each record in the software database comprises general information about the product, as well as educational information (subject area, topic, target users, educational strategy, prerequisites) and a user-oriented description of the product.

Another example of a research project carried out to develop and experiment innovative didactical settings that significantly employ digital technologies is *FENIX*. The *FENIX* project was sponsored in 2008-2009 by an Italian bank foundation, with the specific aim of using digital technologies, such as didactic software, on-line didactic environments and videogames, to line-up cognitive disadvantages, improve the motivation to learn, and strengthen relevant basic concepts such as the mathematical- scientific ones. The Fenix portal (www.edurete.org/fenix) is subdivided into two sections: the first one is a database of didactic games; the second presents didactical paths to be developed at school.

The use of ICT in the Dutch Education System and the Projects/Initiatives involving the use of digital technologies to raise students' achievement in the Netherlands

In the Netherlands the responsibility for the education system lies with the ministry of Education. The ministry establishes conditions for primary and secondary education and the provinces have a limited role to play in the management of education and on its contents. However the ministry wishes to offer educational institutions the space they need to carry out improvements and reforms on their own.

The *Eurydice's Key Data on Learning and Innovation through ICT at school in Europe*, highlights that, in the Netherlands, ICT is taught as a tool for specific tasks in other subjects in both primary and secondary schools and almost all schools use ICT as a tool for education and innovation. No official indications are given about the use of ICT in class or for complementary activities, by students and teachers, moreover, there are no central recommendations on the use of ICT in student assessment.

The report "*Four in Balance Monitor 2012. ICT in Dutch primary, secondary and vocational education*" (Kennisnet, 2012) states that "compared with schools in neighbouring countries, schools in the Netherlands are among the top in the European Union in terms of ICT infrastructure" (p.6). In fact, according to this document and to the country profile of the document "*Survey of school: ICT in education*" (European Schoolnet, 2012), almost every school has one or more interactive whiteboards; wireless Internet and optical fibre connections are becoming standard at secondary schools and in the vocational education and training sector; the majority of pupils in vocational education and training take their own laptops with them to school. With regards to the use of ICT, the number of teachers working with computers during the lessons has increased in recent years. Eight out of ten teachers have satisfactory technical ICT skills and six out of ten teachers have mastered the pedagogical skills they need to use ICT in their teaching.

According to the "*Country report on ICT in Education*" (Ottenheijm et al., 2011), the Dutch Ministry of Education and Culture supports specific ICT multiannual national programmes, aimed at providing a broad impulse regarding specific ICT issues as formulated by the schools themselves or sector organizations. The *Mediawijzer* programme, for example, is an expertise centre for Media Literacy organised by different institutions, such as *Kenniset*, the public educational organization that supports Dutch primary, secondary and vocational institutions in the effective use of ICT, enabling them to take advantage of the opportunities offered by ICT. *Mediawijzer*'s objective is to increase knowledge of new media and the necessary competences in its use. The program "*Stimulating the use of digital learning material*" was initiated in 2008 to stimulate increased use of digital learning material in primary, secondary and vocational education. A specific portal that hosts Dutch and mathematics' contents for vocational training levels has been created within this program.

In 2009, the online platform "*Leraar24*" was created to support teachers in their professionalization with the use of ICT (www.leraar24.nl). Thanks to this platform, teachers can learn from each other's experience, share their methods and discuss key issues.

Since 2004, SURFnet and Kennisnet have been collaborating in the *SURFnet/Kennisnet Innovation Programme*, a project that aims to enrich education through innovative and practical ICT applications relevant to the entire educational process.

Other national programs concern the use of digital technologies in teaching and assessment.

Web-based tools, for example, have been developed as practice programs for elementary school students to help them with specific mathematical content areas:

- *Rekentuin* (Math Garden) is a practice interface that is adaptive to the level of the child, and therefore helpful to a broad range of students (http://www.mathsgarden.com/). With the use of incentives, children practice different categories of problems (arithmetic operations, counting, series…).

- The *Freudenthal Institute* has designed and developed several web-based tools aimed at helping children practice problems through visual aids and provided strategies to be chosen (http://www.fisme.science.uu.nl/publicaties/subsets/speciaalrekenen/). Children could therefore gain insight into the operations and the mathematical constructs they practice. Most of the tools can be understood without elaborate verbal feedback. Some other tools contain more elaborate verbal instruction.

- The project *Educative computer games for kindergarten mathematics* investigates the effects of an educative computer game aimed at facilitating the development of number sense at kindergarten (http://www.nwo.nl/onderzoek-en-resultaten/onderzoeksprojecten/23/2300185423.html).

The use of ICT in the Norwegian Education System and the Projects/Initiatives involving the use of digital technologies to raise students' achievement in Norway

The Norwegian Ministry of Education provides funds to the local authorities across the country to enable them to choose and purchase digital learning resources. The use of digital tools is one of five basic skills within Knowledge Promotion (the Norwegian National Curriculum established in 2006), which defines goals generally and specifically for each subject and each key stage within primary and secondary education. The provision of a range of digital learning resources is therefore essential in all schools. As part of the Knowledge Promotion reform, a three-year plan for funding the upgrade of learning resources was put in place.

The country profile of the document "*Survey of Schools: ICT in Education*" (European Schoolnet, 2012) highlights that students in Norway enjoy near optimal conditions for learning with ICT. In fact, the ratio of computers/laptops to student is the highest in the EU. Although the percentage of students in schools where teachers use ICT in more than 25% of lessons is slightly below the EU mean, the use at grade 11 is well above, and student use at grades 8 and 11 is above the EU average. Teachers' as well as students' confidence in ICT is above the EU mean, and teachers are well supported in terms of training and the presence in schools of ICT coordinators having a pedagogical as well as a technical role. Despite these very positive developments within the primary education sector, Norwegian teachers are quite outspoken about the obstacles they face to using ICT in their classrooms. Many teachers declare their difficulties in finding adequate learning materials for teaching and consider existing teaching materials on the internet to be of poor quality.

At the upper-secondary level, the majority of county authorities have formed a digital learning portal called the *National Digital Learning Arena* (*NDLA*), where content is freely available to everyone. This has facilitated both the purchase of commercial resources and also encouraged the development of resources by teachers and others. These 'user-generated' resources are moderated by universities and colleges. Almost all schools in the Norwegian education system make use of a learning platform. The most widely used are Fronter and It's Learning, which consist of a number of different features that are especially tailored for the education sector.

Since Information and Communication Technology (ICT) are considered important tools, not only for increasing quality, innovation and creativity, but also for efficiency and simplification of processes and services, digital skills are among the five basic skills in taught in Norwegian schools. This also sets requirements for kindergartens and teacher-training programmes.

The *Norwegian Centre for ICT in Education* (Senter for ikt I utdanningen, http://iktsenteret.no/english), which falls under the authority of the Norwegian Ministry of Education and Research, aims at fostering smarter learning and higher quality throughout the education system by offering a variety of services for ICT in education - from kindergarten to teacher training. The main objective of the centre's work is the use of ICT for improving the quality of education, the learning outcomes and the learning strategies.

In the *Country report on ICT in Education* (Gregersen, 2013) it is declared that there is no national initiative that addresses the use of Web 2.0 technology in teaching or education. However it is stressed that there are some initiatives from practitioners, which encourage content sharing by teachers, such as such as the *Del & Bruk* (Share & Use, delogbruk.no).

As regards the use of digital technologies for students' assessment, the report highlights that for the last few years there has been an option to take the final exam after year ten as a computer-based exam and that digital exams are likely to replace paper exams within a few years. Moreover the Norwegian Directorate for Education and Training and the Norwegian Centre for ICT in Education have initiated a project through which they are examining these issues. In addition to traditional exams, annual national tests in Norwegian, English and mathematics are carried out digitally.

The Norwegian Centre for Mathematics Education, which leads and coordinates the efforts to improve and develop work methods and learning strategies in educational mathematics, has developed some web-based test materials, created to give the teachers insight into their pupils' abilities in Mathematics. "*Alle teller*" is an example of these materials. It comprises written tests for grades 1 to 10, a guidance for their implementation and evaluation, the assessment form and a guidance for the students' interviews (http://www.alleteller.no/).

The use of ICT in the South African Education System and the Projects/Initiatives involving the use of digital technologies to raise students' achievement in South Africa

According to the South Africa country report (Isaacs, 2007) of the "*Survey of ICT and Education in Africa (Volume2)*", the current ICT in education policy framework has been evolving since 1996 and is embedded within a broader national government economic, social, and development strategy. This strategy includes a specific focus on the role of ICTs in the promotion of economic growth, and social development and a dedicated policy on the transformation of learning and teaching through the use of ICTs.

In 2001, a Strategy for ICT in Education was jointly presented by the National Department of Education and the Department of Communication. This strategy laid the basis for the *e-Education White Paper* adopted in 2004 (*White Paper on e-Education: Transforming Learning and Teaching through Information and Communication Technologies*). The main goal of this policy is that every learner in the primary and secondary school sectors should be ICT capable by 2013. To achieve this, schools are expected to be developed into e-schools consisting of a community of both teachers and learners with the following characters: learners utilise ICTs to enhance learning; qualified and competent leaders use ICTs for planning, management, and administration; qualified and competent teachers use ICTs to enhance teaching and learning; the access to ICT resources supports curriculum delivery; ICT infrastructures are connected. However, in practice most South African schools computer-based technologies are not yet explored, as teachers do not have access to computers for their daily teaching purposes and lack basic ICT competencies (Blignaut, Hinostroza, Els & Brun, 2010).

ICTs are being used in both initial teacher training and continuing professional development for teachers in sub-Saharan Africa and South Asia. They are being used to support teacher training in ICT use, and more broadly, for their professional development in subject knowledge and classroom practice. Materials are being delivered through a range of technologies including laptops, tablets, mobile phones, media players and DVDs (see Health and Education Advice and Resource Team. (2013). ICTs and Education (pp. 1–33). Oxford).

A wide range of tools and technologies, not necessarily digital, have the potential to support teaching and assessment in mathematics.

In terms of digital tools, various tools are available internationally and in South Africa. A small number of schools have functioning computer labs, so those that require the use of a computer can not be used at most schools. These are examples of online digital tools developed in the South African context:

- *Green Shoots*, which can be used both online and offline, is for grade 3-6 learners and enables students to practise mathematical skills on a computer and teachers to keep track of learners' progress (www.greenshootsedu.co.za);

- *MoMaths* is an online resource consisting of mathematics quizzes for Grades 10-12 learners, provided through Nokia sponsorship (momaths.nokia.com). Learners can access the quizzes from a computer or from their cell phones, along with some explanations of the basic mathematical concepts and processes. This characteristic of MoMaths could help teachers with formative assessment, if they use the MoMaths functionality to register their class and then to use the automatic monitoring mark sheets to check on the progress of their learners;

- *Cami maths* is another online tool that allows learners from all grades to practise mathematics and teachers and parents to track learners' progress (www.camiweb.com). Using Cami at school requires to have a computer lab.

Comparative analysis of the National Projects/Initiatives involving the use of digital technologies to support teaching and assessment in the FaSMEd countries

The analysis of the different National projects/initiatives, developed in the FaSMEd countries, that involves the use of ICT in schools to support teaching and assessment, enabled to subdivide them according to specific categories:

a) Websites to share materials and other forms of support for teachers in the use of technologies;
b) Web-based test and materials to support teachers in students' assessment;
c) Web-based practice programs for students;
d) Programs/Initiatives aimed at fostering the use of ICT in school;
e) Programs that involve teacher professional development to promote an effective use of ICT;
f) Programs and initiatives aimed at developing activities to raise students' achievement in Mathematics and Science through the use of digital technologies;
g) Projects involving the use of question-response systems/tablets or other digital tools in the teaching and learning process and for assessment purposes.

The results of this comparative analysis are summarised in Table 1 (reported in Appendix).

D2.3.3 International Initiatives and Projects focused on the use of digital technologies in teaching and assessment

In this section, significant International initiatives and projects will be introduced, with the aim of presenting the state of the art as regards the research on the use of ICT in teaching and assessment.

The initiatives have been classified according to their main objectives:

(1) Surveys and studies on the use of ICT in Education;

(2) Projects aimed at analysing the implementation/use of ICT at school, disseminating innovative materials and providing new models of teaching/learning through ICT;

(3) Projects involving the experimentation of specific technologies for teaching and assessment;

(4) Projects mainly focused on teacher professional development.

The initiatives belonging to each category will be presented in the following sections.

Surveys and studies on the use of ICT in Education

Different surveys and studies have been developed recently to analyse the levels of implementation of ICT in schools and the main outcomes of this implementation. Most of these have been a fundamental resource for this third deliverable.

The "*Survey of Schools: ICT in Education. Benchmarking access, use and attitudes to technology in Europe's schools"* (2013) is the final report of a study prepared for the European Commission 'DG Communications Networks, Content & Technology'. The study aims at benchmarking progress in ICT availability and use in 31 countries (EU27, Iceland, Norway, Croatia and Turkey) by surveying students, head teachers and teachers. Therefore it contributes to the development of up-to-date and relevant indicators and to the establishment of a continuous monitoring system on ICT access, use and impact in schools. It focused on the following themes: ICT Infrastructure and use; schools' equipment; ICT based learning activities and confidence in digital competence; teachers and students' experiences in ICT based learning activities; school policies, strategies, support and attitudes; teachers' confidence and opinions; students' use of ICT. Moreover it highlights the critical factors in ICT in education, providing recommendations for the future. Country chapters are available on the webpage of the website of the study (https://ec.europa.eu/digital-agenda/node/51275).

Another significant report is the Eurydice's *"Key Data on Learning and Innovation through ICT at school in Europe"* (2011). This report analyses the evolution of ICT use in education and the changes it has brought about in national policies and practices concerning teaching methods, contents and evaluation processes. It also examines the strategies used in countries to train and support teachers in the use of ICT.

Other studies have been commissioned with the aim of analysing the link between successful implementation of educational innovation and successful installation and use of ICT. Many case studies, for example, have been developed within the program "*ICT and the Quality of Learning*", carried out by the Centre for Educational Research and Innovation (CERI) of the Organisation for Economic Co-operation and Development (OECD). The program included international collaborative projects, which disseminate information on successful practice and experience. Some of the reports of the studies, implemented according to a draft structure provided by OECD/CERI, are available on the education section of the OECD website (http://www.oecd.org/edu).

A similar approach was developed within the "*Second Information Technology in Education Study – Module 2*" (*SITES-M2*), carried out by the IEA (International Association for the Evaluation of

Educational Achievement). *SITES-M2* is an international comparative study aimed at examining different pedagogical practices and different ways of using ICT for teaching and learning, examining innovative classroom practices through case study methods. In each of the 28 countries that participated in the study, national panels used common selection criteria, modified by national context, to identify 174 innovative classrooms. National research teams used a common set of case study methods to collect data on the pedagogical practices of teachers and learners, the role that ICT played in these practices, and the contextual factors that supported and influenced them. The International Coordinating Committee (ICC) conducted a cross-case analysis using qualitative and quantitative methods. Implications are drawn for both improved policy and classroom practice.

SITES-M2 follows the previous *SITES* (2006), which examined how teachers and students used ICT in mathematics and science and analysed the conditions at the system, school, and teacher level that were associated with different pedagogical practices and different ways of using ICT for teaching and learning.

Projects aimed at analysing the implementation/use of ICT at school, disseminating innovative materials and providing new models of teaching/learning through ICT

In the last few years, projects analysing the implementation of ICT at school have been developed mainly to highlight models of effective teaching/learning and to disseminate innovative materials among teachers.

CensusAtSchool (started in 2000 in the UK), for example, is an international project that involves the collection and dissemination of real data about the use of ICT across the curriculum for teaching and learning (http://www.censusatschool.org.uk/). One of its aims is to encourage effective ICT teaching and learning, including the use of the Internet.

The project *ICTways* is analysing the implementation/use of ICT in primary, secondary and vocational schools, in the Sciences domain, to: (1) provide an inventory of existing ICT in primary and secondary schools in Europe and the existing gaps in software and hardware, in particular in Sciences; (2) show the impact of the introduction of ICT in the classroom for that purpose; (3) analyse training procedures for teachers in ICT use and to assess the motivation of students and teachers to use ICT in the classroom; and (4) recommended best practices for using ICT in the Sciences classroom. A network of educational communities has been promoted within the project, with the task of analysing the current practice in the application of active methodologies (inquiry-based, problem and project-based, social collaboration, game-based learning) and the use of interactive technologies (digital whiteboards, mobile devices, 3D systems), fostering the exchange of good practice between participants in the network.

Creating a living network of schools was also one of the main methodologies adopted within the *LSL* project (“*Living Schools Lab*” project, 2012-2014), aimed at exploring, sharing and disseminating good practice in whole school approaches to ICT in teaching and learning (http://lsl.eun.org). *LSL* is a two-year project, involving 12 Ministries of Education, funded by the European Commission and coordinated by European Schoolnet. The main objective of the project is to create: (a) a growing network of primary and secondary schools that share best practice and ways to successfully embed the use of technology in teaching and learning; (b) a strong community of practice to foster continuous professional development opportunities for teachers; (c) opportunities for schools to get involved in action-based research.

iTEC (*Innovative Technologies for Engaging Classrooms*, 2010-2014), is another large-scale research project which involves 26 partners (education ministries, technology providers and research organisations) from 20 different countries. The project was led by *European Schoolnet*, a public-sector consortium funded by 31 education ministries and supported by the European Commission.

With the aim of transforming the way in which technology is used in schools and providing a sustainable model for redesigning teaching and learning, 2,500 classrooms across Europe were involved in the experimentation of educational tools and resources. The main objective of the project was to create innovative teaching/learning settings, providing a model able to describe how innovative technologies could be integrated in everyday school activities. The project examined also what necessary processes should be activated to foster the transfer of innovative teaching/learning practice on a large-scale.

An exploration of the challenges and opportunities involved when using social media in learning and education was also developed by the *SMILE* project (*Social Media in Learning and Education*, 2012-2013), aimed at improving the understanding of the challenges and opportunities associated with how children are growing up in a world of social media and technology. The project, which led to the constitution of an online learning laboratory, involved more than 100 teachers from across Europe. Pedagogical materials and resources, together with reflections and suggestions on some critical aspects of the use of social media as regards school policies, pedagogical principles, and professional development are available in the online laboratory. Moreover a digital handbook on the outcomes of the project has been created to represent a reference for the teachers who want to learn how to handle social media in their classroom and how to use them for their professional development.

Some initiatives are specifically focused on digital assessment, such as the *Collaborative Assessment Alliance*, a multi-stakeholder partnership built to extend the research outcomes of the project "Assessment and Teaching of 21st Century Skills" through the engagement of government and education members. The *Collaborative Assessment Alliance* enables local organizations interested in digital assessment to work with leaders in the field to foster the creation of assessment tasks and the transfer of knowledge to provide help to build local capacity and expertise in creating these new types of assessments.

Projects involving the experimentation of specific technologies for teaching and assessment

As highlighted in section D2.3.1, there are different digital technologies that could be useful in supporting teaching and assessment. In order to provide actionable information on their use, in the last decade many research projects have focused on the analysis of their implementation in the classes.

In the following, some examples and their main objectives are introduced:

- The *Creative Classrooms Lab* (2013-2015) involves experimentations on the use of tables in 45 classrooms of nine countries. The project, supported by the European Commission's Lifelong Learning Programme, refers to the Future Classroom Scenarios methodology developed by iTEC (see previous section). One of the aims of the project is to provide coherent strategies to implement tablets to support teaching approaches and to integrate their use in national ICT programmes, enabling Ministries of Education to address common policy challenges related to the rapid introduction of tablet technologies (http://creative.eun.org/).

- The *CCMS* Project (*Classroom Connectivity in Promoting Mathematics and Science Achievement*) is a large national research study on the impact of classroom connectivity technology in Algebra teaching and learning. The intervention includes professional development to support teachers in the implementation of a classroom connectivity technology to communicate with students handheld calculators (Irving et al., 2010).

- The ITEAM Project (*Integrating Technology-Enhanced Assessment Methods*), funded by the not-for-profit company JISC, aims at exploring the use of different technologies to enhance assessment and feedback opportunities for all students and to promote student support and self-regulation. The project provides an integrated approach to the institutional support for a range of in- and out- of-class technologies to enhance the assessment and feedback opportunities for all students. These technologies include Electronic Voting Systems, Questionmark Perception, Automated assessment feedback and an integrating Student Dashboard (http://www.jisc.ac.uk/whatwedo/programmes/elearning/assessmentandfeedback/iTeam.aspx)

- The *WHIRL* Project: (*Wireless Handhelds In Reflection on Learning*), which started in 2002 and was granted by the US National Science Foundation, investigated the potential uses of handheld computers in K-12 science classrooms. The project, which focused on the development of assessment materials, directly involved the teachers, who were asked to apply their own curricular materials, content understanding, and pedagogical content knowledge to the project (Penuel & Yarnall, 2005).

- The *FANC* Project (*Formative assessment in a networked classroom*), funded by the US National Science Foundation, explored a feasible way of implementing formative assessment combining it with technology. In particular, the projects, which involved 32 seventh-grade teachers in 15 schools, studied the effects of two professional development models for using formative assessment in a connected classroom (Olson et al., 2010).

- The *eVIVA* Project (*Electronic virtual ipsative valid assessment*, 2002-2004) was a pilot project that involved the use of mobile phones, voice recognition technology and the Internet to support formative and summative assessment. The assessment process developed within the *eVIVA* project aims to enable pupils to reflect on their work over time, share their thinking and early drafts of their work, receive meaningful feedback from their teacher and their peers, and provide their teacher with a variety of evidence to support their judgements. The responses of pupils and teachers to this new approach and the implications of the project for e-assessment were analysed (McGuire et al., 2004).

Projects involving teacher professional development

A fundamental aspect characterising projects focused on an effective implementation of ICT in teaching and assessment is the full involvement of teachers, often associated with the activation of professional development initiatives. In the following, examples of projects that involve the constitution of educational paths for teachers are introduced.

CPDLab (*Continuing Professional Development Lab*) is a two-year project, supported by the Commission's Lifelong Learning Programme as a Comenius Multilateral Project (http://cpdlab.eun.org). It develops and delivers training courses to help teachers in the implementation of new technologies and pedagogies, unlocking their full potential. Teachers are guided to identify effective ways to better use new technology in the classroom and to engage students to improve motivation and results.

The courses, proposed in the Brussels' training venue "*Future classroom lab*", are aimed at secondary schools teachers and range from making the most of interactive whiteboards, bringing eSafety into everyday teaching, and implementing new teaching and learning activities in the future classroom. Each of the courses consists of several modules that can be used independently and combined in different ways, enabling different learning pathways according to the need of different target groups. The "*Future Classroom Lab"* consists of a room designed as an interactive classroom to illustrate how a traditional classroom setting can use technology to enhance interactivity and student participation. The potential of *"Future classroom lab"* to become a more permanent 'Living Lab' or 'Ideas' Lab' has been recognised. It represents, therefore, also a place where policy makers, ICT suppliers, teachers and educational researchers can find concrete evidence and data for effective use of technology in schools and discuss how to support schools and teachers in their teaching practices.

TeLLNet (*Teachers' Lifelong Learning NETwork*, 2009-2012) is a project aimed at studying how teacher networks can offer ways to support teachers' competence building and personal and professional development (http://www.tellnet.eun.org/web/tellnet). Through the study of the eTwinning network (which involve more than 80,000 teachers) by means of visualization techniques and social network analysis, the project highlighted that learning networks play a key role in supporting in-service teachers, enabling them to effectively exploiting the transformative potential of ICT for innovative and effective teaching and learning approaches.

Another project specifically focused on studying teacher learning and pedagogical change is the *TLT* Project (*Teacher learning of technology-enhanced formative assessment* 2005-2010, https://www.srri.umass.edu/tlt), whose focus was the analysis of how secondary science and mathematics teachers learn to use an electronic "classroom response system" to implement a specific pedagogical approach called Technology-Enhanced Formative Assessment (Beatty et al. 2008). Other goals of the *TLT* project were to identify effective and efficient methods of teacher professional development in TEFA and to develop tools and techniques for the evaluation of teachers' TEFA mastery. Intensive on-site professional development programs were conducted for 40 middle- and high-school science and math teachers involved in the project.

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APPENDIX

Table 1: Comparative Analysis on the tools/programs/initiatives to support teaching and assessment through dygital technologies in the FaSMEd countries								
	England	**France**	**Germany**	**Ireland**	**Italy**	**Netherlands**	**Norway**	**South Africa**
Websites to share materials and other forms of support for teachers in the use of technologies	NAACE ALT British Educational Communications and Technology Agency (Becta) Futurelab The National Centre for the Excellence in the Teaching of Mathematics (NCETM)	MATHEMATIQUE ET SCIENCES EN LYCEE PROFESSIONNEL AIDE AUX ELEVES EN DIFFICULTE SIALLE PRIMTICE: EDUBASES	$T^{3.}$	SCOILNET DISCOVER SENSORS	ESSEDIQUADRO	KENNISNET	NATIONAL DIGITAL LEARNING ARENA	
Programs/Initiatives aimed at fostering the use of ICT in school	TECHNOLOGY ENHANCED LEARNING Becta		SEMIK D21 T^3	DISSOLVING BOUNDARIES BRIDGE 21 DIGITAL SCHOOLS	SCUOLA DIGITALE-LIM SCUOLA DIGITALE-CLASSI 2.0 ARDESIA TECH	The projects developed by KENNISNET	The initiatives developed by the Senter for IKT i utdanningen (Centre for ICT in Education)	The White Paper on e Education: “Transforming Learning and Teaching through Information and Communicatio

								n Technologies”
Programs that involve teacher professional development to promote an effective use of ICT	The Naace Annual PDE Programme The futurelab CPD workshops		T^3	PDST TECHNOLOG Y in EDUCATION				
Programs and initiatives aimed at developing activtities to raise students’ achievmente in Mathematics and Science through the use of dygtital technologies	The NCETM resources on the use of ICT and digital technologies in the teaching of mathematics			MISSION V SCIENCE UNLEASHED	FENIX	KENNISNET - TECHNIEKPACT - NATIONAAL REGIEORGAAN ONDERWIJSONDERZO EK OFFERS OPPORTUNITIES FOR PRACTICE-RELATED RESEARCH ON THE USE OF ICT - PLATFORM BETATECHNIEK		
Web-based test and materials to support teachers in students’ assessment						- KENNISNET - REKENWEB -REKENTUIN	ALLE TELLER	
Web-based practice programs for students	The BBC library of educational online materials					REKENTUIN (MATH GARDEN) The WEB-BASED TOOLS DESIGNED BY THE FREUDENTHAL INSTITUTE		GREEN SHOOTS MOMATHS CAMI MATHS
Projects involving the use of question-response systems/tablets or other dygital tools in the		INTEGRER DES BOITIERS DE VOTE DANS L’EVALUATION DES ELEVES DURANT LES		THE USE OF TABLET DEVICES IN ACCS SCHOOLS				

teaching/learning process and for assessment purposes		SEANCES DE MATHEMATIQUES UTILISATION DE LA TABLETTE NUMÉRIQUE POUR APPRENDRE AUTREMENT EN EPS: L’ÉVALUATION FORMATIVE PAR COMPÉTENCES						