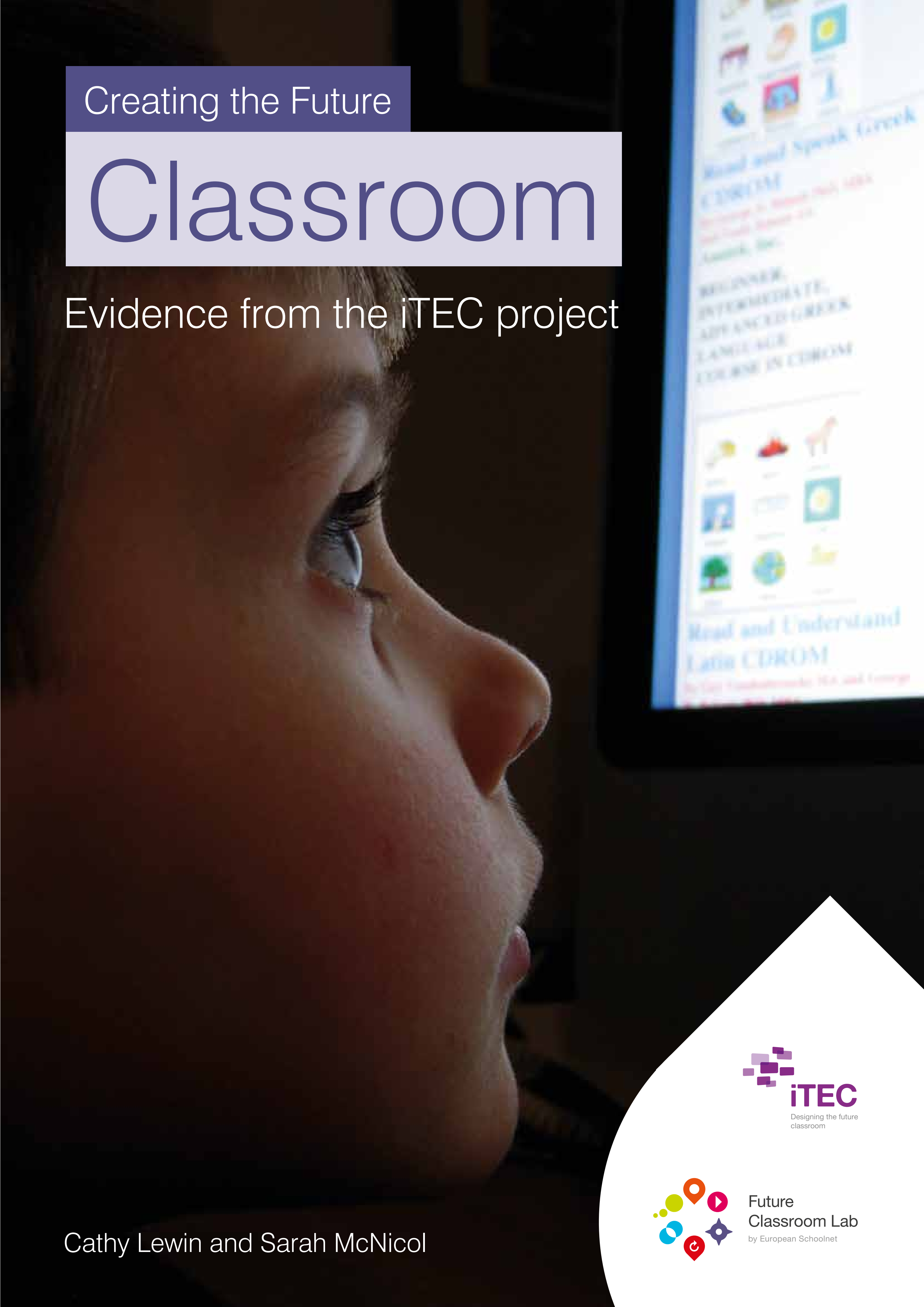

Creating the Future

Classroom

Evidence from the iTEC project

Cathy Lewin and Sarah McNicol

iTEC
Designing the future classroom

Future Classroom Lab
by European Schoolnet

Creating the Future Classroom: Evidence from the iTEC project

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Contents

Glossary of terms used in iTEC

Composer
The Composer is a prototype planning tool for teachers to create, adapt and share Learning Activities. It provides teachers with suggested resources, including tools and services, to use in the delivery of a selected Learning Activity, potentially exposing them to technologies they have not come across before.

Cycle
The 18-month period during which scenarios, and then Learning Activities, were developed; Learning Activities were pre-piloted; and Learning Activities (exemplified through Learning Stories) were validated and evaluated through large-scale pilots. Each cycle overlapped, there being five in total.

Design challenge
Key issues in teaching and learning that need to be addressed in designing Learning Activities, for example barriers to engagement in learning, difficulties in understanding a concept.

Design opportunity
Existing practices or circumstances that support learning and that can address design challenges (ways of overcoming identified barriers).

Future Classroom Maturity Model
The Future Classroom Maturity Model is an online self-assessment and benchmarking tool. It shows a number of progressive stages of maturity in the adoption of learning technology to support advanced pedagogical practices. The tool has five levels, or stages of innovation, and five dimensions. It can be used prior to scenario creation to enable stakeholders to review current technology integration within their specific context and to inspire areas for scenarios that can be incrementally innovative. It can also be used as a means of evaluating existing scenarios.

Future Classroom Scenario
A Future Classroom Scenario (FCS) is a narrative description of learning and teaching that provides a vision for innovation and advanced pedagogical practice, making effective use of ICT. A Future Classroom Scenario: takes into account issues, trends and challenges relating to the current school or educational system; provides a high level description of Learning Activities and resources; describes the roles of learners, teachers and other participants; and is not limited to the 'classroom', taking place in any context, environment or place where learning is possible.

Future Classroom toolkit
A collection of tools and processes to support the scenario-led design process including the identification of trends, the development of Future Classroom Scenarios, and the development of Learning Activities and stories.

Innovation
An innovation in education is defined in iTEC as a change that brings about a positive result in learning and teaching. It is understood as being context specific, i.e. a learning scenario that is considered an innovation in one country or school is not necessarily considered so in another.

iTEC approach
The iTEC approach is designed to bring about change in classroom practice, in order to better equip young people with the competences and attitudes to meet the opportunities and challenges of 21st century society and the workplace. The approach is based on Future Classroom Scenarios and the systematic design of engaging and effective Learning Activities using innovative digital pedagogies.

Learning Activities
Learning Activities are concrete descriptions of discrete actions. They add practical detail and provide concrete guidance for teachers in how to deliver the approaches described in the scenarios. The Learning Activities provide details of the role of the teacher and learner, and include ideas for using ICT resources effectively. These Learning Activities are non-curriculum specific, but do provide opportunities for the development of 21st century skills.

Learning Story
A Learning Story can be provided to describe the sequence in which the Learning Activities could be delivered, how the activities inter-relate and some example contextual information such as curriculum or subject area and learners involved. Learning Stories are useful in helping teachers think about how they could use Learning Activities in their own classrooms, but should not be considered as lesson plans for adoption, just examples for guidance and inspiration. A typical Learning Story will include 3-8 Learning Activities, which describe the resources that are needed to successfully complete each activity.

National Pedagogical Coordinator (NPC)
Person in charge of coordinating the involvement of teachers in the iTEC project at national level, with a particular responsibility for pedagogical support.

National Technical Coordinator (NTC)
Person in charge of coordinating the involvement of teachers in the iTEC project at national level, with a particular responsibility for technical support.

People and Events Directory
The People and Events directory, a prototype tool, facilitates professional network development and collaboration for teachers. It connects teachers with similar interests, allowing them to share knowledge and experiences. It also enables them to identify people (from outside their current networks) and events that might support learning and teaching.

ReFlex
ReFlex is a prototype tool that enables students to create a personal reflection space and build up a series of reflections about their learning, which are subsequently displayed on a timeline.

Scenario Development Environment (SDE)
The Scenario Development Environment (SDE) is a prototype recommender system which takes into account the user's profile (for example school level and subject) and can provide recommendations for resources such as applications, events, widgets and lectures.

TeamUp
TeamUp is a prototype tool designed to organise students into groups by interests, and also to enable the groups to record reflections on their progress.

Widget
An ICT based software application or tool that provides a user with useful data or a function. Often widgets are small user interfaces that give access to information on the internet, or make use of information on the internet.

Widget Store
The Widget Store provides a means of curating resources (widgets) and moving them easily between learning platforms, potentially offering seamless integration and facilitating interoperability. Teachers are able to create their own widgets to add to the store a prototype tool. Users can rate and review the widgets.

Executive summary

iTEC (Innovative Technologies for an Engaging Classroom) was a four-year research and development project funded by the European Commission involving 26 partners: ministries of education (MoEs), technology providers and research organisations. iTEC aimed to transform and scale-up the use of technology in teaching and learning in primary and secondary education. Through iTEC, educational tools and resources were piloted in 2653[1] classrooms with around 50,000 students across 20 European countries[2]. The resulting iTEC approach develops Future Classroom Scenarios (narratives of classroom innovation), engaging Learning Activities (descriptions of discrete activities) using innovative digital pedagogies and inspiring Learning Stories (exemplifying sequences of Learning Activities). These resources support teachers to rethink and develop their pedagogical practices, providing detailed examples of how learning and teaching could be more student-centred, authentic and engaging using digital tools. During the project, research and development led to the creation of some prototype technologies designed to support the iTEC approach.

The main outputs of iTEC are:

- a scalable scenario-led design process for developing digital pedagogy;
- the Future Classroom Toolkit and accompanying training provision;
- an extensive library of Future Classroom Scenarios, Learning Activities and Learning Stories.

This report synthesises the evidence of the impact of iTEC on learners and teachers, and the potential of the iTEC approach for system change, looking at:

- iTEC processes, tools and resources (case studies, user/teacher surveys, focus groups);
- Classroom perspectives (case studies, teacher/learner surveys);
- National perspectives (case studies).

In order to facilitate system-wide uptake of the iTEC approach, the project provided ongoing training and support both within and beyond the end of the project. Under the umbrella of the European Schoolnet Future Classroom Lab initiative[3], a five-day, face-to-face training course was developed. This includes a suite of iTEC modules and materials that can also be localised and adapted for use at national and regional level[4]. The course was also adapted for online delivery in the style of a MOOC (Massive Open Online Course), as part of the new European Schoolnet Academy initiative[5] .

Five overlapping cycles of piloting were undertaken over the four years of the project (C1-C5). These were supported at national level by coordinators who recruited teachers; provided training and facilitated online and face-to-face communities; and collected evaluation data. In the first four cycles, packages of Learning Activities, exemplified through 2-4 Learning Stories, were created centrally and subsequently localized by national coordinators. Learning Activities focused on '21st century skills' (notably independent learning, critical thinking and problem solving, communication and collaboration, creativity, digital literacy) integrated with project-based approaches, teamwork, reflection, peer assessment, outdoor learning, involving outside experts, and students as designers and producers. In the final cycle of the project, national coordinators took over ownership of the process and organised learning design locally, in order to foster sustainability. Over 300 people were involved in scenario development workshops and over 400 people were involved in Learning Activity development workshops, the majority of whom in both cases were teachers. In addition, with central support, a small number of teachers created scenarios that were deliberately intended to be radical or disruptive. As iTEC prototype technologies became available, teachers were encouraged to incorporate them into their piloting activities.

Evaluation activities using a mix of instruments took place during all five cycles and regular reports were produced. The key findings identified in this report, covering all cycles, are outlined below under three headings.

1: How did the iTEC approach impact on learners and learning?

1.1 Teachers perceived that the iTEC approach developed students' 21st century skills, notably independent learning; critical thinking, real world problem solving and reflection; communication and collaboration; creativity; and digital literacy. Their students had similar views.

1.2 Student roles in the classroom changed; they became peer assessors and tutors, teacher trainers, co-designers of their learning and designers/producers.

1.3 Participation in classroom activities underpinned by the iTEC approach impacted positively on students' motivation.

1.4 The iTEC approach improved students' levels of attainment as perceived by both teachers (on the basis of their assessment data) and students.

[1] This number has been revised slightly since the summary report was finalised.

[2] AT, BE, CZ, DE, EE, ES, FI, FR, HU, IE, IL, IT, LT, NL, NO, PL, PT, SK, TR, UK

[3] http://fcl.eun.org

[4] http://cpdlab.eun.org/course-materials

[5] http://europeanschoolnetacademy.eu

2: How did iTEC impact on teachers and teaching?

2.1 The Future Classroom Scenario development process was viewed as innovative by policy makers, teachers and stakeholders, but further work is needed.

2.2 Teachers and coordinators perceived that the Learning Activity development process has potential to develop innovative digital pedagogies in the classroom, but further work is needed.

2.3 Teachers perceived that the iTEC approach enhanced their pedagogy and digital competence.

2.4 Teachers became more enthusiastic about their pedagogical practices.

2.5 Teachers stated that they used technology more frequently; it was systematically integrated throughout the learning process rather than reserved for research or presentations.

2.6 Teachers were introduced to digital tools they had not used before; some were more favourably received than others.

2.7 Teachers collaborated more, both within and beyond their schools, a process facilitated through the online communities.

3: What is the potential of iTEC for system-wide adoption in schools?

3.1 Awareness of the iTEC approach is growing in educational systems, and there are signs of widespread uptake.

3.2 The scenario-led design process can support mainstreaming of innovation, provided the process is refined.

3.3 The library of scenarios, Learning Stories and Learning Activities was viewed by policy makers and teachers as a valuable output of iTEC to support system-wide classroom innovation.

3.4 In countries in which iTEC aligns closely with national policies and strategies, the iTEC approach is likely to be adopted and to influence future practices.

Recommendations

The iTEC project has provided evidence that an incremental approach to change, at the heart of the learning design process that was developed, can be effective. The findings, and the evidence behind them gathered during the project, naturally lead to a number of consequential implications that impinge on policy making, learning management, technology provision and research.

Policy making

Towards a learning culture. Mechanisms and structures should be put in place, supported through changes to formal curricular and assessment systems, to encourage the development in schools of a culture of self- and peer-reflection, continuous development, new roles, innovation and risk-taking, in order for schools to continue to be fit for purpose, to exploit new opportunities, and to meet evolving needs. Such changes should be communicated effectively to all stakeholders including parents in order to encourage positive attitudes. The potential of the iTEC approach and legacy resources to support this culture should be exploited in professional development, online communities, and through teacher ambassadors. This is particularly true in countries where the iTEC approach aligns closely with national policies and strategies. Opportunities to incorporate the iTEC approach in initiatives and programmes related to 21st century learning and change in schools should be identified.

Investigate learning outcomes. Further, larger-scale, impact studies of classroom implementations of iTEC tools, Learning Activities and Learning Stories at national level – including randomised controlled trials – could be commissioned, focusing on learning outcomes (specifically 21st century skills) and student attainment. The revised Future Classroom Toolkit could be validated in countries where the toolkit clearly supports current policy directions.

Build teacher capacity. Policies and support systems, including professional development, technical and pedagogical suppport, should be put in place to A) develop teachers' digital competence, particularly in digital pedagogy, and B) facilitate teachers' engagement in collaborative processes for learning design. Cost-effective online professional development, such as MOOCs and communities of practice, should be supported at national and international level, including the use of video clips and screencasts to enable teachers to share ideas and good practice. The potential for integrating iTEC assets (the Future Classroom Toolkit, Scenarios, Learning Activities and Learning Stories) created within national professional development structures and initial teacher training should be explored further. To facilitate this trainers and teacher educators would benefit from targeted development on the use of the toolkit and should be supported to use the toolkit in their own practice.

Management of teaching and learning

A culture of collaboration. School leaders should put in place organisational structures (e.g. embedding professional network participation in the school culture, and ensuring that teachers have sufficient time for effective networking) and incentive schemes to ensure that teachers share their experiences with other teachers, within and beyond their own school and develop positive attitudes towards teacher networking and collaboration. Teachers should establish and maintain connections with colleagues in their own school, and beyond, to share and jointly develop digital and pedagogical knowledge and skills as a community.

21st century competences. Teachers, supported by school leaders and through professional development, should create opportunities for students to take greater responsibility for their learning, work collaboratively, engage in authentic learning experiences and develop 21st century skills through the adoption of digital pedagogy. This demands a shift in teacher and learner roles. It also demands a positive attitude towards change, innovation and risk-taking. As students engage in more active and student-centred learning approaches, the development of digital competence becomes increasingly important.

Technology provision

End-user involvement. Technology providers should take account of the lessons learned through the iTEC project in relation to meeting needs, evolving pedagogical practices, motivating and engaging teachers as partners rather than end-users in product development and testing.

Product development. Of the various iTEC prototype technologies developed, the Scenario Development Environment would benefit most from further research and development with a view to its commercial development. It would be beneficial to conduct a larger scale pilot study, particularly in the countries where it was received favourably.

Research

Research topics. Research should continue to study whole school change, new ways of designing and managing learning, and pedagogies that make most effective use of new digital tools to produce desired learning outcomes, where possible using randomised controlled trials. Research should build on iTEC results and investigate further how best to mainstream technical and pedagogical innovation, assessing both radical and incremental approaches in school education contexts.

National specificities. Further research should be undertaken in countries in which the iTEC approach does not align so closely with national policies and strategies to identify how the approach could be adapted to fit different needs.

Research methodology. It would be beneficial to analyse, refine and validate methodologies for large-scale evaluations of projects lasting more than two years, where the object of study and the technologies used themselves evolve. Developing approaches for assessing learning outcomes in such conditions would be worthwhile.

1. Introduction

> *[T]he story of digital learning technologies has hardly begun, and there will be no end until they have become so fully embedded in education that we will not even ask [if technology has potential for learning]. (Laurillard, 2012, p210)*

Decades of research and investment in Europe have demonstrated some key drivers and mechanisms for improving standards in schools by making effective use of technology. Technology-enhanced learning, remains high on European agendas, embedded throughout Europe 2020, the EU growth strategy for 2010-20[6]. The two targets for education are reducing the rates of early school leaving and increasing completion of tertiary education. Another target is to increase employment and this in turn relates to ICT (information and communications technology) through the recognition of the imperative to develop e-skills and digital literacy through education and training. Indeed, the success of Europe 2020 is considered to be 'dependent on the strategic and effective use of ICT'[7].

Each country has its own examples of excellent, leading edge schools producing impressive results through technology-enhanced learning. However, a clear challenge remains - the mainstreaming gap. The Digital Agenda for Europe, one of the seven flagship initiatives of Europe 2020, highlights the importance of mainstreaming eLearning in national policies (EC, 2012). The use of ICT in teaching and learning is promoted across all subject areas and it has long been argued that technology has the potential to act as a lever for pedagogical innovations (Law, 2008). Yet use of ICT in classrooms is still limited (EACEA P9 Eurydice, 2011; EC, 2013) and where it is used it does not always lead to changes in pedagogical practices (Law, 2009; Shear, Novais et al., 2010). '[E]vidence of digital technologies producing real transformational change remains elusive' (Luckin et al., 2012, p8).

This report presents the evaluation of a four-year research and development project (2010-2014) designed to address the mainstreaming challenge and scale-up the adoption of digital tools in the classroom. iTEC (Innovative Technologies for an Engaging Classroom) involved ministries of education (MoEs), technology providers and research organisations with the aim of transforming the way that technology is used in teaching and learning. The project had 26 project partners, including 14 ministries of education, and funding of €9.45 million from the European Commission's FP7 programme. The project also had 26 associate partners, two of which participated in the evaluation. Through iTEC, educational tools and resources were piloted with around 50,000 students in 2,653 classrooms, exceeding the original target of 1,000, across 20 European countries.

The key objective of the project was to develop a sustainable model for fundamentally redesigning teaching and learning through embedding digital pedagogy in teachers' day-to-day practices. Digital pedagogy, a term growing in use in the field of education, is the use of technology to change the learning experience rather than replicate existing practices (Tchoshanov, 2013). The aim was to bring about large-scale change in classroom practices across Europe. The main focus was not on radical visions involving the use of blue skies technologies, but progressive adoption of innovative Learning Activities that effectively use and exploit both existing and emerging technologies in order to better equip young people across Europe for life and work in the 21st century. The resulting iTEC approach concerns Future Classroom Scenarios and the systematic design of engaging and effective Learning Activities which use innovative digital pedagogies.

This evaluation report synthesises the evidence of the impact of iTEC on learners and teachers, and the potential of the iTEC approach for system change, looking at:

- iTEC processes, tools and resources (case studies, user/teacher surveys, focus groups);
- Classroom perspectives (case studies, teacher/learner surveys);
- National perspectives (case studies).

Firstly, the report outlines the context of the project by describing the underpinning rationale; outlining the scenario-led learning design process developed in iTEC; and summarising the evaluation approach and how this was responsive to the changing needs of the project.

Secondly, the ICT and pedagogy landscape at the start of the iTEC project (2010) is briefly reviewed and subsequent changes and new/developing research foci that have influenced the project are highlighted.

Thirdly, the iTEC evaluation addressed three key questions which are examined in detail:

- How did the iTEC approach impact on learners and learning?
- How did the iTEC approach impact on teachers and teaching?
- What is the potential of the iTEC approach for system-wide adoption in schools?

Finally, the conclusions and recommendations are presented.

[6] http://ec.europa.eu/europe2020/index_en.htm

[7] http://ec.europa.eu/enterprise/sectors/ict/e-skills

1.1 Rationale for the project

The innovation in iTEC is that it gets teachers focussed from the start on rethinking their pedagogical approach and is not technology-led. (Finland, national case study)

From the outset, the project set out to develop mechanisms for scaling-up pedagogical change through technology integration as advocated by Rodríguez and colleagues (2012) who argue for a 'process to generate innovations' (p.83). These mechanisms included:

- A learning design process;
- Professional development for teachers;
- Support systems such as online communities.

Moreover, the focus in the project was on pedagogy enabled through, rather than driven by, technology innovation, critical to effective adoption of technology-enabled learning (Ertmer & Ottenbreit-Leftwich, 2013; Kampylis et al., 2013; Mor & Mogilevsky, 2013). That is, the project has 'emphasize[d] how, not what, technology should be used to achieve meaningful learning outcomes' (Ertmer & Ottenbreit-Leftwich, 2013, p.175, emphasis as in original).

At the heart of the ITEC project is the development of a scenario-led learning design process. Learning design is growing in importance, although not yet widely adopted (Emin-Martínez et al., 2014). It demands 'subject knowledge, pedagogical theory, technological know-how, and practical experience' and can 'engender innovation in all these areas' (Emin-Martínez et al., 2014, p.4). The process should enable designers to share their ideas and re-use those ideas of others (Emin-Martínez et al., 2014). Processes which facilitate access to 'exemplary' resources for re-use are effective change mechanisms (Voogt et al., 2011). Approaches to learning design should be suitable for all teachers, not just early adopters and those skilled in learning design (Dillenbourg & Jermann, 2010). Approaches should take account of the existing classroom ecosystem and be flexible enough to accommodate teacher and student preferences (for technologies for example) (Dillenbourg & Jermann, 2010).

The iTEC learning design process is collaborative and involves many stakeholders, not only teachers and students but also prospective employers, researchers and the wider community. The pedagogical approaches underpinning the scenarios created in the project emerged through this collaborative process, through a shared belief that they were appropriate for developing ambitious scenarios that would inspire teachers to make their classrooms more engaging. These approaches included developing 21st century skills, adopting social constructivist approaches, personalisation, active and project-based learning. The term 21st century skills, sometimes referred to as 21st century competences, covers a broad range of skills that young people are believed to need to operate effectively in education and the workplace (P21, 2009; Binkley et al., 2012). Although many of these skills were just as relevant in the 20th century, it is still important to 'ask whether enough is being done in current education systems' (OECD, 2013, p45); hence, is it a valuable concept. Of the many frameworks and definitions that exist, most refer to collaboration, communication, ICT, creativity, critical thinking and problem solving (Voogt & Pareja Roblin, 2012)[8]. This particular set of (transversal) skills were the ones that repeatedly surfaced through iTEC, as a result of the processes that were developed and piloted. The development of such skills can be enhanced through the use of technology (Ananiadou & Claro, 2009; Groff, 2013). This demands changes in pedagogical practices across the curriculum and ensuring that teachers have the know-how to use technology effectively (Voogt & Pareja Roblin, 2012; Voogt et al. 2013).

1.2 The iTEC approach

The iTEC approach involves the development of Future Classroom Scenarios, and the Learning Activities that are derived from them, to inspire teachers to develop digital pedagogy. Scenarios were developed through bringing together a wide range of stakeholders (including teachers and students) to identify current educational trends, together with collaborative workshops tasked with developing responses to such trends. Learning Activities were developed, in a participatory process involving teachers, by identifying design challenges, then selecting resources and developing prototype tools to address the challenges. These two development processes are described in more detail below (see section 4.2).

In order to facilitate system-wide uptake of iTEC results, the project developed provision for ongoing training and support both within and beyond the end of the project. iTEC contributed to the development of a five-day face-to-face professional development course under the umbrella of the European Schoolnet Future Classroom Lab[9], designed as a Living Lab to further develop, demonstrate and showcase scenarios for teaching and learning in the future classroom. This course included a suite of iTEC modules and training materials that were first delivered to teachers within the Future Classroom Lab in Brussels in July 2013. The course can also be localised and adapted for use at national and regional level by educational ministries and other partners[10]. Initial investigation into the integration of this training programme into teacher training has been undertaken. Shorter two-day versions of the course have been run for eTwinning teachers in the Future Classroom Lab. The course was also adapted for online delivery for a substantial number of users in the style of a MOOC (Massively Online Open Course), as part of the new European Schoolnet Academy initiative[11], and run twice: in March-April and July-August 2014 (see section 4.3 below).

The iTEC project also developed a number of prototype technological tools intended to support the learning design process and classroom activities. These are described and discussed in section 4.6 below.

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[8] The remaining commonly occurring skill according to Voogt and Pareja Roblin (2012) is social and/or cultural competences such as citizenship.

[9] http://fcl.eun.org/

[10] http://cpdlab.eun.org/course-materials

[11] http://www.europeanschoolnetacademy.eu/

Five cycles of piloting were undertaken involving 2,653 classrooms with around 50,000 students in 20 European countries (see appendix B for further details). Piloting was supported at national level by pedagogical and technological coordinators who recruited teachers, provided training and facilitated online and face-to-face communities and workshops, and undertook aspects of data collection for the evaluation.

In the first four cycles, teachers were presented with a package of Learning Activities, exemplified through 2-3 Learning Stories. These were created centrally (involving a wide range of stakeholders) and subsequently localized by national coordinators. Localization in some cases involved a selection process at national level which meant that teachers had little, or no, choice (i.e. teachers were presented with a single Learning Story and accompanying package of Learning Activities). In other cases, national coordinators elected to pilot Learning Stories and activities from a previous cycle, or to create their own Learning Story to accompany the Learning Activities. As iTEC technologies became available, teachers were encouraged to incorporate them into their piloting activities. Across the four cycles Learning Activities included 21st century skills (independent learning, critical thinking and problem solving, communication and collaboration, creativity, ICT) integrated with project-based approaches, teamwork, reflection, peer assessment, outdoor learning, involving outside experts, and students as designers and producers.

iTEC in practice: Redesigning School Learning Story, C3, UK

This Learning Story required students to think about spatial design and the different motivations of people who use a particular learning space. The aim was to design a new space for future use based on identified current challenges in relation to school-based activities. Implemented in a UK secondary school as part of a Product Design course, it took 10 lessons over a period of 5 weeks. Students were divided into groups of three using TeamUp (an iTEC prototype technology). Before they started, students agreed the class ground rules and their team roles. The teacher created an Edmodo group (a social learning network designed specifically for formal education[12]) to allow students to share their work, receive group messages and access resources in the 'library'. Students were presented with a design brief that the teacher had created, students were allowed to use their own mobile devices to record the issues they found around the school and then used their own tablets to record photos, videos, make notes and record their thoughts and reflections throughout the project. Students without tablets were loaned portable video cameras. Students created a prototype and then discussed their design with future users. Based on the feedback, students then created their final design prototype, which they presented to the class. Perceived innovation included students working as producers, collaboration, easy collection of multimedia data and students developing a better understanding of the design process.

In the final cycle of the project, coordinators in each participating country facilitated the learning design process (rather than this being facilitated centrally), running workshops for scenario and Learning Activity development that involved a wide range of stakeholders including students and head teachers (in excess of 700 across both processes, the majority of whom were teachers). In this cycle, coordinators were asked to incorporate an iTEC tool for learning design into the Learning Activity development process and to encourage teachers to use other iTEC tools either in their classroom activities or through workshops. In addition, 19 teachers were recruited and supported centrally to create scenarios that were deliberately intended to be radical or disruptive.

The main outputs of the project were:

- a scalable scenario-led design process for developing digital pedagogy;
- the Future Classroom Toolkit and accompanying training provision;
- an extensive library of Future Classroom Scenarios, Learning Activities and Learning Stories.

The scenario-led design process, the toolkit supporting its use and the library of resources created through the process are the aforementioned mechanisms of change which the project set out to create. In addition, iTEC technologies were developed to support the design process, to curate digital resources and to connect teachers. These prototype tools designed to research proof of concept were intended to support the scenario-led design process through making people, tools, services and content interoperable and discoverable. The user perspective on these tools was undertaken as part of the evaluation and is reported here. A full review of the prototype tools is available in the full technical research report which includes usability testing and the analysis of usage logs (together with the user perspective) (Griffiths et al., 2014).

1.3 Evaluation methodology

The evaluation was designed to support the development of the iTEC approach and prototype tools, as well as to assess the impact of the iTEC approach on learning and teaching. Therefore, formative, rather than summative, evaluation was necessary, underpinned by qualitative data collection (Creswell, 2009). Learning Activities and Learning Stories were sources of inspiration for teachers to own and adapt, rather than a fixed series of prescribed actions, resulting in wide-ranging interpretations and implementations. Given the diverse nature of the pilots, the project could not set out to provide quantitative measures of impact on student performance.

[12] https://www.edmodo.com/

Regular surveys of teachers and learners yielded perceptions about the impact and future potential of iTEC outputs. Teachers' opinions about whether or not an idea 'works' for them are important (reflecting their experiences, understanding of the complexities of the classroom, and the particularities of their context), as are indications of intended future use (Dillenbourg & Jermann, 2010; Voogt et al., 2011). Case studies, including interviews with relevant stakeholders (e.g. teachers, students, head teachers) and observations of lessons, enabled the particularity and complexity involved in the implementation of Learning Stories to be explored (Stake, 1995) and provided an opportunity to triangulate teachers' claims against observed practices. In order to strengthen the evidence further, national case studies involving interviews with policy makers and key stakeholders were conducted. Assertions that are warranted by a wide range of data sources are stronger than those warranted by a single data source, irrespective of the number of 'instances' of such data (Erickson, 1986). Therefore, collecting data representing a wide variety of stakeholders' perspectives about their experiences of the iTEC approach increased the robustness of the evaluation approach adopted.

Data were collected (September 2011 to June 2014) as follows:

- 68 implementation case studies (an interview with the classroom teacher, head teacher, 6-8 students, ICT coordinator and a lesson observation);
- 1399 teacher survey responses (online questionnaire);
- 1488 student survey responses (online questionnaire);
- 18 teacher focus groups (with 10-12 teachers);
- 16 national case studies (an online interview with two policy makers and the MoE partner lead)

Coordinators arranged for the surveys to be translated into national languages. Surveys were administered centrally using an online survey service. Data collection for classroom pilots and iTEC processes, tools and resources was undertaken by national coordinators. Co-ordinators were provided with an evaluation handbook each cycle, which specified the procedures to follow and provided interview schedules and data collection checklists. To complement the handbook, an online training session was provided each cycle. Coordinators were also encouraged to seek advice as and when required. National case study interviews were conducted directly by members of the iTEC project team. Whilst the analyses of these interviews are presented as 'national case studies', of course they actually only reflect the view of 2-3 stakeholders, albeit directly or indirectly related to national policy making.

The evaluation has thus utilised a wide range of data collection approaches and gathered the perspectives of a wide range of stakeholders including teachers, students, national coordinators, policy makers, head teachers, and school ICT coordinators. Moreover, it has taken place over the course of three years, embedded within a cyclical design which enabled the iTEC approach and iTEC prototype technologies to be tested and refined.

A responsive approach to the evaluation was undertaken. Following feedback from the second project review in November, the project adapted the evaluation plan in the latter stages of the project in order to provide more evidence relating to how the iTEC approach had the potential to be exploited and scaled up. The rationale for this refocus was:

- To capture and document the innovative iTEC processes which could support mainstreaming;
- To shift the focus of evaluation from classroom impact to strategic impact;
- To place greater emphasis on the evaluation of iTEC technologies.

To meet this need, case studies of the iTEC approach were conducted, together with national case studies of policy makers' perceptions. The teacher surveys in cycles 4 and 5 were shortened and amended to focus less on classroom practices and more on perceptions of the potential of iTEC technologies. Questions on what teachers felt was innovative about iTEC (in relation to pedagogy and technology) were also included. Classroom impact continued to be evaluated, but on a smaller scale as the evidence from cycles 1-3 was substantial, positive and confirmatory. The number of case studies conducted each cycle was reduced from three per country to one per country. NPCs were requested to ensure that teachers selected for case studies in cycles 4 or 5 used iTEC technologies and/or radically innovative scenarios and/or nationally developed scenarios.

A number of limitations apply to the data presented in this report. Firstly, the evaluation relies substantially on the perceptions of teachers, students and other stakeholders, which of course are subjective and may not represent fully their real experiences. Observations of lessons were undertaken by national coordinators, providing an opportunity for triangulation, but these data formed a smaller proportion of the full range of data analysed. Therefore, the findings reported below are not necessarily 'objective truths' but, as argued above, teachers' (and others') opinions are important.

Secondly, due to differences in the numbers of teachers from each country participating in the evaluation (typical for a large-scale evaluation of tool/process development), comparative analyses of individual countries are not possible; rather, aggregated findings are presented acknowledging the limitation that cultural differences are thus not accounted for. Given the wide-ranging interpretations of iTEC resources it is likely that the variation within a country in terms of teacher practices is substantial, although of course at the country level (and in some cases regional level) policies and the curriculum will influence teachers. In addition, variation in the numbers of teachers responding to the survey each cycle naturally leads to some degree of bias towards certain countries. Responses from a single country in a cycle (dependent both on the numbers of teachers piloting and the number responding to the survey) are as low as 1 or 2, and as high as 64. Nevertheless, the data do provide an overview of European teachers' experiences and perceptions of the iTEC approach.

Thirdly, the recruitment of teachers was managed by national coordinators and varied from welcoming all interested teachers to selection processes and individual recommendations. Irrespective of this, participation was voluntary, leading to a bias towards teachers interested in changing their practice and developing their digital pedagogies. Therefore, the findings presented in this report are not necessarily representative of all European teachers; rather, the findings represent the views of innovators and early adopters of digital pedagogy. It must be noted that such teachers may be more biased towards responding positively to survey and interview questions through feeling an affinity to the project. However, teachers did also comment on challenges and limitations of the iTEC approach and iTEC prototype technologies. They were also more cautious in relation to some questions such as their perceived impact on student attainment and potential uptake of the iTEC approach by teachers at national level, suggesting that they did give careful consideration to the questions being asked of them.

Finally, the iTEC evaluation had to account for large numbers of teachers involved, national coordination and the diverse range of interpretations and adaptations of the iTEC resources (eg Learning Activities and Learning Stories). This has meant that data collection instruments were necessarily broad. With limited resources, it was not possible to explore issues deeply (for example, how the perceived barrier of time actually manifested itself) or to account for multiple understandings of complex concepts underpinning the evaluation (for example, student motivation and engagement).

The evaluation of each cycle was documented in a separate report[13]. Findings were shared with project members and work package leaders in several ways, often prior to finalising the reports. After each of the first four cycles, findings were shared with teachers, policy makers and others through a webinar. Results were also presented at project meetings (face-to-face and online) and conferences. Most importantly, analysed and raw data were shared with relevant work package leaders to inform project development tasks and processes. Furthermore, evaluation results have been integrated with work package specific evaluation activities and included in other work package reports, for example providing the user perspective on iTEC prototype technologies. Further detail on the evaluation methodology is presented in Appendix C.

[13] http://itec.eun.org/web/guest/deliverables

2. The ICT and pedagogy landscape

2.1 Mapping the terrain in 2010

The design of iTEC was based on the assumption that educational systems are slow to change; school and 'the classroom' will endure; and that designs for future classrooms need to be connected to current practice. Therefore, a collaborative process involving a wide range of stakeholders was proposed. The purpose was to develop innovative scenarios (challenging yet feasible) which were pedagogically-led rather than driven by technology (Meyer, 2010; Ertmer & Ottenbreit-Leftwich, 2013). The potential of technology to support increased collaboration and communication in, and beyond, the classroom was recognised (Johnson et al., 2009), particularly for constructivist approaches to learning and teaching. At this time, learning platforms and social media were predicted to become increasingly important, together with multi-touch surfaces, games-based learning and access to resources beyond content (e.g. experts) (Johnson et al., 2009).

At the start of the project, innovative current practices (2008-2011) were reviewed in order to examine the evidence behind the proposed process in more detail; to situate the iTEC evaluation in general and national contexts; and to provide a baseline for participating countries (Lewin et al., 2011). The focus was on teachers' actual use of technologies in the classroom, and not on the potential of emerging technologies to change practices.

The literature reviewed supports the assertion that technology can support innovation in learning and teaching although, of course, educational technology is not without its critics (for a critical review see Selwyn, 2014). The majority of the studies reviewed were small-scale and involved enthusiastic early adopters of technology. They found that teachers using ICT regularly adopted more student-centered and varied pedagogies (Voogt, 2009; Pelgrum & Voogt, 2009). For example, increased learner autonomy (leading to changes in student and teacher roles), collaboration, games making, self-assessment, peer assessment and learner construction of digital artefacts and knowledge (Fredriksson, Jedeskog & Plomp, 2008; Crook et al. 2010).

'Innovative practices' at the time fell into five thematic areas:

- Core subject teaching and learning
- Blurring boundaries
- Learner agency, individualisation and mobility
- Innovation in classroom-based assessment
- Game-based learning

Core subject teaching and learning. Innovative practices were taking place across a range of curriculum subjects. In science, location-based data logging enabled students to capture and analyse data and through visualisation tools, providing opportunities to collaborate and engage in more authentic tasks (Crook et al., 2010; Woodgate et al. 2011). Networked graphing calculators were used in mathematics to support collaboration, peer review and investigative approaches, together with increasing learner autonomy and classroom discussion (Duncan, 2010; Wright, 2010). In literacy, multimodal text production resulted in changing the roles of learners and teachers; improved collaboration, communication and digital literacy skills; and was believed to deepen learners' knowledge and understanding (Burnett et al., 2006; Ryan et al., 2010; Wikan et al., 2010).

Blurring boundaries. Virtual schooling was growing at the beginning of the iTEC project, particularly in the US, although pedagogical change did not necessarily take place (Bacsich et al., 2010; Cavanaugh et al., 2009). Where pedagogical change occurred, students were given greater autonomy, and engaged in reflection and collaborative activities (Heck et al., 2009; Means et al., 2009). Technology was also used to enable access to remote experts (Murcia & Sheffield, 2010). The uptake of learning platforms was slow in Europe - except in Denmark (Wastiau, 2010). Where in use, learning platforms enabled collaboration, discussion, and independent and personalised learning to take place (EUN, 2009a; Granic et al., 2009; Jewitt et al., 2010). Notably, Granic and colleagues concluded that the 'crucial element [for successful integration of technology] remains the teachers and their pedagogical approaches, hence the need for a well-developed pedagogical framework' (2009, p1070). The use of social software in school contexts in countries with more developed uses of educational technology such as the UK was rare (eg Crook et al., 2008). Innovative practices supported by social software included peer assessment, peer review, collaboration and reflection leading to changes in teacher and learner roles, increased learner independence, more spontaneous discussion and authentic tasks (EUN, 2009a; Garcia et al., 2010; Tarasiuk, 2010).

Learner agency, individualisation and mobility. Personal ownership of mobile devices was becoming increasingly common and predicted to have a significant impact on education in the medium term (Johnson et al., 2009). However, the uptake of tablets, laptops and netbooks did not necessarily lead to pedagogical change (Penuel, 2006; Drayton et al., 2010), emphasising the need for professional development (Drayton et al., 2010). When teachers changed their pedagogical approach, such technologies were used to support collaboration, inquiry or project based learning, individualised and independent learning (Cranmer et al., 2009; Li S.C., 2010; Li et al., 2010; Vuorikari et al., 2011). At this point in time, mobile and smartphone use was limited. Exploratory studies suggested that such devices supported self-assessment, data capture, reflection and collaboration (De Marcos et al., 2010; Moura & Carvalho, 2009). More extensive research had been undertaken on the use of handheld devices, for example, to support collaborative learning and student autonomy with an impact on student communication skills and learning outcomes (Nussbaum et al., 2010; Roschelle et al., 2010). However, some use of handheld devices was reportedly 'traditional' (McFarlane et al., 2008).

[14] The project was organised as 11 work packages with four focused on technology

Innovation in classroom-based assessment. The use of technology increases opportunities for formative, self- and peer-assessment (Clark-Wilson, 2009; Kimbell et al., 2009) through, for example, handheld devices and recording video clips. At the beginning of the project, learner response devices were becoming increasingly prevalent, particularly in tertiary education, but also in schools. Whilst sometimes used to support more traditional practices, the devices were also used to facilitate collaborative learning and constructivist pedagogies (Bannister, et al., 2010; Hoekstra, 2008); to promote active learning (Moss & Crowley, 2011; Simpson & Oliver, 2007); and to increase opportunities for formative feedback (Roschelle et al., 2004; Simpson & Oliver, 2007).

Game-based learning. At the start of the iTEC project game-based learning was still at an early adopter stage (Blamire, 2010). In 2010, the Horizon report for K-12 noted that there was increasing interest in game-based learning and predicted that it would have a wider uptake within 2-3 years (Johnson et al., 2010) with learner creation of games potentially developing critical thinking and creative design skills. As with other technologies, teachers may not change their pedagogical practices when adopting such new tools (Miller & Robertson, 2010; Williamson, 2009) but games can be used to support constructivist approaches (Groff et al., 2010; Ulicsak & Wright, 2010; Whitton, 2010).

Whilst the potential of technology for changing pedagogy was (and still is) discussed at length (eg. Crook et al. 2009; Moyle, 2010), typical use by European teachers at the time the iTEC project was conceived rarely extended beyond skills practice in mathematics and looking up information in science, whilst in other subject areas such as language learning technology, was little used (EACEA P9 Eurydice, 2011). Similar large-scale studies concluded that even when reliable infrastructure is in place, evidence of pedagogical change was limited (Law, 2009; Shear, Gorges et al., 2010; Shear, Novais et al., 2010).

The implications of the review were that, while pedagogical innovation is possible, at that point in time it was still rare as it required teachers to engage in professional development, invest time and take a degree of risk (Penuel, 2006; EUN, 2009). The barriers to innovation through technology are well-documented (e.g. unreliable infrastructure, teacher attitudes and identities, external factors such as national curricula and high-stakes testing). These barriers to adoption meant that when the iTEC project was conceived the update of technologies to support teaching and learning was low. The iTEC project set out to develop a process designed to scale up technology use by challenging teachers to rethink their practices and making them aware of a range of technological tools which could support such endeavours.

2.2 Shifts and new horizons in 2014

Over a four-year project the landscape will inevitably change, particularly in relation to technology and digital pedagogy. This is not only driven through emerging and blue skies technologies, but also through changing policy priorities. The iTEC approach does not focus on specific technologies, nor even digital pedagogies. It is designed to account for these ebbs and flows, and enable learning design to respond the current context (at many levels including policy, national and school). Here we present a short review of selected current trends (those most closely linked to teachers' experiences in the iTEC project) to illustrate that innovation can take place irrespective of the changing context.

Personalised learning. Personalised learning enables the individual needs of learners to be met, giving each student autonomy and choice over methods, pace and evidencing knowledge (Johnson et al, 2014). It can be facilitated through blended learning environments, creating personalised learning pathways, and engaging a wider-range of stakeholders in the learning process (Tanenbaum et al., 2013; Johnson et al., 2014). Personal Learning Environments, designed explicitly to support such approaches, are not used extensively in school contexts, and often not for their intended purpose (Aceto et al., 2014).

Mobile learning. During the project there was a rapid uptake of mobile and tablet devices. In a recent study in the US, 73% of the 2,462 teachers surveyed claimed that their students used their own mobile phones either in the classroom or to support homework (Purcell et al., 2013). In the same study, 43% of teachers felt that their students used tablets for similar purposes. Tablets are becoming prevalent in some European classrooms (EC, 2013). The use of mobile devices is perceived to be important for innovation in secondary school classrooms (Aceto et al., 2014). Bring Your Own Device (BYOD), enabling learners to bring their own smartphone and/or tablet to school, is predicted to become more prevalent over the forthcoming year (Johnson et al., 2014).

Flipped learning. One of the pedagogical shifts during the course of the project has been the growing interest in flipped learning (Bergmann & Sams, 2012; Strayer, 2012; Hamdan et al., 2013) in which teachers use technology (eg instructional videos) to enable learners to study the content outside the classroom, leaving classroom time for active learning such as discussion and group activities. Although the approach per se is not new, technological advances and the ubiquity of devices that facilitate media recording have made it easier for teachers to implement flipped learning (Davies et al., 2013). Adopting such an approach can lead to students being more willing to work together and engage in active and student-centred learning in the classroom rather than passively receiving knowledge (Strayer, 2012; Hamdan et al., 2013). Time in the classroom can also be used to provide individual support, particularly for students who are struggling with specific concepts (Davies et al., 2013; Hamdan et al., 2013). Small-scale research suggests it can have a positive impact on student attainment in school contexts (Fulton, 2012; Hamdan et al., 2013).

Game-based learning. Game-based learning continues to be highlighted in many foresight studies as likely to impact on the classroom in the near future (Groff, 2013; Sharples, et al., 2013; Johnson et al., 2014) and important for supporting innovation in primary and secondary schools (Aceto et al., 2014). However, it seems to remain on the horizon in terms of mass uptake. The evidence on the relationship between games-based learning and impact on 'academic achievement' is mixed, but there is consensus that such use can impact positively on 'problem solving skills, broader knowledge acquisition, motivation and engagement' (Perotta et al., 2013, pii).

Computational thinking and game-making. With the increasing prevalence of computing in the workplace, it is argued that children should be taught computational thinking (Barr & Stephenson, 2011; The Royal Society, 2012). Indeed, many suggest that computational thinking is an essential 21st century skill, particularly in relation to problem solving, complementing subjects such as mathematics and engineering (Wing, 2006; Grover & Pea, 2013). In England for example, computing has become mandatory in the curriculum from September 2014, as a result of concerns about unsatisfactory delivery of computing education and the dwindling uptake of computing qualifications (The Royal Society, 2012; Berry, 2013). In the US, there is an initiative to substantially increase the number of computer science teachers in secondary schools (Grover & Pea, 2013). In Europe, Neelie Kroes (current vice-president of the European Commission) recently gave a speech arguing for scaling-up coding to an audience of industry partners, NGOs, coding clubs, educators and ministry representatives (Kroes, 2014).

One means of introducing computational thinking is through game-making. Authoring of stories, games and animations by students has emerged as a new pedagogical strategy following the increasing interest in environments such as Scratch[15], Gamestar Mechanic[16] and Kodu[17]. Scratch, for example, was designed to 'support self-directed learning through tinkering and collaboration with peers' (Maloney et al., 2010). The communities surrounding tools such as this have supported the 'social turn' (Kafai & Burke, 2013) from 'computational thinking' to 'computational participation' in which young people create, remix and share their digital artefacts. Game-making can lead to improved understanding of subject knowledge, creativity, increased engagement and the development of problem solving skills, critical thinking and deep learning strategy use (Li Q., 2010; Briggs, 2013; Vos et al., 2011; Yang & Chang, 2013). It facilitates independent and active learning, collaboration and exploratory approaches, leading to a shift in teacher and student roles (Briggs, 2013; Yang & Chang, 2013).

Maker culture. The maker movement, for example Fab Labs[18], provides further opportunities to engage in rapid prototyping processes to create a wide range of physical and digital objects with huge potential for supporting learning in the classroom (McKay & Peppler, 2013; Peppler & Bender, 2013). 3D printing has also becoming increasingly available in school contexts through low-cost options and community access through libraries and universities. Maker culture is predicted to grow in importance in the medium term (Sharples et al., 2013).

Connected learning. Whilst social media use has become commonplace in everyday life, its use in school contexts has yet to be adopted on a wide-scale, although is growing (Aceto et al., 2014). Although research evidence is limited, there are indications that social media, combined with student-centred approaches to learning, can positively impact on student achievement (Hew & Cheung, 2013). Teachers and students are less confident in their social media skills as compared to their operational ICT skills (Wastiau et al., 2013). Therefore, whilst being a technology that is becoming more commonplace in school contexts further work is required to support teachers to make the most of it.

Students as producers. Student production of multimedia resources has become easier in the classroom due to the integration of simple media capture functionality (video, audio, photographs) in commonplace technologies such as tablets and smartphones. Digital storytelling for example can provide an authentic and motivating task, facilitating collaboration and co-construction of knowledge whilst leading to improved attainment (in this case in English) and critical thinking (Yang & Wu, 2012).

Accessibility of infrastructure and resources. The provision of infrastructure and resources has increased, thereby facilitating more opportunities for classroom use. Even so, many teachers are still not using digital pedagogy (Ertmer & Ottenbreit-Leftwich, 2013; Wastiau, 2013). This can largely be attributed to teachers' attitudes and beliefs towards pedagogy and technology (Ertmer & Ottenbreit-Leftwich, 2013).

Reflecting on the changing landscape from the conception of the iTEC project to date there have been many changes. In 2010, social media use was comparatively rare; it is now more prevalent although teachers and students still require support to use social media safely in schools and to develop their skills to maximise the impact on learning. There has been a huge increase in the use of tablets and smartphones since 2010, both in day-to-day life, the workplace and education. Game-based learning continues to be 'on the current horizon'; this remains unchanged. It is interesting to note that whilst its proponents remain optimistic, even evangelistic, uptake remains limited. The potential of gaming and gamification warrants further research to understand why it is not being adopted by teachers. Game-making in particular has potential to support the development of computational thinking, another 21st century skill that advocates claim is important for life beyond education. The typical use of technology to support teaching and learning remains rather unadventurous, confined largely to using office tools and internet searches; digital pedagogy is still undeveloped in the average European classroom despite improved provision of infrastructure and other resources (EC, 2013).

15 http://scratch.mit.edu/

16 https://gamestarmechanic.com/

17 http://www.kodugamelab.com/

18 http://www.fabfoundation.org/fab-labs/

3. How did the iTEC approach impact on learners and learning?

European educational policy (such as Europe 2020) includes as one of its targets increasing employability and life-long learning through developing students' digital competency[19]. There is also a need to develop students' 21st century skills, generic skills that are increasingly important in the workplace (Dede, 2010; Redecker et al., 2011; Toner, 2011). It is therefore important to consider how the iTEC approach affected learners and their learning experience.

The iTEC approach concerns Future Classroom Scenarios and the systematic design of engaging and effective Learning Activities which use innovative digital pedagogies. Here, we report on how iTEC impacted on the learner's classroom experience. 2,653 cohorts of students participated in iTEC – approximately 50,000 across five cycles and from a total of 20 countries. Through their participation, they engaged in Learning Activities including group work, reflection, peer feedback, product design and producing digital (and other) artefacts, all underpinned through the use of digital tools.

3.1 Key findings

This section brings together the evidence gathered in relation to learners and learning. It focuses on how the learners' experience changed during classroom implementations which typically involved students undertaking projects lasting around six weeks. It considers the evidence of perceived impact (by both students and teachers) on students' 21st century skills and attainment. It also reflects on the impact of participating in iTEC pilots on student motivation. The evidence of impact was gathered from the teacher survey (n=1399), student survey (n=1488), national case studies (n=16), teacher focus groups (n=19) and implementation case studies from cycles 3-5 (n=68).

The iTEC approach positively impacted on students':

- Development of 21st century skills, notably independent learning, critical thinking, real world problem solving and reflection; communication and collaboration; creativity; and digital literacy.
- Roles in the classroom. Students became peer assessors and tutors, teacher trainers, co-designers of their learning and designers/producers.
- Motivation, through participation in classroom activities underpinned by the iTEC approach.
- Levels of attainment. Both teachers (on the basis of their assessment data) and students perceived that academic performance in curriculum subjects had improved.

3.2 Developing 21st century skills, knowledge and understanding

As stated above, the development of students' 21st century skills has been one of the pedagogical drivers underpinning the development of scenarios, Learning Activities and Learning Stories. Of this wide range of skills, six have surfaced repeatedly in iTEC: independent learning; critical thinking, problem solving and reflection; communication and collaboration; creativity and digital literacy.

The evidence is drawn from teacher surveys from all five cycles (n=1399), implementation case studies from cycles 3-5 (n=68) and teacher focus groups from cycles 4 and 5 (n=19). National case studies involving interviews with 41 policy makers and other stakeholders from 16 countries also provided evidence in relation to learning experiences as interviewees were asked to comment on perceived pedagogical change.

Independent learning refers to students having a greater understanding of their learning needs and taking more responsibility for their learning, through support and resources provided by the teacher; it includes learning in collaboration with others as well as learning alone (Meyer et al., 2008). Critical thinking has been defined in multiple ways (Kennedy et al., 1991) but broadly refers to making informed decisions on the basis of analysing, synthesising and evaluating information. Reflection is 'central to critical thinking and deeper learning' (Quinton & Smallbone, 2010, p126). Problem solving, creativity, collaboration and communication skills are generic skills increasingly required in the workplace with its shift away from manual work (Dede, 2010; Toner, 2011). Digital literacy is defined as 'the ability to use information and communication technologies to find, evaluate, create and communicate information, requiring both cognitive and technical skills' (ALA, 2011, p1).

Digital pedagogy has a key role in supporting the development of 21st century skills (Ananiadou & Claro, 2009; Groff, 2013). Technology, with appropriate scaffolding for learners' use, can facilitate independent learning and opportunities to use technology in this way are increasing (McLoughlin & Lee, 2010; Luckin et al., 2012). It has long been argued that technology has a useful role to play in facilitating critical thinking, problem solving and collaboration (e.g. Jonassen, 1999). ICT is an important tool for facilitating communication in educational contexts (National Research Council, 2012). Furthermore, technology can support creativity in education through enabling ideas to be developed, connections to be made, and facilitating opportunities for creating and making (Loveless, 2002).

[19] http://ec.europa.eu/europe2020/index_en.htm

Key finding 1.1 Teachers perceived that the iTEC approach developed students' 21st Century skills, notably independent learning; critical thinking, real world problem solving and reflection; communication and collaboration; creativity; and digital literacy. Their students had similar views.

Teachers and students agreed that engaging in iTEC Learning Activities developed students' skills for:

(The percentage of teachers (n=573-594) and students (n=1444-1488) in agreement, C4-5.)

Similarly, teachers (n=595-826, cycle 1-3) agreed that iTEC Learning Activities enabled students to:

- engage in active and independent learning (84%);
- express ideas in new ways (89%);
- communicate with each other in new ways (85%);
- communicate with their teacher in new ways (81%);
- develop collaborative skills (90%) (also supported by, C3-5: 41 of 68 case studies; C4: 6 of 10 teacher focus groups);
- develop creativity skills (90%);
- and use digital tools to support collaboration (91%) (also supported by, C3-5: 42 of 68 case studies; C4: 2 of 10 teacher focus groups).

85% of students (n=1488, C5) agreed that they became more confident in using ICT and 86% agreed that they could now use a wider range of new technologies.

I am totally convinced that the digital learning outcomes have been very substantial, and I think that doing the Learning Story has prepared the class for using some of the tools in a good way later on. I think that may help learning also.

(Norway, teacher interview, C2)

...the fact that classes became more appealing, and that it developed pupils' critical thinking. They began learning to listen, argue, which was something they were not used to doing; they learnt to address their own views in a relative manner and to accept the ideas of others. Then they began gathering different points of view, reflecting and making decisions. This is very innovative and beautiful to see in the pupils who managed to get there.

(Portugal, teacher C5)

...I think their ability to work together and co-operate has improved [. . .] when I think back, there were some students who preferred to let others do things for them, although they pretended to be involved in the group work, but when I look at them now, they are all contributing to the work.

(Estonia, teacher interview, C5)

It also helps us to be more creative because sometimes a pencil and a piece of paper aren't enough to show what is in my mind in real terms.

(Turkey, student interview, C3)

The positive impact of the iTEC approach on the development of students' 21st century skills replicates findings from similar studies such as the impact of digital storytelling (Niemi et al., 2014) and one-to-one laptop provision combined with a shift to student-centred pedagogies (Lowther et al., 2012). Generic and transversal skills become increasingly important as learning becomes more student-centred, social and collaborative (Redecker et al., 2011). Therefore, it is important to identify effective pedagogical approaches to develop students' 21st century skills, including digital literacy. Furthermore, a recent study identifying policy actions for mainstreaming ICT in education recommends that assessment systems should be revised to better account for 21st century skills and key competences (Brecko et al., 2014). Introducing effective pedagogical approaches, together with policy reforms, will ensure that students leave education with appropriate skills for the workplace.

3.3 Changing learning experiences, including student/teacher roles

The pedagogies presented through the Learning Activities included group work, reflection, peer feedback, product design and producing artefacts, all underpinned through the use of digital tools. For some teachers this represented a real shift in their pedagogical approach and for many, it extended their repertoire. The evidence is drawn from teacher surveys from all five cycles (n=1399), implementation case studies from cycles 3-5 (n=68) and teacher focus groups from cycles 4 and 5 (n=19). National case studies involving interviews with 41 policy makers and other stakeholders from 16 countries also provided evidence in relation to learning experiences, as interviewees were asked to comment on perceived pedagogical change.

Key finding 1.2: Student roles in the classroom changed; they became peer assessors and tutors, teacher trainers, co-designers of their learning and designers/producers.

According to the teachers surveyed, the most common way in which iTEC had made a difference to their pedagogy was that students roles changed (C4-5: 24%, n=586). Changes in teacher and student roles were noted as an important pedagogical innovation in nine of 16 national case studies. More specifically, teachers referred to increased independent learning and autonomy (C4: 5 of 10 teacher focus groups; C4-5: 10 of 21 case studies; C5: 15% of teachers surveyed, n=252)

It was more as if I was overseeing [their work]. I checked or guided, I adjusted, but they were the ones who went looking for the information, so I think that in their own school work, it changed a lot of things. It will be helpful for them at secondary school.
(France, teacher interview, C2)

...you give them free rein throughout the project. People work at very different speeds and do very different things. So I have to give up some control here. I must. I have to rely on the students to actually do the job even though I can't see them all the time.
(Norway, teacher interview, C4)

[The iTEC pilot] shifted the pedagogical activity from the teacher to the pupil, the teacher became the guide, the pupil is more in charge of his own learning, research and questioning. It makes pupils grow, enhances their commitment, prevents them from looking at the watch the whole time. Classes become more attractive.
(Portugal, teacher interview, C5)

Through the changes in student-teacher roles, learners became 'teachers' through a variety of activities including as peer assessors, peer tutors, teacher trainers and co-designers of learning.

Students were involved in assessment and giving feedback to their peers (C4-5: 7 of 21 case studies, 1 of 10 teacher focus groups). There were also examples of peer tutoring among students and the use of students as 'experts' – indeed teachers and authors – within the classroom (C3-4: 15 of 60 case studies).

If there were any problems with programming the game, two advanced students in programming helped them out, which added to a nice social pattern of behaviour.
(Austria, case study report, C3)

The role switch (student becomes a teacher and has to explain something) is also great.
(Belgium, teacher interview, C4)

In a group there are always some students who do not know quite what to do and another student will explain; they seem to learn better [this way] than when I explain even with the same words.
(Spain, teacher survey, C5)

In a few examples, students could be seen to be acting as teacher trainers, especially in supporting teachers in their use of technology (C4: 2 of 10 teacher focus groups; C4-5: 3 of 21 case studies):

> New ideas crop up during the process and new ways of putting things together that mean you have to act quickly. For instance, students discover lots of new programs that are appropriate to use
> (Norway, teacher interview, C4)

In some cases, there was evidence that students were developing a role as co-designers of their learning experiences, working together with teachers to develop new approaches to learning and assessment (C4: 2 of 10 teacher focus groups; C4-5: 4 of 21 case studies):

> In those lessons, we do a lot more and we contribute to the lesson a lot more than in a normal lesson. Sometimes we get the feeling of being in charge and that is great.
> (Austria, student interview, C4)

Three of the first four cycles involved Learning Stories and/or Learning Activities underpinning the design and/or creation of artefacts (beyond simply representing knowledge in a multimedia format for assessment purposes). Technology can support production in a wide variety of ways and in iTEC included video production, games creation engines and 3D printing technologies.

> It's very nice to know that [the teaching resources we have created for our peers] affects someone in the world. But then again, it's a bit stressful and confusing to know that someone is going to use what you've created, and it also makes you want to improve it.
> (Israel, student interview, C3)

iTEC has enabled a shift in the role of learners towards being producers not just consumers; with this role they develop a range of essential skills relating to critical thinking, digital literacy etc., which are not developed when students are passively receiving information. The most radical aspect of this is the publishing of their products to a wider audience, increasing the importance of their work.
(Norway, national case study)

> The devices are being used a lot. What we see now is that students use them more to create things than only use them to look up or produce texts.
> (Belgium, head teacher interview, C3)

Teachers (n=595-826, cycle 1-3) agreed that iTEC Learning Activities enabled students to:

- engage with complex, real-world problems (76%);
- have opportunities to learn beyond the boundaries of the classroom (86%).

An important feature of the iTEC approach for a number of teachers was that it offered students more authentic learning experiences which more closely reflected situations they were likely to encounter in the workplace and in later life more generally. These included, working in teams, working with external partners, and producing work which would be seen, and used, beyond the school. The use of technology to bring the outside world into the classroom was also viewed as beneficial.

> Here there are people who come into the class... people who are journalists, photographers, illustrators... I, I really like it because we discover lots of jobs, which we didn't really know about before.
> (Austria, student interview, C4)

Collaboration was noted as one of the most innovative aspects of iTEC in three countries (3 of 16 national case studies; BE, FR, NO). When asked what the 'best thing about iTEC' was, 24% of students (n=1293) most appreciated the opportunity to engage in collaborative activities (the second most frequent response to an open-ended question). In countries for which more than 30 students responded, collaboration was identified as the 'best thing' more frequently than increased use of technology (which was the most popular response overall) for students in Lithuania (49%, n=82), France (37%, n=56) and Slovakia (22%, n=148).

> Working in a group [was the best thing about iTEC]. It is something that is useful in the world of work, but is not taught in schools. Working in this project with other people has been very constructive.
> (Italy, student survey, C5)

[20] CZ, FI, FR, IT, LT, NO, PT, SK, ES, TR

iTEC in practice: Students Creating Resources, C2

In France, students created revision resources in Chemistry for peers by video-recording practical sessions with commentary, using smartphones or a camcorder, and uploading them to YouTube. TeamUp was used to form groups, plan the activity and record progress. Planning was also facilitated by mind mapping software. The students enjoyed the task, which they perceived to be purposeful and useful, and also appreciated the greater degree of autonomy. They also enjoyed producing a video-based outcome, which required clear and concise explanations on their part rather than a traditional written report.

Technology, combined with student-centred approaches, offers increasing opportunities for students to adopt more active roles rather than passively receiving knowledge from their teacher. Peer assessment through technology can lead to learning gains (Nicolaidou, 2013). However, teachers and students need further guidance on implementing peer assessment and feedback effectively (Harris & Brown, 2013). The use of technology to facilitate peer tutoring, for example through student-generated content, can be effective both for tutor and tutee (Wang, 2012; Topping et al., 2013). Students undertaking digital production engage in effective learning through making and sharing artefacts (Luckin et al., 2012). Digital games creation, for example, can improve students' problem solving skills (Akcaoglu & Koehler, 2014).

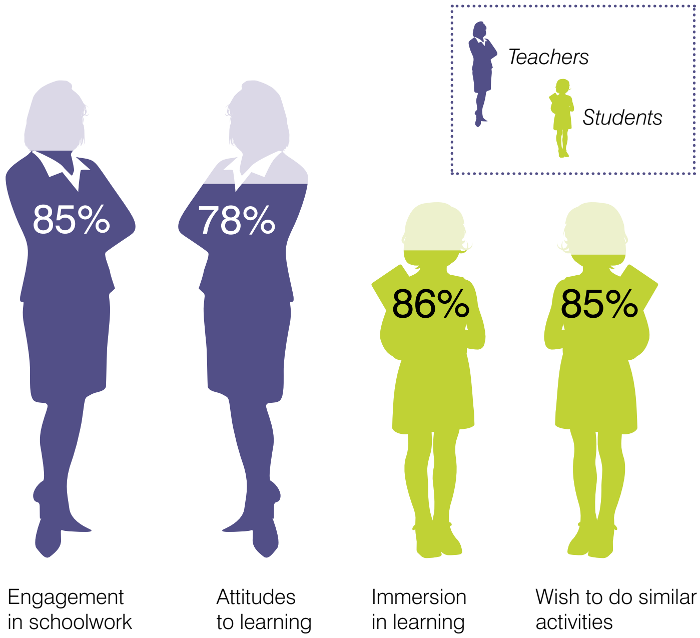
The development of student-centred and project-based, hands-on, real-world experiences, together with student collaboration, are becoming increasingly important globally, necessarily influencing student and teacher roles (Redecker et al., 2011; Johnson, 2014). This means it is more important than ever to create opportunities for personalised and authentic learning experiences that provide preparation for life and engage students (Lombardi, 2007; Redecker et al., 2011; Johnson et al., 2014). Learning should be grounded in connectivity and interactivity, readily facilitated through technology (Davidson & Goldberg, 2009). Technology can enable teachers to more easily support authentic learning through, for example, facilitating greater access to resources and experts in the field, data recording, recording reflections and sharing ideas (Gustafson, 2002; Lombardi, 2007; Laurillard, 2012). As indicated, above the iTEC approach can help students to adopt new roles, collaborate with peers, and engage in authentic learning experiences, all supported through technology.

3.4 Positively affecting motivation, engagement, attitude

Key finding 1.3: Participation in classroom activities underpinned by the iTEC approach impacted positively on student motivation.

The positive impact on student motivation was one of the strongest themes emerging from the data as evidenced by survey data (see below) and qualitative data (C3-5: 58 of 68 case studies; C4: 7 of 10 focus groups).

Teachers and students agreed that engaging in iTEC Learning Activities positively impacted on students':



(The percentage of teachers (n=826-1399) and students (n=1444) in agreement, C1-5.)

Overall we liked the lesson very much. The level of engagement and motivation was quite different. Peers that normally do not participate very much got involved and that was very new
(Turkey, student interview, C3)

I did not think I would accomplish a lot with them in but the way they practised speaking French today is really good...They are often hard to motivate. If you do this with the whole class and make some traditional exercises, they experience it as boring... Doing this in a more creative fashion, I notice that they learn a lot, that they speak and do more.
(Belgium, teacher interview, C3)

Pupils love activities connected with using modern tools and creating a PC game was a thing that was really motivating for them. So from my point of view, the greatest thing was the interest.
(Czech Republic, teacher survey, C4)

Willingness and motivation of students increased.
(Turkey, Head teacher interview, C4

This finding accords with other recent research on teacher perceptions of the impact of technology use in the classroom on student motivation and engagement (eg Hillier et al., 2013; Pegrum et al., 2013; Perrotta, 2013). Indeed, research on the impact of ICT teaching and learning frequently refers to increased motivation and engagement (Condie & Munro, 2007).

3.5 Raising student attainment

Key finding 1.4: The iTEC approach improved students' levels of attainment, as perceived by both teachers (on the basis of their assessment data) and students.

67% of teachers (n=1399, C1-C5) agreed that the iTEC process improved their students' attainment in subjects, as evidenced by their assessment data (also, C3-5: 27 of 68 case studies; C4: 5 of 10 teacher focus groups). In cycle 4, teachers were asked why they thought this was so and, among the 232 responding, the most frequently given reasons were increased student motivation (31%); collaboration (13%) and use of technology (10%). 80% of students surveyed in cycle 5 (n=1444) agreed that the knowledge and skills they had gained through participating in iTEC would help them to do better in their assessments.

We had possibilities to improve our practical skills. We liked working together, collaborating, creating web-pages, photos, film. We have got a lot of positive assessment, high scores – it's especially inspired us.
(Lithuania, student interview, C1)

We remember and we know more about what we learned – because we had to do newsflashes which means we had to summarise and learn by heart what we had learned through the lesson.
(Israel, student interview, C2)

The most obvious main benefit is the incorporation, by means of ICT, of oral work in Physics/Chemistry teaching, subjects where the focus is more usually on written work. This approach allows pupils who struggle with written work, but perform better orally to show their true merit. Taking oral work into account is important in science because it allows learners to assimilate knowledge better by using several working modes, and it can equally be used within an assessment framework.
(France, teacher interview, C2)

My French is not very good, I cannot read and speak it that well. But in this course it went better because I was being filmed. I wanted to do it really well.
(Belgium, student interview, C3)

iTEC has led to significant improvements [in students' learning outcomes through creating a deeper] understanding of a topic located in the curriculum and [relating it to] daily life with the use of technology.
(Turkey, teacher survey, C4)

It should be noted that the data gathered in relation to impact on student attainment focused on perceptions (although teachers were explicitly asked to respond on the basis of their assessment data) and has not taken direct account of formal assessment data. With the positive evidence gathered thus far of the potential impact on student attainment, it would be beneficial to conduct more rigorous impact studies at national level through randomised controlled trials.

Overall, there is compelling evidence that the use of ICT in the classroom can have a positive impact on student attainment (eg Means et al., 2009; Tamim et al., 2011; Cheung & Slavin, 2013) although of course many factors can influence this such as subject area, type of technology and teacher experience. In common with general evidence, although based on perceptions, both teachers and students agreed that student achievement was positively affected by technology use in iTEC. Teachers' professional opinions about the benefits of ICT should not be ignored (Dillenbourg & Jermann, 2010).

4. How did the iTEC approach impact on teachers and teaching?

The majority of European teachers are using ICT primarily for lesson preparation; use in lessons with students is still limited despite infrastructure having improved substantially (EC, 2013). There is, thus, a growing need for teachers to be supported in the development of digital pedagogy through learning design, an approach which is growing in importance but not yet widely adopted (Emin-Martínez et al., 2014). Such a process needs to facilitate sharing, re-use and be suitable for all teachers, not just early adopters of technology (Dillenbourg & Jermann, 2010; Voogt et al., 2011; Emin-Martínez et al., 2014). The iTEC project has developed an approach to learning design to meet these needs.

Across the five cycles, pilots were held in 2,653 classrooms. Teachers participating in iTEC were involved in learning design processes and implementing Learning Stories and Learning Activities with cohorts of students. Thirty-six detailed scenarios were developed in cycles 1-4 by a small number of teachers who were managed centrally. A further 22 scenarios were created in cycle 5 by larger numbers of teachers using a standalone toolkit and managed at national level. Another 14 scenarios were created through a centrally-run training course and an expert group. In cycle 5, a wide range of different Learning Stories and Learning Activities were created through workshops held nationally.

4.1 Key findings

This section brings together the evidence gathered in relation to teaching and teachers. It focuses on stakeholder perceptions of the scenario-led design process, together with the development of innovative teaching approaches and the impact of the iTEC approach on teacher motivation and attitudes. The scenario-led design process involved 304 teachers and stakeholders overall who worked together with workshop facilitators to develop Future Classroom scenarios and Learning Activities. Therefore, as the number of participants in this process was lower than in classroom pilots (183 teachers, 121 other stakeholders), the evidence is drawn from interviews and surveys of small numbers of key stakeholders such as policy makers, workshop facilitators and some of the teachers who participated in the process. The evidence of impact on classroom practices, teacher motivation and attitudes was gathered from the teacher survey (n=1399) and implementation case studies undertaken in cycles 3-5 (n=68).

- The Future Classroom Scenario development process was considered to be innovative by policy makers, teachers and other stakeholders, but further work is needed.
- The Learning Activity development process was perceived by teachers and coordinators as having potential to develop innovative and creative digital pedagogies in the classroom, but further work is needed.
- Teachers perceived that the iTEC approach enhanced their digital pedagogy and their digital competence.
- Teachers became more enthusiastic about their pedagogical practices.
- Teachers stated that they used technology more frequently; it was systematically integrated throughout the learning process rather than reserved for research or presentations.
- Teachers were introduced to digital tools they had not used in learning and teaching before; some were more favourably received than others.
- Teachers collaborated more, both within and beyond their schools, a process facilitated through the online communities.

4.2 A scenario-led approach to learning design

Rationale for scenario development: creating visions for the classroom of the future, supported by technology

The scenario (see Appendix D for an exemplar) presents a narrative description of 'novel learning and teaching […] which maximise[d] the engagement of learners in the future classroom through the effective use of ICT' (iTEC, 2012 p9). The aim was to inspire teachers to change their own practices (through adaptation of the ideas presented) rather than providing a lesson script (Cranmer et al., 2013). The scenario development process involves a wide range of stakeholders including learners; accounts for current trends in society and technology; provides a template for documenting scenarios; and offers a selection process for scaling-up the most effective of these. The rationale for this process was 'to bring about incremental but sustainable change […] in the education system' (Ulicsak & McLean, 2013, p8).

This change concerns 'innovation' as defined in iTEC as 'an idea, practice, or object that is perceived as new by an individual' (Rogers, 1995, p11) that provides benefits through impact on learning and/or improved efficiency (Miles, 1964; Kirkland & Sutch, 2009). It is necessarily context-dependent and therefore no single tool or practice will be seen as 'innovative' in every classroom (OECD, 2013). Rogers' (1995) 'diffusion' model of innovation demonstrates how individual, small-scale changes can support and lead to a broader set of local innovations. While micro-level interventions may not be grand, they 'are usually the most permanent and make the deepest impact on practice' (OECD, 2008, p17). Thus, innovation need not be the same as 'transformation' but rather seen as a process of incremental steps, the most common approach in educational contexts (Kampylis et al., 2013). Indeed, an incremental approach is the most commonplace form of innovation in the workplace (Toney, 2011). The iTEC approach focuses on pedagogical innovation enabled through, rather than driven by, technology. (See section 5.2 below for a full description of how innovation has been conceptualised in the project).

A key feature of the scenario development process itself is the Future Classroom Maturity Model (originally called the 'Innovation Maturity Matrix'). The original version drew on work undertaken in the UK by Becta (Underwood & Dillon, 2005; Bradbrook et al., 2008). This tool was developed to enable judgements to be made about the relative levels of innovation in scenarios developed within the project (Lesgold, 2003) and to stimulate self-reflection (Marshall, 2010). The original tool provided a self-review framework of five levels, or stages of innovation, and five dimensions: outcomes or learning objectives, pedagogy, learner role, management and underpinning technology (Cranmer et al., 2013). It was used prior to scenario creation to enable stakeholders to review current technology integration within their specific context and to inspire scenarios that could be incrementally innovative.

It was also used as a means of evaluating existing scenarios, as radar diagrams could be generated from the assessment to visualise the stage reached for each of the five dimensions.

The initial resources for scenario development process were a set of printed documents presented as a 'toolkit', trialled with National Coordinators and iTEC partners, and then piloted in national workshops with over 300 participants (Ulicsak & McLean, 2013). This generated 22 scenarios from eight countries and two commercial providers. 60% of the scenario development workshop participants (183 of 304) were teachers. Over the course of iTEC teachers took a greater role in scenario development and their engagement in the process provided 'a powerful form of professional development' (ibid, p.14). The toolkit was subsequently reorganised into six specific areas, to make the resources more accessible, and presented online. The revised online toolkit was piloted with 30 teachers and 6 teams of Masters level students in Estonia in cycle 5 who adapted existing scenarios or created new ones. In the final months of the project, the process was adapted for use in a free online professional development course run through the European Schoolnet Academy.

The development of scenarios

A total of 41 policy makers, and other stakeholders selected for their knowledge and understanding of ICT in education, were interviewed from 16 countries either individually or in groups to contribute to national case studies of the potential of iTEC to influence national policies. As part of this study, the interviewees were asked about the scenario development process and whether the data obtained reflected existing perceptions of high status key stakeholders. In addition, a small-scale study of the scenario development process was undertaken between January and July 2013. NPCs participated in a focus group and completed a survey (n=11) and survey responses were received from 13 participating teachers and two additional stakeholders[21]. In cycle 5, a case study on the full learning design process in Estonia also provided relevant data.

Key finding 2.1 The Future Classroom Scenario development process was viewed as innovative by policy makers, teachers and stakeholders, but further work is needed.

The scenario development process was viewed as innovative in eight countries (7 of 16 national case studies[22]; Estonian case study) through localising a visioning process (putting it into the hands of teachers and other local stakeholders). It should be noted that in the remaining countries it was not mentioned by interviewees (rather than them stating it was not innovative) and this could be attributed to differences in the backgrounds, level of knowledge and involvement in the project of the 41 people interviewed[23]. Valuable aspects were noted to be identifying trends (see Appendix D for exemplars); the original version of the Future Classroom Maturity Model (see Uliksak & McLean, 2013, Appendix A); guidance for adapting existing scenarios; and the scenario selection process (NPC focus group, Estonian case study).

The most far-reaching change relating to the iTEC process is perceived to be the structured approach to documenting and sharing best practices facilitated through the scenario development toolkit. (Hungary, national case study report)

Once they are completed, [the interviewees] believe that the iTEC toolkits will be of great value at national level. (Finland, national case study report)

Normally people don't think about trends, it's something very abstract, a concept which is there, but you really don't think about those processes. It made [teachers] think… (Estonia, case study)

The original version of the Future Classroom Maturity Model was perceived to be useful although, in a number of countries, similar tools for self-review already existed. It was perceived to stimulate participants to think about innovation (5 of 11 NPCs[24], Estonian case study).

The [Future Classroom Maturity Model] served as a basis for reflection and participants had the chance to position their schools regarding the different stages and to think about ways of moving forward and above. (Portugal, NPC)

However, six countries[25] already had similar tools for self-review in place and a further three noted potential challenges when introducing a maturity-modelling tool such as lack of school autonomy or lack of knowledge/motivation.

The 15 teachers and stakeholders (responding to the survey[26]) who participated in the scenario development workshop all enjoyed the experience, and intended to continue to develop their ideas, share them with others and adopt them in their regular practices.

Involving teachers in the [scenario development] process has been a good experience for those teachers. It has proved to be an effective way of motivating teachers and as such has augmented their continuing professional development. (Norway, National Case Study)

[21] There was a requirement for these respondents to speak English and therefore only 3-4 per country were approached.

[22] BE, FI, FR, HU, LT, NO, PT

[23] Interviewees were asked "What parts of the iTEC process for developing and piloting scenarios would you describe as the most innovative and why?"

[24] AT, IT, PT, SK, SMART

[25] ES, FI, HU, IS, NO, UK

[26] 13 teachers and 2 stakeholders responded. This sample is necessarily small as teachers were required to be able to communicate in English.

The project was presented to the school community. I engaged my colleagues in the use of new teaching activities and tools. I shared iTEC project files and results online in the iTEC community and Facebook. I shared my own good practice in the local Webinar and iTEC website. I use web based services such as Gmail, Facebook, ThinkBinder for communication and collaboration and sharing ideas with other teachers from my country.
(Lithuania, teacher)

I have used a lot of the technology tools that I found out about from other teachers and have used the 'explore, map, make, show' words when planning lots of activities.
(UK, teacher)

86% of teachers (n=295)[27] who participated in the online course run by European Schoolnet Academy[28], based on the scenario development process, and who responded to the evaluation survey, also noted that they had tried out new pedagogical approaches as a result of their participation.

A number of benefits of the process were identified, the most notable being facilitating collaboration and bringing diverse partners together (4 of 15 workshop participants, 2 of 11 NPCs, Estonian case study, 1 of 16 national case studies).

A number of potential improvements were identified: simplification of the process, improving the presentation (originally text-based) through multimedia (pictures, video, story boards etc.) and interactive online tools (for maturity modelling for example), more guidance on the scenario selection process and improving the scoring procedure, addressing vocabulary issues, including more exemplars, better integration with other iTEC outputs and including assessment tools. In a later case study of the revised scenario development toolkit, the tools were considered to be 'quite mature and ready for use' although still too text-based (Estonian case study).

Rationale for Learning Activity development: A collaborative design-based approach

Learning Activities describe discrete sessions of actions in more concrete terms. The collaborative Learning Activity development process was designed to enable teachers to translate educational scenarios into classroom practices. The scenarios provide a stimulus for the development process. The process (involving team work and participatory design with stakeholders):

- identifies challenges and opportunities relating to scenario implementation;
- identifies suitable resources (tools, services, content, people and events) to address challenges and support implementation;
- documents the resulting Learning Activities.

Grounded in research-based design (Leinonen et al., 2008; Leinonen et al., 2010), the process is iterative and involves close collaboration with stakeholders (Leinonen, 2010; Keune et al., 2011).

During the final piloting cycle, all NPCs were asked to facilitate Learning Activity development workshops involving teachers and other stakeholders including head teachers, teacher educators, trainee teachers, commercial providers, students and parents. In excess of 400 people were involved in these workshops, the majority of whom were teachers.

Teacher as designer of learning: moving beyond the isolated teacher

In accordance with the ethos of iTEC, each country adapted the process in different ways, using different tools to support the process, simplifying and selecting aspects rather than implementing in full. For example, one country created a tool to visualise the process. Therefore, the findings presented below represent the reactions to the principles of the approach rather than the adaptation of the full process as documented in the accompanying teacher guide.

The evidence is drawn from five case studies of the Learning Activity development process (2 group interviews involving 10 teachers, follow-up interviews with 14 teachers, survey responses from 9 workshop facilitators and a follow-up survey of 11 NPCs). In addition, a case study on the full learning design process undertaken in cycle 5 in Estonia also provided relevant data. Finally, an interview with the coordinator of the online short course developed for the European Schoolnet Academy also informed the findings below.

Key finding 2.2: Teachers and coordinators perceived that the Learning Activity development process has potential to develop innovative digital pedagogies in the classroom, but further work is needed.

Feedback from a small number of teachers (n=15) was positive; they enjoyed participating in the workshop (8 interviews) and the process (6 interviews), the opportunities to think differently about their practice (6 interviews), be creative (4 interviews) and collaborate with others (including those from other schools) to design learning (4 interviews). Two teachers commented that the emphasis on digital tools was innovative.

The aspects of the workshop which workshop facilitators (n=8) felt had worked particularly well were: sharing experiences and working in groups (4); and encouraging people to think about challenges (2).

[27] There was a requirement for these respondents to speak English and therefore only 3-4 per country were approached.

[28] BE, FI, FR, HU, LT, NO, PT

It has been very inspiring…I still have to step beyond my comfort zone and that is challenging, but I realise it is good for me because I need to know these new things about teaching with technology… this is one way to train myself and to get familiar with it.
(Finland, teacher interview, C5)

It was nice to work with so many colleagues. You gain ideas; you can tell your ideas; you get constructive criticism to enrich your ideas. It's a nice way of working. It adds something extra to your teaching.
(Finland, teacher interview, C5)

We started to think that we can teach differently. The most important was I stopped [being fearful].
(Slovakia, teacher interview, C5)

However, the original version of the process was perceived to be too time-consuming and complicated for regular use, particularly for a single lesson (3 teacher interviews, 2 NPCs). Some repetition in the stages of the process was also noted by one workshop facilitator, conveying the responses of participating teachers. The concept of a Learning Activity, as an element of a Learning Story, was perceived to be difficult for some teachers (2 NPCs, online course facilitator).

The concept of Learning Activity is hard to understand for teachers. They mostly don't really understand how long a Learning Activity is, where the borders of one activity are. (Hungary, NPC, C5)

NPCs (5 of 11[29]) noted that teachers found the participatory design process difficult to engage with, being more used to planning lessons alone, but also finding the development of Learning Activities challenging. Four workshop facilitators also confirmed that teachers had found it difficult to engage with some aspects of the process.

It's too much work for them. They normally don't plan activities like this… it's much more like a toolset for curriculum designers... normally teachers don't do so much work, they don't spend so much time…. (Estonia, NPC, C5)

Our teachers are not used to cooperating, so the most difficult aspect to understand and to explain to teachers is that they have to make decisions in a group. (Slovakia, NPC, C5)

The accompanying teacher guide to Learning Activity design (a paper booklet) was perceived to be positive (6 teacher interviews).

It's simple and it has really good ideas and it helps you to work with this learning design process.
(Finland, teacher interview, C5)

…it is well structured, clearly stated and gives the path to a successful implementation.
(Spain, teacher interview, C5)

Suggested improvements included providing an interactive version (1 teacher interview, 3 NPCs) and translations into national languages (1 teacher interview, 1 NPC). NPCs (5 of 11) also perceived that the toolkit would benefit from more exemplars demonstrating the different elements of the process.

Anticipated future uses of Learning Activity development approach vary by country and are thus context dependent. Of the 12 teachers asked about post-workshop activity, five had already implemented the Learning Activities they had created and five planned to do so. Five of the 12 teachers had also shared their experiences of the Learning Activity development process with colleagues. However, other teachers had some reservations about disseminating the ideas. Only three of the 12 teachers said that they would feel confident enough to facilitate the process with colleagues in their schools.

They have showed interest on one hand but were afraid of using new tools and technology during their lessons. I think some of them are likely to be interested in becoming involved in Learning Activity design but they need some time to use it with confidence. (Hungary, facilitator, C5)

[29] EE, FR, PT, SK, TR

Although based entirely on small-scale qualitative case studies, a wide range of data sources (teachers, stakeholders, national coordinators, workshop facilitators, policy makers) strengthen the evidence presented and provide support for the assertions made (Erickson, 1996). The Future Classroom Scenario and Learning Activity development processes were perceived as innovative and having the potential to develop digital pedagogies in the classroom. The self-review framework, the Future Classroom Maturity Model, has potential to support classroom innovation in countries which have yet to develop such change management tools.

The iTEC scenario-led learning design process is collaborative, involving a wide range of stakeholders for both scenario and Learning Activity development. Both teachers and facilitators noted that this aspect of the process was beneficial. Learning design tools that promote collaboration and increase creativity are becoming increasingly important (Gustafson, 2002). Moreover, active engagement as co-designers can lead to effective integration of digital pedagogies (Cviko et al., 2014). Therefore, the development of these processes through iTEC is timely.

However, there is strong agreement from those who have piloted the iTEC approach that the learning design processes need to be simplified; presentation needs to be improved; flexibility needs to be increased; and further guidance and exemplification are essential. Teachers need learning design tools that they can use independently (Gustafson, 2002). Such tools need to provide a balance of structure and flexibility in terms of learning design (de Jong et al., 2012). However, communication is key, and to facilitate resource use teachers must be provided with effective support materials that have been subjected to extensive pilot testing (Borko, 2004). Moreover, tools to support learning design are unlikely to scale up unless they are simple and easy-to-use (Gustafson, 2002).

4.3 Facilitating innovative teaching

One of the aims of the large-scale piloting activities was to develop innovative digital pedagogies and teachers' competences through providing project resources; an online community of practice for teachers; and nationally-led training and support. In addition, face-to-face workshops for teachers were offered at pan-European level. Teachers who engaged in the iTEC pilots reported positive impacts on their professional development in relation to developing digital competences and creative teaching practices. An outcome of the project is the development of a free online short (six-week) course for teachers drawing substantially on the iTEC process, the pilot of which has been popular and well-received.

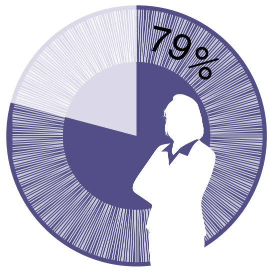
The evidence presented here is drawn from teacher surveys from all five cycles (n=1399), implementation case studies from cycles 3-5 (n=68) and teacher focus groups from cycles 4-5 (n=19). In addition, the lead facilitator of the online course based on the iTEC learning design process was interviewed and also provided data from the participants' evaluation (n=295).

Key finding 2.3: Teachers perceived that the iTEC approach enhanced their pedagogy and digital competence.

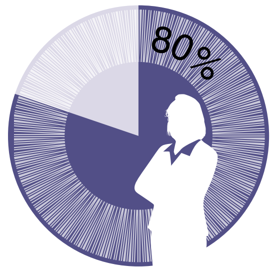
Teaching creatively involves experimentation and innovation, and making learning exciting through imaginative (and sometimes unexpected) approaches (Jeffrey & Craft, 2004; Education Scotland, 2013). 'Creative classrooms' include "innovative practices such as collaboration, personalisation, active learning and entrepreneurship" supported through digital pedagogies (Bocconi et al., 2012, p4). Thus teaching creatively demands change, and the incorporation of digital tools (requiring the development of digital competences) to support new pedagogical practices is one way of achieving this.

Facilitating iTEC Learning Activities enabled teachers to develop their:

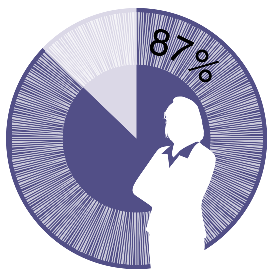
ICT skills



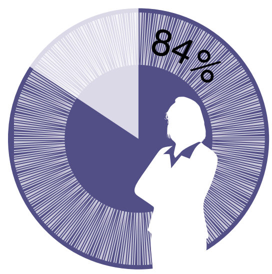
Knowledge of the pedagogical use of ICT



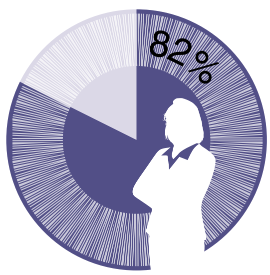
Range of pedagogical practices



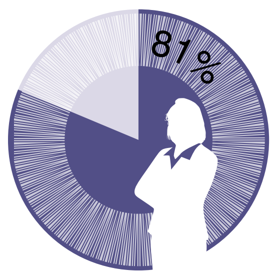
Creative skills



Assessment practices



Understanding of different teacher/student roles



(The percentage of teachers (n=826) in agreement, C1-3.)

iTEC was perceived to lead to increased creative teaching.

> ...despite all the obstacles, I don't see myself getting stale, because I've tried and [...] I'm convinced there will be good results. I'm going to carry on experimenting to see, and I'm sure I will change my practice in that sense.
> (Portugal, teacher interview, C1)
>
> Now I'm way more convinced of the need to push the school practice in this direction, because this enriches the students, offers new learning possibilities, and makes my teaching more interesting.
> (Italy, teacher, C2)
>
> Learning Stories are innovative as it is, and it made me renew my pedagogy, [...] Learning Story descriptions remind you to apply more details, which you may skip. For example reflection – it was very helpful to emphasise this Learning Activity.
> (Lithuania, teacher interview, C4)

New forms of assessment were implemented by many teachers, supported through Learning Activities, including peer feedback, reflection, self-assessment, online assessment and the assessment of digital artefacts. For example, reflection through blogs enabled teachers to monitor progress, developed students' metacognition and self-evaluation, and supported peer learning.

> A discussion forum was started on [the VLE] for the students to give positive feedback on the materials. Students were given ground rules that they should given constructive feedback and positive comments. They really enjoyed using the forum to give comments about the resources and each other's resources.
> (United Kingdom, teacher interview, C1)

> The significant progress was peer assessment – helped us greatly to see our work in the eyes of colleagues and examine our progress.
> (Israel, student interview, C2)

> ... it allowed me to assess some things which are not always easy to measure in a normal class. For example, autonomy, creativity, critical thinking, often during a lecture, or even if there is some dialogue or when there is some dynamics, it is always more difficult to asses. With this project, specifically, I got more feedback in these situations and sometimes even surprises with some students...
> (Portugal, teacher interview, C3)

Implementing Learning Stories in the classroom encouraged teachers to innovate and experiment (C3-5: 21 of 68 implementation case studies; C4: 4 of 10 teacher focus groups). This echoed findings from a survey of NPCs in which five NPCs[30] indicated that the Learning Stories helped to promote innovative approaches among teachers (Le Boniec and Ellis, 2013). Furthermore, 88% of students (n=1488) agreed that their teacher was using different methods to help them learn.

Teachers (C4-5: n=583) were asked to rate how different their pedagogy was when implementing the Learning Story in comparison to what they were doing before on a scale from 1 (not at all) to 10 (radically different). Figure 1 below presents an overview of the aggregated responses, indicating the actual percentages of teachers rating themselves at each point on the scale. The mean rating was 6.0 (SD=2.24) with 28% of teachers stating that their pedagogy had changed substantially (a score of 8-10). One in four teachers (25%) perceived that their pedagogy was not markedly different to their previous teaching methods (a score of 1-4). This is unsurprising given that there was a bias towards teachers who perceived that ICT competency level was high; teachers with greater confidence are more likely to volunteer to participate in projects such as iTEC.

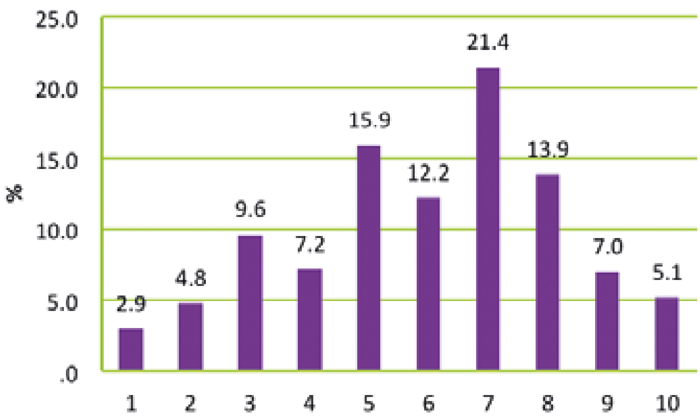


Figure 1: Teachers' ratings of how different their pedagogy was in iTEC pilots compared to previous practices, 1=not at all, 10=radically different (n= 583, C4-C5)

[30] EE, IT, NO, SK, SMART

Piloting radically innovative scenarios enabled a small number of teachers to build on the iTEC experience and develop their digital pedagogies further. The 'radical pilots' ran from April-June 2014 and involved 19 teachers. The teachers attended a workshop at which they designed 'radical scenarios' supported by pedagogical advisors from European Schoolnet and technology advisors from the project industry partners. Teachers were presented with state-of-the-art technologies from industry partners (including some prototypes) and asked to develop ideas which could be completely new or based on existing scenarios, Learning Stories and Learning Activities.

An analysis of the teacher reports suggests that these radical pilots differed from the cycle 5 pilots in that they involved teachers from more than one country working together to develop, and then implement, activities. Students also communicated with their peers in other countries, for example, acting as evaluators of each other's work. This naturally presented a number of logistical challenges as teachers and students needed to find ways to communicate and share content. Access to appropriate technical solutions was critical in facilitating this communication.

In many other respects, however, these radical pilots were highly similar to other case studies from cycle 5, and from previous cycles, for example activities included, designing maths games in Scratch and creating a presentation about the local area. It was also notable that these radical pilot teachers experienced many of the same barriers as other iTEC teachers, for example, time, basic technical problems, and a lack of resources. The teachers undoubtedly valued the support they had received in conducting these activities from other teachers, their local community and technical partners, as well as from the project, but it is difficult to claim that this additional support resulted in pilots which could truly be considered pedagogically 'radical' at an international level.

iTEC in practice: Algebra games 'radical pilot', C5

Three teachers (two from Spain, one from Portugal) developed a 'shared programming' activity in which students from two countries designed, programmed and evaluated online maths games. Students from Spain were aged 13-15 years and students from Portugal were aged 11-13 years. The scenario was based on a cycle 3 Learning Story – 'Designing a maths learning game'. The main objective was to introduce basic algebra in a context which would be engaging, through programming. The Learning Activities were shared through the Scenario Development Environment. Students in both countries had to work in teams, create a rubric for evaluating existing games, design a prototype, present the prototype to other students and experts, consult an expert teacher via video conferencing, then evaluate each other's games and provide feedback. Students used Scratch, ClassFlow, the eTwinning platform and a learning platform. Some students also used their smartphones. Students' collaboration and communication skills improved, for example, being able to evaluate each other's work, time management, and online communication. They also developed their independent learning skills.

Students found it challenging but motivating, and felt the experience contributed to their understanding of algebra. It also enabled participating students to develop programming skills. Whilst games produced by the (older) Spanish students were more complex in terms of programming those produced by the (younger) Portuguese students incorporated more complex content. Technologies to facilitate file storage and communication were essential.

There was evidence of the **positive impact of iTEC on teachers' digital competence** throughout the project. Qualitative data echoed that of survey data in relation to the development of ICT skills, including digital pedagogy (C3-4: 15 of 60 case studies; C4: 3 of 10 teacher focus groups).

It was very interesting because I learned a lot about new technologies.
(Teacher, Spain, C5)

The project invites me to use more new technologies and suddenly you feel more comfortable and they can be used more easily. This is what I found.
(France, teacher interview, C4)

...the confidence of using the technology on a daily basis cannot be emphasized enough.
(Austria, ICT co-ordinator, C3)

In Cycle 2, many teachers felt that they had increased their ICT skills, sometimes learning from the students, leading to more regular use in the classroom and 'enriching [their] professionalism' (Teacher, Italy). In Cycle 5, when asked about the benefits of iTEC, 12% identified the impact on digital literacy skills as the most important benefit; there were examples of teachers referring to the development of both students' skills and their own[31]. Furthermore, teachers believed that wider implementation of the iTEC approach would impact on teachers' motivation (13%; n=234), professional collaboration (7%) and digital literacy skills (6%).

In addition, the teacher survey included a question asking respondents to self-rate their level of ICT competency for teaching and learning on a scale from 1 (none) to 10 (very high). It was possible to match the responses from teachers responding to both surveys who participated in cycle 3 and cycle 4 (n=105), in cycle 3 and cycle 5 (n=52) and in cycle 4 and cycle 5 (n=42).

[31] It is not possible to say whether teachers were referring to their own skills or students' in all cases.

Table 1: T-Test results

		Mean	N	Standard deviation	Significance level	Effect size
Pair 1	Cycle 3	7.58	105	1.780	p=0.01	0.03
	Cycle 4	8.03	105	1.547		
Pair 2	Cycle 3	7.37	52	1.826	p=0.001	0.503
	Cycle 5	8.17	52	1.354		
Pair 3	Cycle 4	8.00	42	1.379	p=0.101	N/A
	Cycle 5	8.26	42	1.127		

Teachers involved in more than one cycle believed that their level of ICT competency for teaching and learning increased. Whilst there was a statistically significant increase between cycle 3 and cycle 4, the effect size (representing the importance of the extent of the increase) was small. This is not surprising given that cycle 3 and cycle 4 were undertaken in the same academic year. Notably, teachers reported an increase in perceived levels of ICT competency for teaching and learning between cycle 3 and cycle 5 (run a year later) which was statistically significant, and had a medium effect size. These results support the evidence above that the iTEC approach has contributed to teachers' increased digital competence.

In the final year of the project, the iTEC process was adapted and integrated into a pilot free online course run as part of the EUN Schoolnet Academy, providing online professional development courses for teachers and launched in September 2013. The Future Classroom Scenario course ran for six weeks and was based on a face-to-face workshop that had previously been run for iTEC teachers. As described above, the iTEC processes for scenario development and Learning Activity design were simplified and presented in a more accessible formats such as animations. The intention was to empower teachers to facilitate innovation in the classroom through the development of scenarios and Learning Activities.

The first pilot (evaluated by an external consultant) was considered to be a success with 2,235 people enrolling, 1,326 starting the course, 49% of whom completed all modules. The majority of teachers were female (76%) and 53% of the participants had at least 16 years' experience of teaching. The countries most highly represented were Spain, Portugal, Greece and Italy. Some of the participants had prior experience of iTEC, but most were new to the project. Of those responding to the pilot evaluation (n=449), 99% rated their experience as very good or good. There was a perceived impact on practice with 87% of respondents indicating that they had tried out new pedagogical approaches (ie more student-centred) since attending the course and 69% reporting they had made some change to their classroom setup. Professional development therefore could be supported in a cost-effective manner through the provision of online in-service training courses.

Learner-centred pedagogies are essential given the growing importance of the knowledge society (Voogt et al., 2013). Current technologies readily support learner-centred activities such as collaboration and communication, and can thus easily support such pedagogical shifts (Beetham, 2013). However, it should be noted that repeated attempts to change classroom pedagogy through educational reforms have not been successful (Cuban, 2013). Instead, there have been what Cuban describes as 'hybrid' changes – mixes of teacher and student-centred approaches. Whilst the iTEC approach has been successful with a relatively small cohort of teachers, further work is required to understand if and how learner-centred digital pedagogies can be mainstreamed.

The online professional development course facilitated by the EUN Academy can be judged as a success. Retention rates for Massive Open Online Courses (MOOCs) are notoriously low, often only 10%-20% of those enrolling complete (Morris, 2013; Hew & Cheung, 2014). The retention rate in this case was much higher (49%). MOOCs are gaining in popularity and potentially could have a large impact on education systems (Sharples et al., 2013). Their use for supporting teachers' professional development is growing (Thompson, 2013).

Teachers need adequate support to update their pedagogies and teaching materials, and to facilitate authentic learning experiences. The iTEC approach together with online professional development, and support at national level, can provide this support effectively.

4.4 Positively affecting teachers' motivation and attitudes

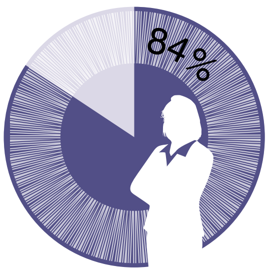
The evidence in relation to teachers' motivation and attitudes is drawn from teacher surveys from all five cycles (n=1399), implementation case studies from cycles 3-5 (n=68) and teacher focus groups from cycles 4 and 5 (n=19).

Key finding 2.4: Teachers became more enthusiastic about their pedagogical practices.

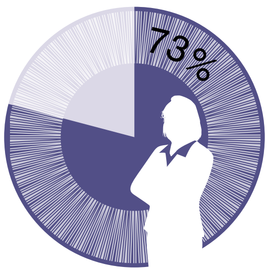
The pilots were described by teachers as making their practice more interesting through a shift to student-centred digital pedagogies. Teachers were also motivated through seeing the impact the project was having on their students.

Facilitating iTEC Learning Activities impacted on teachers':

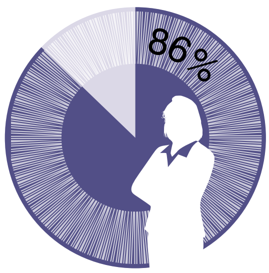
Uptake of ICT



Enthusiasm for teaching



Engagement in exciting new practices



Qualitative findings echoed that of the teacher survey data: teachers reported an increase in their own motivation (C3-4: 12 of 60 case studies; C4: 5 of 10 teacher focus groups).

The teacher feels much more motivated. His students are learning with fun and experimenting. Their eagerness gives the teacher a positive energy for his future classes and the teacher is more involved in the projects and effective teaching. (Turkey, case study report, C3)

Participating in the iTEC project stimulated and allowed me to create my own teaching system and to produce new ideas as well.
(Lithuania, teacher focus group, C4)

The adoption of constructivist digital pedagogies can have a positive affect on teacher morale (Baylor & Ritchie, 2002). Teachers certainly found this to be the case in iTEC; they enjoyed the opportunity to try out new ideas and increase their use of technology.

4.5 Scaling up technology use through Learning Activities

Evidence in relation to scaling up technology use came from teacher surveys (n=1399) and implementation case studies (n=60).

Key finding 2.5: Teachers stated that they used technology more frequently; it was systematically integrated throughout the learning process rather than reserved for research or presentations.

More regular, and increased, use of technology in the classroom was perceived to be new for both teachers and students. In some cases, use of technology by students per se was seen to be novel (9 of 17 student group interviews in C3). 37% of students (n=1293, C5) said that the 'best thing about iTEC' was the increased use of technology in the classroom (the most frequent response to an open-ended question).

I've had this class only from the beginning of this year and the students have almost never used ICT in school so for them everything was new.
(Italy, teacher survey, C5)

While the teachers involved in iTEC had used technology to support student research or presentation work in the past, they started making use of technology to interact and communicate with students; facilitate team working; support design and production tasks; assess work; and encourage students' self-reflection. This can be attributed to the learning design process, which highlights the need to include digital tools in each Learning Activity, thus ensuring that an embedded digital pedagogy is adopted.

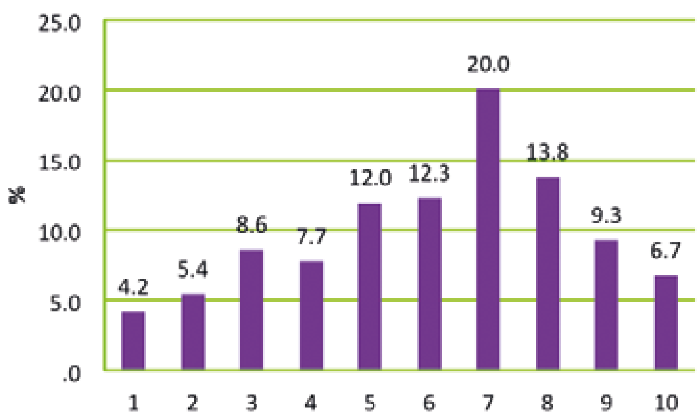
Teachers incorporated a wider range of types of digital tools/services into teaching and learning than they had done previously (most commonly for data capture, accessing information, communication, collaboration, media sharing, media authoring and mobile learning). Reflecting the rapid growth in mobile devices in some countries (European Commission, 2013), their reported use to support the pilot implementation increased over the course of the project from about half of teachers (C1-C3) to approximately two thirds of teachers (C4-C5).

Table 2: Types of digital tools used by teachers each cycle

Type of digital tool used[32]	% of teachers reporting use C1 (n = 231)	% of teachers reporting use C2 (n = 261)	% of teachers reporting use C3 (n= 336)	% of teachers reporting use C4 (n= 329)	% of teachers reporting use C5 (n=260)	% overall
Data capture device	88%	72%	74%	88%	79%	80%
Digital resources	72%	86%	66%	80%	80%	77%
Communication tool	74%	75%	67%	71%	79%	73%
Collaboration tool	71%	65%	49%	63%	64%	62%
Music/photo/video/slide sharing sites	55%	65%	44%	63%	64%	62%
TeamUp	59%	62%	38%	65%	73%	59%
Media authoring tool	74%	59%	35%	63%	59%	58%
Mobile devices	50%	46%	46%	66%	66%	55%
Interactive whiteboard	52%	63%	45%	59%	53%	54%
Game based learning	27%	30%	27%	35%	38%	31%
Student information system	N/A	23%	20%	25%	32%	25%
Learner response system	N/A	23%	9%	20%	26%	20%
Document camera/digital visualiser	24%	13%	15%	21%	24%	19%
Virtual experiments and simulations	7%	18%	14%	23%	20%	16%
High tech instruments for science	8%	8%	4%	7%	8%	7%

Teachers (n=583, C4-5) were asked to rate how different their use of technology was when implementing the Learning Story in comparison to what they were doing before on a scale from 1 (not at all) to 10 (radically different). Figure 2 presents an overview of the aggregated responses, indicating the actual percentages of teachers rating themselves at each point on the scale. The mean rating was 6.2 (SD=2.43) with 30% of teachers stating that their technology use had changed substantially (a score of 8-10). One in four teachers (26%) perceived that their technology use was not markedly different to their previous teaching methods (a score of 1-4). As with teacher perceptions about the change in pedagogy reported above, this is unsurprising given that there was a bias towards teachers with a self-reported high level of ICT competence.

Figure 2: Teachers' ratings of how different their technology use was in iTEC pilots compared to previous practices, 1=not at all, 10=radically different (n= 583, C4-C5)



[32] This list was derived in conjunction with WP2 (in relation to the scenario mapping tool) and WP10 in relation to the functionalities and devices vocabularies in order to align with other work packages.

[33] This question was not asked in the C4 survey

86% of teachers (C4-5: n=585) said that their use of technology changed when implementing the Learning Story, either due to the use of new digital tools (29%); students' increased use of technology (15%); more regular and embedded use of technology by the teacher (10%); or using tools to facilitate different types of Learning Activity (8%). Tools used included TeamUp, ReFlex, the iTEC Widget Store, Corkboard.me, Voicethread, Sketchup, Scratch, Popplet, blogs such as Blogger, wikis such as GoogleDocs, cloud storage such as Dropbox, AudioBoo, Instagram, Facebook, and video editing software.

With the help of this project I learned Google SketchUp and some other new things and I like them very much because before iTEC I had only known Powerpoint before but now I know many presentation tools, design and mindmap tools and I can even create my own blog.

(Turkey, student interview, C3)

The differences are that during this project all the students have used a computer not like the rest [of our lessons] where only the teacher uses the computer

(Spain, student interview, C3)

The difference between the maths lessons and the other lessons is that in these lessons we work a lot with GeoGebra, with Facebook, and with Glogster and we record things and in other lessons we don't. In the other lessons the most we can do is some work on the computer once in a while.

(Portugal, student interview, C2)

Before participating to iTEC Project, I thought that technology could be used mainly for the realization of the final product: we work in class in a traditional way, then the students could make their own power point presentation or whatever. Here is different, because technology is used throughout the project and accompany to reach the goal. In this I've changed my idea of the use of technology.

(Italy, teacher interview, C3)

We used technology in every step: pupils searched for all the information about the content from internet, videos, by email or from experts who visited our school. They learned to send emails to experts. They also used iPads for the first time and shot a video and edited the video by using iPads. They reflected their learning using TeamUp tool.

(Finland, teacher survey, C4)

There are continued claims about technology's potential to enhance teaching and learning (OECD, 2013). However, very few teachers in Europe use technology to support teaching and learning, other than for lesson preparation (EC, 2013). Use in lessons with students is still limited, with one in five rarely using digital tools in lesson time, despite infrastructure having improved substantially (EC, 2013). The adoption of the iTEC approach by teachers has led to the systematic integration of digital pedagogies in the classroom and increased use by students.

4.6 Experimentation with innovative digital tools

Evidence in relation to scaling up technology use came from teacher surveys (n=1399), the cycle 5 teacher focus groups (n=9) and implementation case studies (n=60).

Key finding 2.6: Teachers were introduced to digital tools they had not used before; some were more favourably received than others.

60% of teachers surveyed (C1-C3, C5[33]: n=1048) indicated that they used digital tools/services that they had not used before. Each set of Learning Activities, presented at the start of each piloting cycle, guided teachers to try new digital tools through general recommendations for types of tools such as social networking sites, blogs and mind-mapping tools. The iTEC project also developed a number of prototype tools, which were introduced to teachers at various points in the project and incorporated into piloting activities by some of them. The evaluation focuses on the user perspective gathered through piloting. A full report on the research and development of iTEC prototype tools is also available (Griffiths et al., 2014).

Prototype tools for supporting learning and teaching

TeamUp is a tool for allocating students to teams, either randomly or based on criteria (e.g. gender, topic preference). It also enables students to record short (60 second) reflections on their progress. **ReFlex** is another tool designed to support student reflection through recording short audio clips organised on a timeline.

TeamUp was available to teachers in all five cycles. Teachers were largely positive about TeamUp and felt that it was an intuitive tool, which was useful for forming groups. The reflection feature was considered to offer students the opportunity to develop communication, critical thinking and reflection skills. Teachers who used TeamUp in cycles 4-5 felt that it has potential to lead to both pedagogical innovation (65%, n=393) and technological innovation (64%, n=393) in the classroom. Using a digital tool to facilitate reflection was perceived to be innovative. Two thirds of teachers (67%, C4-C5: n=394) who used TeamUp said that they intended to use the tool again and would recommend it to other teachers. Suggestions for improvement included: integration with other classroom management tools, increasing opportunities to personalise student profiles, enabling use without a webcam and integrating it with mobile devices (particularly iPads).

ReFlex was introduced in cycle 4. Its uptake in piloting was limited. A relatively small number of teachers in cycles 4-5 (n=55) tried ReFlex and were positive about its use and potential. The majority of teachers who used ReFlex felt that it has potential to lead to both pedagogical innovation (47 of 55) and technological innovation (44 of 55) in the classroom. The majority of teachers who tried ReFlex had similar views: they intended to use the tool again (44 of 54) and would recommend it to other teachers (46 of 54). ReFlex was seen to provide simple functionality not yet available through other tools. However, in wider discussions (teacher focus groups) it was noted that little use had been made of this tool and that it offered similar functionality to TeamUp.

Prototype tools for supporting the design process

The Composer is a planning tool for teachers to create, adapt and share Learning Activities. It enables teachers to find Learning Activities based on a taxonomy of transversal skills, enabling them to discover new pedagogical approaches. It provides teachers with suggested resources, including tools and services, to use in the delivery of a selected Learning Activity, potentially making new technologies available to them. The **Scenario Development Environment (SDE)** is a recommender system that takes into account the user's profile (for example school level and subject) and can provide recommendations for resources such as applications, events, widgets and lectures. Users can create their own resources and, for the purpose of testing, a standalone prototype tool was provided which also enables teachers to create their own scenarios and/or Learning Activities.

Following piloting in Austria in the cycle 4 large-scale pilots, NPCs were asked to introduce the Composer to Learning Activity development workshop participants in cycle 5. It was subsequently used actively in four Learning Activity development workshop case studies (BE, CZ, ES, SK). It was also considered by teachers in Estonia who explored the use of both the scenario development and the Learning Activity development processes.

Teachers used the Composer to create, share and find Learning Stories and Learning Activities, as well as for learning about new technologies. The concept, particularly a library of Learning Stories, was viewed positively. However, reported responses from participants who had actively used the Composer were mixed; one workshop facilitator said participants 'found [the] Composer as [a] good tool for inspiration' as teachers could see existing scenarios and activities, but another felt 'it feels somewhat old fashioned and is more a reporting tool to finalise what you have prepared'. A third facilitator saw positives and negatives: '[Teachers] think is very useful, but needs a lot of improvements'. The two facilitators (of the three) with less positive views of the Composer commented that it was repetitive, time-consuming and confusing for teachers. Teachers expressing their views in focus groups (n=9) had similar mixed views, noting it was useful for less experienced teachers. However, they raised concerns about usability including layout and login, complexity and translations. Suggestions for improvement included 'drag and drop' features, improving search and browse functionality and offering it in all languages.

The Composer tool seems to have the potential… for younger teachers just starting their career. Their lessons planning should be improved by the Composer tool .
(Austria, ICT co-ordinator interview, C4)

This makes it easier for us to share with colleagues.
(Austria, teacher focus group, C4)

The SDE was used to support the Learning Activity development process in one country (Finland). In addition, NPCs were asked to recruit 15-20 teachers to test the SDE and complete an online survey. Perceptions of the SDE were also gathered through the teacher focus groups.

The SDE was perceived to be one of the most useful prototypes generated as part of the project in three of four countries[34]. All teachers responding to the survey (n=20) felt that it was easy to use and that they would recommend the tool to other teachers. The visual appearance was viewed as positive, as was the opportunity to discover new resources through recommendations. The bookmarking feature was also welcomed. When searching for a learning topic, 15 (of 20) respondents agreed that the SDE returned a greater variety of educational resources compared to Google although 11 respondents thought that Google generated more results. It was also noted to be useful for less experienced teachers.

Some teachers felt the SDE provided the same functionality offered through the Composer and the People and Events directory.

Suggestions for improvement included greater national contextualisation, a better interface/layout, ensuring fewer irrelevant results are returned, and the ability to search all resources simultaneously. Ideas to improve the Future Classroom Scenario and Learning Activity editors in the SDE included: improving the layout/interface (3 teachers); making it possible to upload files (1 teacher); and improving the suggested resources (1 teacher).

The Widget Store: a prototype tool for curating digital resources

The Widget Store, designed as a productivity tool, provides a means of curating resources (widgets) and moving them easily between learning platforms, potentially offering seamless integration and facilitating interoperability. Teachers are able to create their own widgets to add to the store. Users can rate and review the widgets.

The Widget Store was piloted at scale in cycles 4 and 5. 28% (n=590) of teachers participating in cycles 4-5 used the Widget Store and of these 32% (n=166) created their own widgets. It was difficult to convince some teachers of the added-value of the Widget Store due to their preferences for existing tools and the proliferation of widgets and apps becoming available, which led some teachers to feel 'overwhelmed' (C5: 2 of 4 NTC interviews). Creating widgets was noted to demand a higher level of technical expertise although, in cycle 5, Portuguese students undertook this. The most frequently used widgets were TeamUp, the Composer, Popplet[35], bubble.us[36], Six Thinking Hats[37], and online tools which could replace basic classroom equipment such as a calculator and stop watch. Four out of five teachers (C4-C5: n=161) who used the Widget Store said that they would use it again in the future (81%) and would recommend it to other teachers (82%). Given that many iTEC teachers rated themselves as having high levels of ICT competence, its reception among a wider group of teachers may differ somewhat.

Teachers felt that the main benefit of the Widget Store was easy access to a repository of a wide range of resources suitable across a range of subject areas (C4-C5: 47%, n=161).

> All meaningful and 'useful' tools together in 'a place'; you can choose what you want to use.
> (Austria, teacher survey, C4)
>
> Easy access to many different programs that can help to support teaching and learning methods in different subjects.
> (Norway, teacher survey, C4)
>
> It's very useful having a repository where, at the time of need, you can find what's necessary for the activities in class to be carried out.
> (Italy, teacher survey, C5)

A number of challenges were raised by teachers' survey responses. Teachers found the Widget Store difficult to use, particularly the search facility to identify suitable widgets, thus requiring additional support (C4-C5: 35%, n=161). The range and quality of widgets was perceived to be limited (C4-C5: 20%, n=161, C4: 3 case studies; C5: 7 of 9 teacher focus groups). General technical issues were also noted (C4-C5: 16%, n=161).

> The number of widgets provided by the project were huge and it was sometimes difficult to be able to understand which are the ones with a higher added value.
> (Italy, teacher focus group, C4)
>
> It's always difficult to find something suitable – at any rate I didn't find anything that was absolutely right.
> (Austria, teacher survey, C4)
>
> [There is a need to increase] the amount of widgets in terms of variety.
> (Portugal, teacher survey, C4)

iTEC in practice: The Widget Store, cycle 4, Portugal

The Portuguese iTEC team felt there was not enough information and support in Portuguese to enable teachers to use the Widget Store successfully. Therefore, the approach taken was to establish an 'advanced group' comprised of teachers from previous iTEC cycles. The national technical coordinator provided highly practical guidance and support through a manual (in Portuguese, with examples and links to Learning Activities) and online community. The latter was found to be a particularly efficient way to deal with common problems as the whole community could read suggestions and solutions, meaning the technical co-ordinator did not need to respond individually. Widgets were new to most of the teachers. The widgets most commonly used included: Windows Live MovieMaker, YouTube and Blogger. Although not all the teachers had the technical skills to create their own widgets, some did do so, for example, using Geogebra. However, some of the advanced skills required in relation to creating more complex widgets were considered beyond even the more skilled teachers. Time was an issue for some, given the lack of prior experience.

Teacher from some countries were positive, whilst in other contexts the potential value of the Widget Store was less apparent, particularly compared to a growing number of similar tools and services.

The connected teacher: The People and Events directory

The **People and Events (P&E) directory** facilitates professional network development and collaboration for teachers. It connects teachers with similar interests, allowing them to share knowledge and experiences. It also enables them to identify people (from outside their current networks) and events that might support learning and teaching.

[34] AT, LT, TR; Only six focus groups completed the ranking exercise, of which four had considered the SDE.

[35] A mindmapping tool (http://popplet.com/)

[36] Brainstorming/mindmapping app (https://bubbl.us/)

[37] http://exchange.smarttech.com/details.html?id=c22fce6f-b61f-4bf2-a3ad-cd714228ee82

In the last year of iTEC, project partners and teachers were encouraged to create 3-7 minute webinars on topics intended to help other teachers innovate in their classrooms and upload them as events. That is, the focus was on supporting the iTEC community of teachers involved in pilots rather than the broader remit of providing a networking service for all teachers. This enabled the principle of professional network development to be explored and evaluated.

Most teachers (participating in the focus groups at the end of cycle 5) had registered with the site and some had added an event. Of those responding to the online survey (n=132, 48% of the 274 registered participants), the main advantage of the directory compared to other social networking sites was perceived to be its specific focus on education and the needs of teachers (47 responses):

> Sites as such LinkedIn are too general. This is for teachers.
>
> It is a more specific network it is connected to education.

Twelve respondents felt that the structure of the P&E Directory was better than existing sites. Nine respondents said they did not feel the P&E Directory had any advantage over existing social networking sites.

In relation to events (which included webinars uploaded by iTEC teachers), location-based searches were the seen as most the useful ways of using the P&E Directory (n=131):

- Finding information about regional or national events (59% ranked in top 3)
- Finding information about local events (59% ranked in top 3)
- Finding information about international events (58% ranked in top 3).

In relation to people, the facility to identify collaborators at all levels was appreciated most (n=121):

- Identifying potential collaborators regionally or nationally (65% ranked in top 3)
- Identifying potential collaborators locally (64% ranked in top 3)
- Identifying potential collaborators internationally (63% ranked in top 3).

The Events section of the P&E directory had been used by a number of teachers to discover new technologies and design new learning activities. For example, 23% of teachers (n=91) said they had discovered a new technology or learning activity from the teacher videos available within the P&E directory. 11% of respondents (n=108) said they had attended an event they discovered through the P&E directory. However, the People section of the directory was not used as much. Only 8% of teachers (n=91) said they had contacted, or been contacted by, an expert or collaborator they identified through the P&E directory.

Respondents were very positive about the potential benefits of the directory should it be developed into a mature product, sufficiently populated with both people and events. For example, 84% (n=113) of respondents agreed that teachers and learners would have more access to videos of ideas, technologies and practices posted by teachers and experts. The opportunities for networking and collaboration were appreciated.

If it was developed into a mature product, 81% (n=106) of respondents said they would use the directory again and 80% (n=89) of teachers said that they would recommend it to others. However, some teachers felt that the directory duplicated existing tools which provide information about people and events (2 of 9 teacher focus groups). Cultural differences can also affect uptake. For example, in Estonia teachers do not usually involve outside experts or events (Estonian case study, C5)

Suggested improvements included increasing the events and people listed (24 teachers, 3 other stakeholders, 3 of 9 teacher focus groups, 1 implementation case study), improving the interface (7 teachers, 6 stakeholders, 2 of 9 teacher focus groups), including a wider range of resources or linking to other services/platforms (7 teachers, 3 stakeholders), more active promotion of collaboration (6 teachers) and improvements to the search facility (5 teachers).

Models to support the redesign process are needed, thus reaping the benefits of reusability and addressing the limited time that teachers have available for 'original design' (Gustafson, 2002). Support for designing technology-enabled pedagogy demands approaches which take account of context (Mor & Mogilevsky, 2013). Tools to support this process must have effective search mechanisms and tagging systems, making recommendations based on the specified criteria (Laurillard et al., 2013). Designs should be adaptable and editable to maximise flexibility (Laurillard et al., 2013). The prototypes developed in the iTEC project were designed to incorporate these features. Teachers who used the prototypes in their classrooms appreciated the potential benefits of their use; however, given the prototype status teachers perceived that there was room for improvement in many of the tools. This research and development strand of the project has contributed to knowledge and understanding in the field of educational technology for supporting learning design. It is discussed fully elsewhere (Griffiths et al., 2014).

4.7 Increased networking and collaboration

Key finding 2.7: Teachers collaborated more, both within and beyond their schools, a process facilitated through the online communities.

The iTEC approach led to increased collaboration between teachers (C3-5: 15 of 68 case studies; C4: 4 of 10 teacher focus groups; 3 of 16 national case studies). Training and support were positively received by teachers who particularly enjoyed face-to-face meetings, networking with other teachers, opportunities for hands-on experience of tools, online discussion forums, webinars and video-tutorials.

The innovation takes place in the school itself and less in the individual classroom. Teachers talk more to each other about using technology. They work together in an interdisciplinary way using projects
It is a more specific network it is connected to education.
(Belgium, case study report, C3)

Working with ITEC has motivated me to engage other colleagues. It awakened a strong desire not to deal with this project on my own. The challenge is to untangle the frameworks in which we work.
(Israel, teacher focus group, C4)

iTEC Learning Activities not only move teachers out of their comfort zone in terms of the way they teach and interact with students, but also encourage teachers to share what they are doing with others. They are said to be "no longer afraid of a third person seeing what is happening." Traditionally teachers remain isolated from each other and other stakeholders. (Austria, national case study)

Another innovation is the development of a community of practice of teachers. Dissemination by teachers has taken place via a national blog and websites. There has been an increase in collaboration and interaction between teachers. (France, national case study)

The use of national online communities was evaluated in cycle 4. Although how the online communities were used varied, they were most commonly used to share ideas and examples of good practice. They were also used to support collaborative problem solving within the online community, but this was a less frequent activity (except in communities expressly intended for this purpose).

The use of video clips within online communities could support dissemination of ideas further. Of the teachers who used the People and Events (P&E) directory (n=91) designed to facilitate professional network development and collaboration (see section 4.8 above), 23% said they had discovered a new technology or learning activity from the teacher videos available within the directory, and 60% (12 out of a total of 20) had used this technology or activity within their own teaching, or planned to do so. 31% of P&E directory users (n=131) ranked the opportunity to meet potential collaborators locally as the most useful feature of the People section of the directory and 15% ranked the opportunity to meet collaborators nationally and regionally as the most useful feature. This is a facility that online communities could provide. In addition, 27% ranked the opportunity to meet potential collaborators internationally as the most important feature. This suggests that the provision of international communities would be beneficial although of course there are issues such as language and cultural differences.

Professional networks for teachers will become increasingly important as teachers need to continuously update their practices (Redecker et al., 2011; Johnson et al., 2014). Many teachers recognise the importance of the internet in facilitating such networks (Purcell et al., 2013). Moreover, participating in such online communities fosters a positive attitude to collaboration, sharing resources and supporting peers (Tseng & Kuo, 2014). However, only one in three teachers in Europe are at schools that support collaborative approaches to learning design (European Commission, 2013).

5. What is the potential of the iTEC approach for system-wide adoption in schools?

It is widely asserted that, in order to remain competitive in global markets, education and training needs to transformed; one of the means to address this is through mainstreaming the use of technology for learning and teaching through national policies (EC, 2012; Brecko et al., 2014). Given that uptake of digital pedagogy is still low, it is essential to explore mechanisms that can support system-wide change (Brecko et al., 2014). The iTEC project has developed a process, toolkit and library of resources that could provide such a mechanism for system-wide adoption of digital pedagogy.

This section considers the evidence to date in relation to the potential of the iTEC approach for system-wide adoption. The iTEC approach concerns Future Classroom Scenarios and the systematic design of engaging and effective Learning Activities using innovative digital pedagogies. The evidence for the potential of iTEC outputs for innovation is considered, followed by evidence of the impact on systems to date. The evidence draws on the teacher survey (n=1399), national case studies (n=16), teacher focus groups (n=19) and implementation case studies undertaken across all five cycles (n=68).

5.1 Key findings

There are three main outputs from the iTEC project:

- a scalable scenario-led design process for developing digital pedagogy;
- the Future Classroom Toolkit and accompanying training provision;
- an extensive library of Future Classroom Scenarios, Learning Stories and Learning Activities.

Across all five cycles, 72 detailed scenarios were created, including 36 created at national level rather than centrally facilitated. In cycles 1-4, 13 Learning Stories were created and 28 Learning Activities. A wide range of further Learning Stories and Learning Activities were developed at national level in cycle 5.

- Awareness of the iTEC approach is growing in educational systems, and there are signs of widespread uptake.
- Upscaling/mainstreaming of innovative classroom practices can be supported through the scenario-led design process, provided the process is refined.
- The library of scenarios, Learning Stories and Learning Activities was viewed as a valuable output of iTEC to support system-wide classroom innovation.
- The iTEC approach is most likely to be supported in the future and to influence future practices in countries in which iTEC aligns closely with national policies and strategies. Plans for such support include integration of the iTEC approach with training provision, dissemination at national levels, and developing links with similar projects/initiatives.
- Conditions for success are:
  - Access to reliable and sufficient ICT infrastructure
  - Appropriate school ICT policies
  - Pedagogical and technical support for teachers
  - Positive attitudes at all levels towards change
  - Teacher pedagogical and digital confidence
  - Sufficient digital resources

5.2 iTEC enabling system-wide change

Incremental and radical innovation

System-wide change begins with an innovation.[38] However, innovation is matter of perception and is not an absolute: it is 'an idea, practice, or object that is perceived as new by an individual' (Rogers, 1995, p11). In education, innovation is not a goal in itself but only has value if it provides benefits through impact on learning and/or improved efficiency (Miles, 1964; Kirkland & Sutch, 2009). As the value of innovation is based on subjective assessment (Moyle, 2010), a practice perceived as innovative by a late adopter teacher will not necessarily be perceived as such by an early adopter; it is contextually dependent. Therefore, no single tool or practice will be seen as 'innovative' in every classroom, nor will its implementation or impact necessarily be replicable, making it impossible to generalise (Somekh, 2007; OECD, 2013).

Pedagogical innovation (Fullan, 2007), rather than technological innovation, is at the heart of iTEC and refers to fundamentally transforming practices in order to improve learning. In education, pedagogical innovations are increasingly associated with advances in student-centred teaching practices that develop 21st century skills, new roles for teachers and learners, and shifts in assessment, and an emphasis on authentic tasks (Kozma, 2003; McLoughlin & Lee, 2010). Technology is available to support pedagogical innovation, and in many cases, it is an essential requirement. However, pedagogical innovation does not demand technological innovation; innovative pedagogy can be developed through adoption of 'ordinary technology' (Kozma, 2003).

Rogers' (1995) 'diffusion' model of innovation demonstrates how individual, small-scale changes can support and lead to a broader set of local innovations. While micro-level interventions may not be grand, they 'are usually the most permanent and make the deepest impact on practice' (OECD, 2008, p17). Such a view is echoed by iTEC partners. In this sense, innovation need not be the same as 'transformation' but rather seen as a process of incremental steps. The approach undertaken in iTEC was to identify these potential pedagogical innovations through scenarios and Learning Activities and ensure widespread uptake.

At the same time the project was encouraged by Commission reviewers to investigate 'radical scenarios', to test the assertion made in some quarters that the limits of reform in the system may have been reached, demanding change beyond incremental, steady, innovation (OECD, 2010). The iTEC concept of radical innovation consists of a number of indicators (Ellis et al., 2013, p29):

- There is no or very little evidence of the scenario currently in use in European Schools, other than in specific research projects.
- There are clear barriers to up-scaling resulting in very low probability of mainstreaming in the near future e.g. policy barriers (BYOD), technical barriers such as limited technical

[38] Our definition of innovation is based on work undertaken by Alison Oldfield and r eported in Cranmer et al (2013).

infrastructure and current pedagogical constraints of curriculum and assessment.
- Technologies rarely seen in schools are used (e.g. very new technology, expensive technology, or technology not perceived to have a place in education).
- The innovation concerns a theme of current TEL research e.g. cloud computing; mobile learning; 3D printing; augmented reality; serious games and gamification; personalised learning; and virtual laboratories or remote labs.

The piloting of radical scenarios involving emerging technologies may provide evidence for their future potential if, and once, such tools become established within educational contexts. However, consortium members felt that, in terms of facilitating up-scaling and mainstreaming, the promotion of radical scenarios could be counterproductive. Rather, scenarios that support incremental innovation are much more likely to lead to pedagogical change and wide-scale uptake.

Teachers participating in iTEC pilots have reported changes in technology-supported pedagogy. The nature of these changes varied from individual to individual. The filtering processes adopted at European, national, regional and local levels in relation to the selection, presentation and uptake of Learning Activities have led to the majority of teachers making incremental rather than radical changes. This is only natural given the nature of education and the risks and challenges involved in relation to radical change. It also reflects the ethos adopted throughout iTEC: that the resources provided should be a source of inspiration for teachers, introducing them to new pedagogical approaches and new technologies, and not a prescriptive lesson plan. National coordinators and teachers have naturally selected and adapted resources to best meet national and local needs.

The potential of iTEC outputs for innovation
The iTEC approach is based on Future Classroom Scenarios and the systematic design of engaging and effective Learning Activities which make use of innovative digital pedagogies. The approach is pedagogically-led, noted as one of the most innovative features of iTEC in the national case studies.

Evidence in relation to the potential of iTEC outputs is drawn from teacher surveys from all five cycles (n=1399), implementation case studies from cycles 3-5 (n=68), and interviewees in the national case studies (41 policy makers/stakeholders from 16 countries).

The potential of project outputs for future development will now be discussed.

Key finding 3.1: The scenario-led design process can support mainstreaming of innovation, providing the process is refined.

Policy makers felt that the iTEC scenario-led design process would be an important output of the iTEC project in relation to policy making and the potential for supporting scale-up of digital pedagogy through professional development (7 of 16 national case studies[39]). (See section X above for commentary on the impact of the scenario-led design process on teachers).

The scenario development toolkit is seen as a real asset in Hungary…it is seen to facilitate a professional approach to developing and documenting best practice.
(Hungary, national case study)

The scenario and Learning Activity development toolkits are perceived to be positive and useful, and the most innovative aspect of iTEC. (Lithuania, national case study)

The most innovative and valuable part of the iTEC process is scenario development. [The interviewee] liked the use of trends and narratives (which give a useful picture and direction, showing how to move forward).
(Portugal, national case study)

NPCs were asked how teachers might use the Learning Activity development process in the future; their responses differed somewhat:

- In teacher training and professional development (AT, EE, HU, SK); in France the benefit of professional development was recognised but the main driver was perceived to be the classroom teacher.
- By classroom teachers (FR, IT, PT); at school level (IT, HU, PT, SK); at national level (FR).
- To both design new and adapt existing Learning Activities (HU, PT, SK); to develop new Learning Activities only (FR); to support a developmental process from adopting existing Learning Activities to developing new ones (IT)
- As part of an activity drawing on other parts of the iTEC approach (HU, IT, PT, TR)

As indicated in section 4.2 above, both parts of the process would benefit from further development. In the final months of the iTEC project, the scenario development process has been simplified and integrated with the other iTEC outputs to form a single toolkit: the Future Classroom Toolkit. It is important to ensure that the challenges identified through piloting are addressed: simplifying the process; ensuring the presentation is accessible and interactive; clarifying the complex terminology adopted; and providing lots of exemplars to make the process easier to adopt. In addition, it will be designed so that users can select, adapt and adopt elements of the toolkit to suit their needs.

The scenario-led design process, once finalised, also has the potential to be included in initial teacher training programmes and continuous professional development (for school leaders and teachers). For example, the scenario development process has already been integrated into a Masters level programme in Estonia and is considered to fit well with course aims and to be useful; its use will continue there in future years.

[39] It should be noted that at the time of the national case studies only the scenario development process had been piloted, thus there was less familiarity with the Learning Activity development workshop.

Key finding 3.2: The library of scenarios, Learning Stories and Learning was viewed by policy makers and teachers as a valuable output of iTEC to support system-wide classroom innovation.

The library of Learning Stories and Learning Activities are perceived by teachers to have the potential to lead to both pedagogical and technological innovation in the classroom (C1-C3: 97%, n=826; C4-5: pedagogical - 89%, technological – 88%, n=573). Policy makers noted that the library of resources provided an effective structure; is sufficiently innovative without being overwhelming; and is easy for teachers to use (8 of 16 national case studies). In addition, they suggested that Learning Activities are valuable because they provide concrete examples of novel approaches, emphasise innovation and flexibility, and encourage teachers to become learning designers (8 of 16 national case studies). 85% of teachers (C1-C4: n=1152) said that they would use the Learning Stories they had piloted again whilst 86% (C1-C4: n=1152) said that they would recommend the Learning Story to other teachers.

> *The iTEC scenarios and Learning Stories provide a good structure for teachers. The scenarios received a lot of attention in Estonia. (Estonia, national case study).*

> *[A Ministry of Education official] is 'quite impressed' by the library of iTEC scenarios that already exist and has particularly looked at those that make extensive use of different media. He likes the fact that they are not too high level or innovative as 'this might scare the teachers'. (Belgium, national case study)*

> *The Learning Activities are valuable because they are very practical and show teachers how a lesson can be structured. The fact that they are concrete examples, rather than general descriptions is valuable.*
> *(Czech Republic, national case study)*

In each of the first four cycles, 2-4 Learning Stories underpinned by packages of Learning Activities were presented to the National Pedagogical Coordinators. A selection process then followed. Depending on national circumstances, National Pedagogical Coordinators decided whether or not participating teachers would have a choice of Learning Stories or not. For example, if three Learning Stories were presented, a coordinator might have chosen to present all three, a choice of two, or one only. Given the ethos of the project, teachers also chose which of the accompanying Learning Activities to pilot (although Learning Activities were presented as a 'package'); adapted the Learning Story and Learning Activities; and even, in some cases, combined Learning Stories. That is, they were empowered to use the resources provided as inspiration rather than as a prescribed lesson plan. Each implementation was therefore unique to each teacher. Given this, it is difficult to comment on individual Learning Stories. However, we can suggest which ones were most popular (after the various selection processes were applied) and draw some conclusions as to why this might be.

The most popular Learning Stories according to those teachers responding to the survey each cycle were:

- Cycle 1: Collecting data outside school
  (78% of teachers, n=231)

  Students collect data (scientific, multimedia) outside the classroom (which includes the school grounds). Teams of students plan a project, collect the data and analyse it, documenting and reflecting on their progress. (Based on the cycle 1 scenario 'A Breath of Fresh Air'.)

- Cycle 2: Students creating (science) resources
  (73% of teachers, n=261)

  Students support one another to learn difficult concepts in science or other subject areas. They create exhibits (for example, posters, podcasts, simulations) for younger/other students to teach a concept from the curriculum, with mixed-experience teams focussing on different concepts. (Based on the cycle 2 scenario 'Students creating science learning resources'.)

- Cycle 3: Redesigning school
  (39% of teachers[40], n=334)

  Students are required to think about spatial design and the different motivations of people who use the space. A new space for future use is designed based on identified current challenges in relation to school-based activities. (Based on the Cycle 3 scenario 'Designing with multi-touch technologies').

- Cycle 4: Tell a story
  (55% of teachers[41], n=342)

  Narrating an academic topic through audiovisual means: digital storytelling. Students create an engaging short video story that relates a scientific phenomenon to a personal experience and is no longer than 5 minutes. They are asked to select an audience and tell the story in an engaging, factually correct, yet understandable way. (Based on the cycle 4 scenario 'Digital producers'.)

The explanation of why these stories were most popular is necessarily complex, depending on the selection process adopted, individual teacher's needs (eg curriculum fit) and resources (including technology) readily available. Choice is also dependent on whatever else was on offer at the time. In cycle 1 for example the alternative was to bring in an expert (through technology) but this had more practical challenges, such as identifying someone who would be willing to undertake this role. In cycles 2 and 3, Learning Stories which were more tightly bound to specific subject areas (maths and physics) were less popular. Teachers preferred Learning Stories that were easy to adapt to any subject area, underpinned by generic Learning Activities. Inevitably, although teachers chose a Learning Story to pilot they did not follow it like a script (in the spirit of the project) and instead selected and adapted the resources to meet their needs.

[40] 44% of teachers overall (Le Boniec & Ellis, 2013).

[41] 47% of teachers overall (Le Boniec & Ellis, 2013).

Teachers can be confused by scenarios that are too subject specific – they don't immediately realise it's just one example (Estonia, scenario development process case study)

There will clearly need to be systemic changes and/or incentives if the iTEC approach is to be widely adopted. Within school contexts, a risk-taking culture in relation to the adoption of digital pedagogy should be encouraged (Niemi et al., 2013). Documenting ideas for new activities and scenarios offer 'powerful tools for facilitating change' (Borko, 2004, p7); key stakeholders such as school leaders and policy makers need to recognise the importance of this. There is also a need to develop teacher education such that effective integration of ICT can be modelled and teachers can be encouraged to become agents of change (Twining et al., 2013; Brecko et al., 2014). In addition, upscaling requires teachers and other stakeholders to not only take ownership of the innovation (Coburn, 2003) but also to revise and adapt the process to meet their needs and changing circumstances (Clarke & Dede, 2009). In common with the literature, the evaluation has provided evidence that an incremental approach to innovation, such as that facilitated through iTEC, can be successful (OECD, 2008; Kampylis et al., 2013).

5.3 Impact on systems to date

During the project, evidence of impact on compulsory schooling systems increased. Evidence of dissemination at local/regional/national levels to raise awareness of the benefits of the iTEC approach was stronger than evidence of change. This is to be expected given that awareness-raising is a necessary precursor to scaling up. By the end of cycle 3, there were early indications that the iTEC approach had already begun to transfer without direct intervention, primarily within schools, but also to schools not already involved in iTEC. This activity increased in cycle 4 and cycle 5. With a project focus on exploitation in the final year, MoEs put mechanisms in place to support dissemination and in many cases made clear plans to continue to support the iTEC approach in the future. Examples include running professional development courses, integrating iTEC with new/ongoing projects and working with initial teacher education institutions.

As for the potential of iTEC outputs, evidence in relation to the impact of the iTEC approach on systems to date was drawn from teacher surveys from all five cycles (n=1399), implementation case studies from cycles 3-5 (n=68), and interviewees in the national case studies (41 policy makers/stakeholders from 16 countries). In addition, a further source of evidence was the teacher focus groups held in cycles 4 and 5 (n=19).

Dissemination and transfer at school level

Key finding 3.3 Awareness of the iTEC approach is growing in educational systems, and there are signs of widespread uptake.

In cycle 5, nine out of ten teachers (C5: n=244) said that they intended to use the iTEC approach again in the future (91%) and would recommend it to other teachers (92%). While 81% of teachers (n=244) agreed that the iTEC approach could become part of their own routine practice, only half of them (52%) agreed that such methods could become part of the routine practice of other teachers in their school. They were particularly cautious about the potential for upscaling at national level with only 43% agreeing that the iTEC process could become part of routine practice for the majority of teachers in their country.

Yes, it has the potential to change my future practice because now I have learnt about other ways to get my objectives, other ways to work in groups with my students, other ways to do collaborative work, and I'm going to use it in my future lesson

(Spain, teacher interview, C4)

iTEC is innovative because it is not focused on the use of a particular tool or device, but on issues such as sharing and collaboration; technology is just a tool which is used to facilitate these. (Italy, national case study)

Teachers responding to the survey were asked to indicate if they had shared their experience of various aspects of the iTEC approach with teachers outside the project (both within and beyond their schools). They indicated that they had shared both the Learning Story they had implemented (83%, C4: n=331), and the iTEC approach (86%, C5: n=244).

There is some further evidence of transfer of the iTEC approach within schools (C3-5: 13 of 68 case studies), and of other teachers expressing an interest (C3-5: 19 of 68 case studies; C5: 54% of teachers surveyed, n=245). Other schools had held or planned training events and in many cases head teachers actively supported dissemination (an enabler of transfer). In contrast, there was some evidence of perceptions that other teachers might not be interested in the iTEC approach or would find the use of technology challenging (C3-5: 10 of 68 case studies; C4: 1 of 10 teacher focus groups). Similarly, teachers from cycle 5 (n=244) reported that about one third of teachers they had shared the iTEC approach with had mixed reactions and 14% were not interested.

They were aware of it; K informs us regularly. She talks about it in e-mails, personal conversations and at meetings. Thus, teachers are aware of it, and are curious to know about the latest project K is involved in. This is how far we got. I think later on other colleagues may join too.

(Hungary, head teacher, C3)

But in my school I have introduced quite a lot of ideas. A good example is mathematics, where they are making Learning Stories. There are also teachers who have started to use TeamUp.

(Estonia, teacher interview, C4)

We have organized a workshop for the language teachers about iTEC teacher experience in our school.

(Lithuania, head teacher interview, C4)

Some have tried to use the Learning Stories in their classes and others have used some of the technology and digital tools recommended in the project

(Spain, teacher survey, C5)

To most it seems an interesting project, but they believe it is difficult to integrate into regular classroom practice. Some find it very complicated, lacking a basic digital competence.

(Spain, teacher survey, C5)

Colleagues also involved beyond my project have shown interest, but also scepticism and in some cases unwillingness towards innovation

(Italy, teacher survey, C5)

Transfer to teachers beyond their own schools was less commonplace, with some indications of reticence to share beyond colleagues due to lack of confidence in technical ability, the challenge of project jargon, and competition with local schools (C4: 5 of 13 case studies). Nevertheless, there were a small number of examples where this had happened in each cycle (C3-5: 8 of 68 case studies): for example, one teacher in cycle 4 had presented their work at a conference for maths teachers and in cycle 5, teachers from two countries[42] had spoken about iTEC at national conferences. Others indicated that they believed that dissemination should take place, but this needed to be organised centrally, rather by individual teachers:

More visibility on expositions and meetings for people working in education. For example at the colloquium for head teachers that is being organised annually. Every school shows what they have achieved in the past year. That is where iTEC should be made visible.

(Belgium, teacher interview, C4)

I believe that the research and knowledge-based communities in and around city T's schools are very interested in being part of something bigger and in disseminating this to a wider audience. At the same time there are 53 primary and lower secondary schools in city T, so it's clear that sharing with other schools is a challenge.

(Norway, head teacher interview, C4)

[The iTEC approach] could be presented for [schools] much more widely. Collaboration among the schools [is required for this]. But this needs additional time.

(Lithuania, head teacher interview, C5)

iTEC in practice: Scaling up iTEC within a school, UK, C2-C4

The school, a mixed 11-16 secondary school in the UK, is moving towards providing one-to-one devices for all students, so iTEC fits in well with its future plans. Teachers at this school first became involved in iTEC during cycle 2. During this cycle, just one teacher from the design and technology department was involved. She investigated how iPod Touch technologies could be used to support GCSE revision. The pilot was a success with a noticeable impact on student grades between the mock exam and the actual exam. News about iTEC spread and, in cycle 3, the teacher was joined by three colleagues, including staff from the maths department. Her involvement in iTEC training at an international level has also raised the profile of the project in the school. In Cycle 4, the school's involvement in iTEC expanded greatly to include a total of 12 teachers across 8 subjects. Professional development is a key component of iTEC for the school; teachers participating receive a certificate for their professional development folder.

[42] EE, LT

Impact at national level

Key finding 3.4: In countries in which iTEC aligns closely with current policy direction, the iTEC approach is likely to be adopted and to influence future practices.

The national case studies were undertaken mid-way through the third year of the project, partly focusing on the impact of iTEC on ICT strategy and policy development. Although it was seen as early days, there were initial indications of potential impact in some countries. Dissemination was already taking place in many of the participating countries, with seven indicating that they had held seminars, workshops or forums, and five stating that they had held conferences.

At this stage of the project, interviewees from four countries (FI, HU, IT, LT) felt it was too early for an impact on strategy or policy development. In five countries (CZ, EE, FI, IL, TR), interviewees noted that directly influencing policy was challenging given the remit of the organisations involved in the iTEC project, whilst a further four (BE, HU, SK, UK) argued that top down approaches for mainstreaming were inappropriate (currently) in their national context.

> *It is difficult to have a direct impact as [our organisation] is not a ministry, but rather an organisation under a ministry and iTEC is only being piloted in a small number of schools (Czech Republic[43], national case study)*

> *[The interviewee] suggests that the Ministry in Flanders has limited possibility to influence what each school does and that the three main groups of educational providers (for Catholic schools, community schools, and schools in municipalities/regions) may have the possibility to be more directive and influential. (Belgium, national case study)*

In one country (NO) iTEC had already been influential and had been referenced in official government consultation papers, whilst in five further countries (AT, BE, EE, FI, FR), the iTEC project was noted to align with current policy direction, and was therefore likely to be influential in the future.

> *…this is the right time for policy recommendations to be included in the National Strategy of Education in Estonia. There is a chapter within this on 'digital culture in education'. The underlying ideas of iTEC appear to be very similar to those in the National Strategy. (Estonia, national case study)*

> *iTEC correlates quite well with other national developments, including the development of a new core curriculum, and the aim to digitalise the national matriculation exam in a few years. So, iTEC comes at a good time. (Finland, national case study)*

> *…the main priority for the Ministry of Education is to ensure that schools in France enter the digital society and that technology use in schools increases. This includes increasing online education for students and providing online information services for teachers, particularly for primary school teachers. In addition there is a focus on encouraging teachers to collaborate with their peers and exchange information/resources. One approach currently under development is the use of social media to support the creation of an online professional community but this is at an early stage. The iTEC project reinforces this agenda and its activities. (France, national case study)*

By the end of the project, all partners produced an exploitation plan (Ellis, 2014). All partners intend to make iTEC outputs available on national portals and/or link to resources that are centrally maintained. Other future plans included: holding closing conferences (EE, LT, SK); producing and disseminating national publications (BE, HU); awareness raising events (AT, HU, SK); running further training events for teachers, head teachers and/or ICT coordinators (BE, FR, IT, NO, PT, TR); integrating iTEC with existing online training provision (EE, IT); localising Future Classroom Lab modules (HU, IT, PT, SK); integration with new/ongoing projects (AT, BE, LT, NO); establishing networks of interested initial teacher training (ITT) institutions (NO, PT); running conferences for ITTs (BE, HU); co-ordinating dissemination through one or more ITTs (LT); making initial contacts with ITTs (AT, FR, SK); investigating accreditation options (BE, PT, SK); and maintaining Future Classroom online communities (PT).

Future Classroom Lab modules have already been embedded in Masters programmes (EE, PT) and professional development courses (AT, EE). The University of Lisbon, a partner in the iTEC project, has been particularly proactive in bringing together representatives of ITT providers, developing a call for action document to target ITTs and policy makers. Hungary plans to localise the Future Classroom Lab modules for Hungarian teachers and has been closely involved in the preparation of the forthcoming National ICT strategy which highlights innovative learning approaches through digital pedagogies. In Italy, iTEC has become part of the Digital School strategy. Thus, an additional two countries have stated that iTEC has strongly influenced recent national ICT strategy development (HU, IT).

There has also been impact on commercial providers involved in iTEC. Promethean have used learning from their involvement in iTEC to inform the development of Classflow[44], an "'all-in-one' teaching and lesson orchestration tool for delivering interactive multi-media lessons". For example, building on one of the key iTEC themes, student-centred learning, ClassFlow allows for sharing between devices. This means lessons and content can be developed collaboratively in real time by capturing learner feedback and developing ideas. In addition, Promethean have developed a webinar programme of support as a result of participating in iTEC, which will be continued after the project finishes. Promethean have already established strong links with ITT providers, two of which have been recruited as Associate Partners (University of Newcastle, UK; University of Malaga, Spain).

[43] The Czech Republic was an associate partner and only participated in piloting on a small scale

[44] https://classflow.com/

SMART have built the iTEC approach into training provision for both European consultants engaged in supporting technologies produced by SMART, and also teachers who use SMART technologies. In support of this, the iTEC approach has been integrated with the online resources in the 'SMART Learning Space'. This is an online professional development service offering networking and development resources, including certified training programmes for teachers. SMART also developed two widgets which were well received by iTEC teachers. SMART have relationships with many higher education providers across Europe and will continue to promote the iTEC approach via these connections.

'Bringing a technology innovation to scale in education requires a design that is flexible enough to be used in a variety of contexts and robust enough to retain effectiveness in settings that lack conditions for its success' (Clarke & Dede, 2009, p364). The signs of widespread uptake suggest that the iTEC approach could meet these necessary conditions of flexibility and robustness. However, few ICT innovations in the classroom survive beyond the early adopter stage (Kampylis et al., 2013). Therefore, organisational structures will need to be put in place to support the continued adoption of the iTEC approach. Policy and programme alignment is important for maximising impact (Kozma, 2005); more could be done to understand the challenges and requirements in countries where this is not yet the case. Integrating the approach in teacher education will model effective use of ICT as well as the iTEC approach, and encourage teachers to become agents of change (Twining et al., 2013; Brecko et al., 2014).

5.4 Conditions for success

Evidence in relation to scaling up technology use came from teacher surveys (n=1399) and implementation case studies (n=68).

Access to reliable and sufficient ICT infrastructure

ICT infrastructure, including the provision of reliable and sufficient access to the internet, requires further development in many countries.

One of the top three enablers identified by teachers was reliable infrastructure (C2/3/5: 18%, teacher survey, n=839; C4: 1 of 10 teacher focus groups, 3 of 13 case studies).

However, insufficient access to ICT was one of the top three barriers identified by teachers (C2: 28%, teacher survey, n=261; C3-5: 43 of 68 case studies; C4: 6 of 10 teacher focus groups). In addition, teachers also identified unreliable access to the internet as another of the top three barriers (C2-3 teacher survey: 19%, n=595; C5: 4 of 8 case studies).

Insufficient infrastructure is still seen as major obstacle to uptake by teachers and school leaders (European Commission, 2013; Wastiau, 2013; Brecko et al., 2014) although once addressed could reveal second-order barriers such as teacher beliefs and attitudes (Ertmer & Ottenbreit-Leftwich, 2013).

Appropriate school ICT policies

There needs to be a flexible approach to the development of local and school ICT policies. In particular, it would be beneficial to explore the adoption of 'Bring Your Own Devices' (BYOD) which can help address ICT access issues. Policies encouraging BYOD are already in place in some countries such as Denmark, Portugal and Norway (EC, 2013).

Smartphones were noted to be an enabler in Austria and France in cycle 1, as was students' home access to technology in cycle 4 (7 of 13 case studies). A flexible approach to school organization, including support for BYOD, was perceived to be important (C3/5: 12 of 55 case studies). It was noted in France in Cycle 1 that national, local and school policies may need to be reviewed in order to realise the full potential of BYOD for teaching and learning. Outdated school ICT policies were identified as a barrier (C3: 7 of 47 case studies), preventing access to student-owned technologies, and to social media tools like Facebook and Twitter.

I would have loved to use Twitter to communicate but school policy doesn't allow us to use Twitter in the classes. Well I mean that the communication policy is not decided yet in the school, so meanwhile we can't use it (Twitter, Facebook, Tuenti...). It's such a pity since [students] are actually using Twitter on their daily basis, so to include that in the project would have been great.
(Spain, teacher, C3)

The one thing that has made it possible is that a lot of the students have brought their own PCs to school [. . .] Of course we can't make them do it, but we say that if they have the chance and if they want to bring their own then that's fine. If they don't have a PC they can borrow one from the school, and in general it works. There are usually enough PCs for everyone. And each year there's an increase in the number of students who have their own PCs – which in fact is a good thing
(Norway, teacher interview, C4)

BYOD can provide students with greater ownership and control over devices, leading to increased flexibility such as anytime learning and opportunities to capture media such as photographs and video, whilst being a cost-effective solution for infrastructure provision (Wu & Zang, 2010; Song, 2014). Of course, such initiatives are not without challeges such as ensuring equity (Traxler, 2010).

Higher levels of technology use happen in schools with specific policies on ICT in learning and teaching (in general and more specifically in relation, for example, to professional development and the provision of ICT coordinators) (European Commission, 2013). Between 28-46% of students surveyed across Europe said they used their own mobile phone to support learning in school at least once a week (European Commission, 2013).

Pedagogical and technical support for teachers

ICT technical support and ICT pedagogical support are important enablers. Access to technical and pedagogical support were noted to be essential for mainstreaming (C3-5: 11 of 68 case studies). More importantly, support at national level was an integral element of piloting in iTEC. 82% of teachers (n=826; C1-C3) said that they received training and support from their National Pedagogical Coordinator, with 89% of these 671 teachers agreeing that the training was useful for implementing the iTEC process.

Despite this national support, insufficient local support was identified as one of the most important barriers by teachers in Norway in cycle 2. In cycle 3, basic technical problems which could have been resolved with adequate technical support were noted in 31 of the 47 case studies. Lack of technical support was a problem in cycle 4 when teachers were dealing with immature technologies or faced compatibility issues (2 of 10 teacher focus groups, 4 of 13 case studies).

Such findings are reinforced in a number of studies, most recently the Survey of Schools: ICT in Education (European Commission, 2013), which showed that students in schools where teachers are well supported in pedagogical and technical terms are more likely to use ICT in lessons, regardless of other factors, including student to computer ratios. However, even where support is available, it is not necessarily sufficient. In a recent survey of 2,462 teachers in the US for example, 85% reported that they seek out their own opportunities to learn how to use technologies (Purcell et al., 2013).

Teacher pedagogical and digital competence

Teacher confidence and competence in pedagogical uses of ICT are important enablers; it is important to facilitate opportunities for professional development (including formal training and online and local communities of practice).

In cycle 1, teacher confidence and competence in pedagogical uses of ICT were seen to be essential for mainstreaming. Inadequate teacher ICT skills were mentioned in 13 (of 47) case studies in Cycle 3 and noted to be one of the most important barriers by teachers in the UK in cycle 2.

In cycle 3, face-to-face meetings were noted to be essential by 10 of 13 National Pedagogical Coordinators, a view shared by teachers and National Pedagogical Coordinators in Cycle 1. Teachers from 16 of the 47 case study schools in cycle 3 also noted that iTEC support was beneficial.

As above, such findings are reinforced in a number of studies, most recently the Survey of Schools: ICT in Education (European Commission, 2013) which showed that students in schools where teachers are confident in their operational and pedagogical use of ICT are more likely to use ICT in lessons, regardless of other factors, including student to computer ratios. Teachers need to be provided with professional development opportunities to develop their digital competence and skills in orchestrating learning rather than transmitting knowledge (Brecko, 2014).

Positive attitudes at all levels towards change

It is important to foster positive student, teacher and head teacher attitudes in order for change and innovation to occur.

In cycle 1 it was noted that students need to be prepared to adapt to unfamiliar pedagogical approaches. A positive student attitude was the most frequently cited enabler (C2-3 teacher survey: 32%, n=595).The importance of teachers being prepared to experiment with their approaches and adopt new pedagogies was mentioned in 12 (of 47) case studies in Cycle 3.

Teacher resistance to change was noted to be a concern in terms of potential scaling-up of iTEC processes through the whole school (C3/5: 10 of 55 case studies). Furthermore, the most frequently cited barrier identified by teachers in cycle 2 and cycle 3 was the lack of time required to prepare and implement the Learning Stories (C2-3 teacher survey: 32%, n=595; C5: 2 of 8 case studies).

Whilst lack of time is a frequently cited barrier in relation to the integration of ICT (eg Becta, 2004), it may, in some cases, reflect an underlying resistance to change. On the other hand, given the demands made of teachers across Europe, it could be that teachers feel obliged and/or choose to prioritise other activities over the investment required to integrate ICT into their practices. However 'even when resources and time are limited, exemplary teachers achieve effective use […] because of their strong beliefs, personal visions, and commitment to using technology' (Ertmer et al., 2006, p57). Therefore, it is of great importance to develop positive attitudes to technology use, as these will overcome perceived barriers such as lack of time and resources.

Although not emerging strongly from the iTEC evaluation data, timetabling/curriculum constraints were reported in the Survey of Schools: ICT in Education (EC, 2013) for some, but not all, countries. Rigid national curricula can constrain opportunities for innovation and the development of creative approaches to teaching and learning (Banaji, Cranmer & Perrotta, 2010).

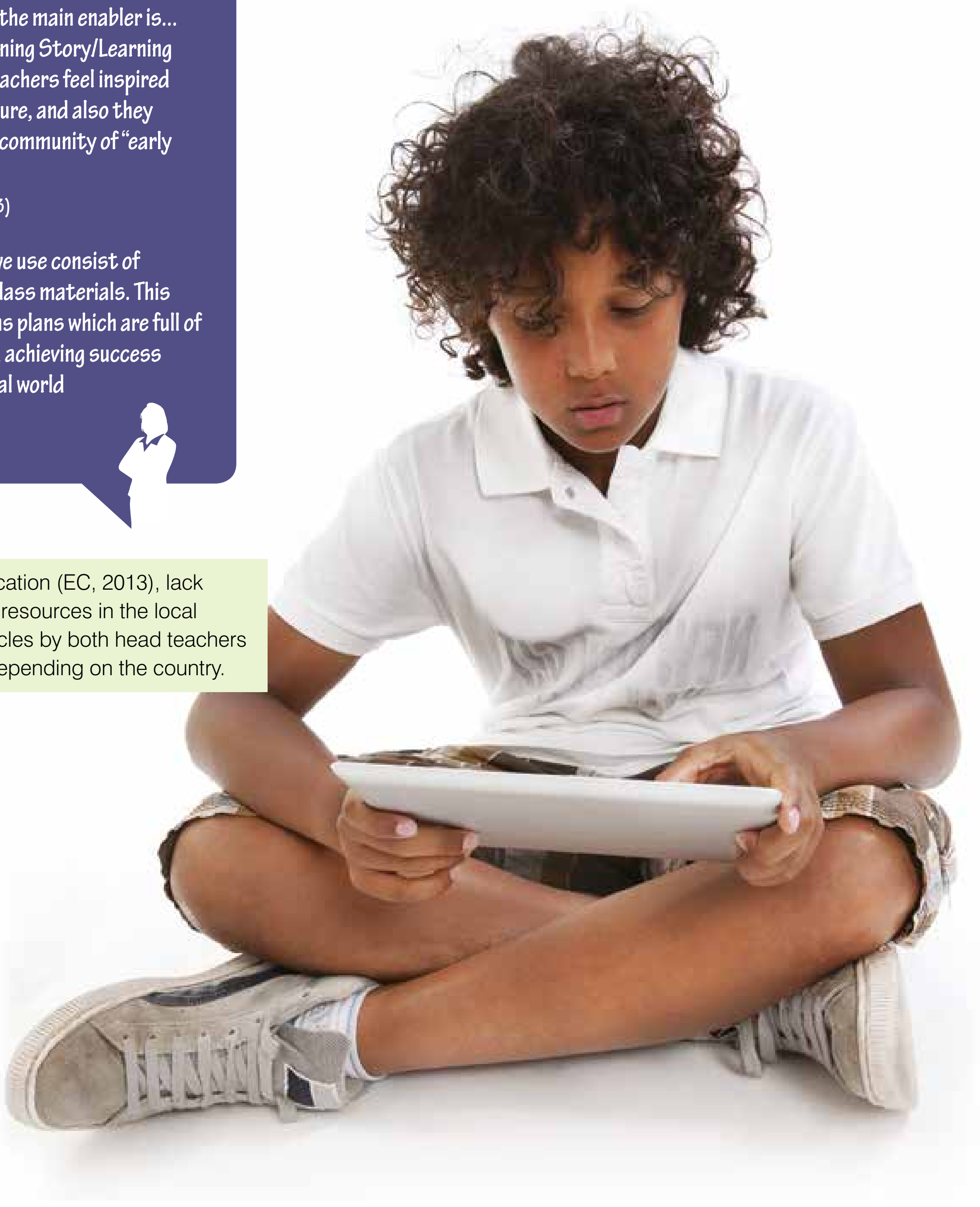
The development of structures and processes to allocate teachers time to develop innovations and engage in professional development should be prioritized. At the same time at local and national policy levels, it would be beneficial to review national curricula with the aim of increasing flexibility for teachers.

iTEC's digital resources can act as enablers of change in the classroom

Although not emerging as one of the most frequently cited enablers, some teachers from all three cycles have noted that the iTEC resources were beneficial and flexible. As described above, the iTEC resources have had a positive impact on change in the classroom. Whilst the iTEC support processes, such as national coordinators and training, have been important, the iTEC resources are one of the main outputs of the project and as such have been the primary lever of change in classrooms.

> Finally we have something useful in hand as we don't have Learning Stories like that, which give us guidelines, step by step descriptions and ideas. I feel strongly that this is something that fills a gap.
>
> (Hungary, ICT coordinator interview, C2)
>
> As in the previous [cycles], I think the main enabler is... the iTEC structure itself: the Learning Story/Learning Activities paradigm/structure. Teachers feel inspired and engaged by this kind of structure, and also they feel themselves as part of a wider community of "early adopters".
>
> (Italy, National Pedagogical Coordinator, C3)
>
> Today's simple lesson plans that we use consist of just books, notebooks and other class materials. This Learning Story has created lessons plans which are full of discovering, thinking, creating and achieving success as well as [being centred] in the real world around us
>
> (Turkey, teacher interview, C3)

In the Survey of Schools: ICT in Education (EC, 2013), lack of digital content and of educational resources in the local language were considered an obstacles by both head teachers and teachers, to a differing extent, depending on the country.



6. Innovative Technology for an Engaging Classroom: conclusions and recommendations

School staff almost unanimously agree that integrating ICT into learning and teaching is necessary for ensuring students are prepared for the 21st century (European Commission, 2013). However, whilst almost all teachers use technology to help them prepare, ICT has not yet become embedded in teaching and learning; use in the classroom is variable (European Commission, 2013).

The main outputs of iTEC are:

- a scalable scenario-led design process for developing digital pedagogy;
- the Future Classroom Toolkit and accompanying training provision;
- an extensive library of Future Classroom Scenarios, Learning Activities and Learning Stories.

Through iTEC, educational tools and resources have been piloted in over 2,500 classrooms, exceeding the original target of 1,000, across 20 European countries. Most teachers were incredibly positive about their experiences of adopting the iTEC approach, plan to use the ideas in the future and have shared their experiences with colleagues.

The iTEC approach, in the form of a learning design process and the library of resources created through the project, has led to the adoption of digital pedagogies and the increased use of technology in European classrooms. The evaluation evidence suggests that the iTEC approach can contribute to the continued uptake of digital pedagogy, if the appropriate support systems such as professional development and online communities of practice are put in place. The project has created a tool kit and professional development resources to provide continued support for the approach; these resources can be (and are being) localised at national level by many of the partners who participated in the project.

Recommendations

The iTEC project has provided evidence that an incremental approach to change, at the heart of the learning design process that was developed, can be effective. The findings, and the evidence behind them gathered during the project, naturally lead to a number of consequential implications that impinge on policy making, learning management, technology provision and research.

Policy making

Towards a learning culture. Mechanisms and structures should be put in place, supported through changes to formal curricular and assessment systems, to encourage the development in schools of a culture of self- and peer-reflection, continuous development, new roles, innovation and risk-taking, in order for schools to continue to be fit for purpose, to exploit new opportunities, and to meet evolving needs. Such changes should be communicated effectively to all stakeholders including parents in order to encourage positive attitudes. The potential of the iTEC approach and legacy resources to support this culture should be exploited in professional development, online communities, and through teacher ambassadors. This is particularly true in countries where the iTEC approach aligns closely with national policies and strategies. Opportunities to incorporate the iTEC approach in initiatives and programmes related to 21st century learning and change in schools should be identified.

Investigate learning outcomes. Further, larger-scale, impact studies of classroom implementations of iTEC tools, Learning Activities and Learning Stories at national level – including randomised controlled trials – could be commissioned, focusing on learning outcomes (specifically 21st century skills) and student attainment. The revised Future Classroom Toolkit could be validated in countries where the toolkit clearly supports current policy directions.

Build teacher capacity. Policies and support systems, including professional development, technical and pedagogical suppport, should be put in place to A) develop teachers' digital competence, particularly in digital pedagogy, and B) facilitate teachers' engagement in collaborative processes for learning design. Cost-effective online professional development, such as MOOCs and communities of practice, should be supported at national and international level, including the use of video clips and screencasts to enable teachers to share ideas and good practice. The potential for integrating iTEC assets (the Future Classroom Toolkit, Scenarios, Learning Activities and Learning Stories) created within national professional development structures and initial teacher training should be explored further. To facilitate this trainers and teacher educators would benefit from targeted development on the use of the toolkit and should be supported to use the toolkit in their own practice.

Management of teaching and learning

A culture of collaboration. School leaders should put in place organisational structures (e.g. embedding professional network participation in the school culture, and ensuring that teachers have sufficient time for effective networking) and incentive schemes to ensure that teachers share their experiences with other teachers, within and beyond their own school and develop positive attitudes towards teacher networking and collaboration. Teachers should establish and maintain connections with colleagues in their own school, and beyond, to share and jointly develop digital and pedagogical knowledge and skills as a community.

21st century competences. Teachers, supported by school leaders and through professional development, should create opportunities for students to take greater responsibility for their learning, work collaboratively, engage in authentic learning experiences and develop 21st century skills through the adoption of digital pedagogy. This demands a shift in teacher and learner roles. It also demands a positive attitude towards change, innovation and risk-taking. As students engage in more active and student-centred learning approaches, the development of digital competence becomes increasingly important.

Technology provision

End-user involvement. Technology providers should take account of the lessons learned through the iTEC project in relation to meeting needs, evolving pedagogical practices, motivating and engaging teachers as partners rather than end-users in product development and testing.

Product development. Of the various iTEC prototype technologies developed, the Scenario Development Environment would benefit most from further research and development with a view to its commercial development. It would be beneficial to conduct a larger scale pilot study, particularly in the countries where it was received favourably.

Research

Research topics. Research should continue to study whole school change, new ways of designing and managing learning, and pedagogies that make most effective use of new digital tools to produce desired learning outcomes, where possible using randomised controlled trials. Research should build on iTEC results and investigate further how best to mainstream technical and pedagogical innovation, assessing both radical and incremental approaches in school education contexts.
National specificities. Further research should be undertaken in countries in which the iTEC approach does not align so closely with national policies and strategies to identify how the approach could be adapted to fit different needs.

Research methodology. It would be beneficial to analyse, refine and validate methodologies for large-scale evaluations of projects lasting more than two years, where the object of study and the technologies used themselves evolve. Developing approaches for assessing learning outcomes in such conditions would be worthwhile.

Next steps

The summary of the evaluation evidence presented above clearly shows that the iTEC approach had considerable impact on learners and teachers, and highlights the potential that exists for system-wide change if the project results are exploited fully. The evaluation results have influenced the final design of the Future Classroom Toolkit, integrating the scenario and Learning Activity development processes, and teachers' guide to learning activity design. Taking into account the need for clearer presentation and simplification of the process should ensure wider adoption.

The project has responded to recommendations made during the evaluation [4] as follows:

- The Future Classroom Toolkit, bringing together the learning design processes, and addressing the issues identified during the evaluation, has been developed. The processes have been simplified; the presentation is more accessible and interactive; the complex terminology adopted has been clearly clarified; and many exemplars have been provided to make the process easier to adopt. The initial version of the Future Classroom Maturity Model has been reviewed by an expert, substantially revised and developed into an interactive tool.
- European Schoolnet is offering to customise the toolkit for industry partners.
- The iTEC community will continue under the umbrella of the European Schoolnet Future Classroom Lab, supported by new Future Classroom Lead Ambassadors nominated by MoEs and Future Classroom Lab industry partners. Lessons learned from the People and Events directory will inform future development of this community.
- The iTEC Future Classroom Scenario process will continue to be used in the Creative Classrooms Lab project and future European Schoolnet projects involving MoEs.
- The Future Classroom Scenarios MOOC will be offered as a regular part of the European Schoolnet Academy programme. Shorter, face-to-face courses related to the Future Classroom Toolkit will continue to be offered regularly to teachers within the Future Classroom Lab in Brussels.
- European Schoolnet plans to work with Initial Teacher Education institutions to support adoption of the iTEC/Future Classroom processes and tools in teacher education.
- The University of Vigo will continue to develop the SDE. It would be beneficial to evaluate the SDE with more teachers, particularly in the countries which viewed it favourably.
- The Widget Store will continue to be maintained. It will be made available for download as open source software. Some MoEs have already expressed an interest. It is unlikely to be taken up widely in the near future, and the reasons for this have been documented together with implications for the development of similar learning services [8].
- The standalone Composer tool is not due to be developed further beyond the project. However, the lessons learned from its development and testing are informing development of other, simpler tools for supporting learning design.
- Whilst it is not the intention to maintain the People and Events directory in its current form, lessons learned from the technical approach and user interactions will inform the development of the Future Classroom teacher community, managed by European Schoolnet.

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Appendix A: Country codes and acronyms

AT:	Austria
BE:	Belgium (Flanders)
CZ:	Czech Republic
DE:	Germany
EE:	Estonia
ES:	Spain
FI:	Finland
FR:	France
HU:	Hungary
IE:	Ireland
IL:	Israel
IT:	Italy
LT:	Lithuania
NL:	Netherlands
NO:	Norway
PL:	Poland
PT:	Portugal
SK:	Slovakia
UK:	United Kingdom
TR:	Turkey
BYOD	Bring Your Own Device
C1	Cycle 1
C2	Cycle 2
C3	Cycle 3
C4	Cycle 4
C5	Cycle 5
EUN	European Schoolnet
ICT	Information and Communications Technology
MoE	Ministry of Education
NPC	National Pedagogical Coordinator
NTC	National Technical Coordinator
MOOC	Massively Online Open Course
SDE	Scenario Development Environment

Appendix B: Overview of pilots

In the first four cycles Learning Stories and Learning Activities were created centrally (Table 3).

Table 3: Learning Stories and Learning Activities created in the first four cycles

Cycle	Dates	Learning Stories	Learning Activities
1	Sep-Dec 2011	Collecting data outside school Working with outside experts	1 Collecting data outside school 2 Working with outside experts 3 Teamwork 4 Recording team newsflashes 5 Peer feedback 6 Mental notes about learners
2	Mar-June 2012	Mathematics in a multicultural setting Embedding exam preparation in Learning Activities Students creating (science) resources	1 Forming teams 2 Ad-hoc collaboration 3 Learning oriented browsing 4 Reflection 5 Peer feedback 6 Information grouping 7 Prepare results
3	Sep-Dec 2012	Redesigning school Visualising the planet surface Designing a physics simulation Designing a maths learning game	1 Design brief 2 Contextual inquiry – observation 3 Contextual inquiry – benchmarking 4 Product design 5 Participatory design workshop 6 Final product design 7 Reflection
4	Mar-June 2013	Creating an object Telling a story Creating a game	1 Dream 2 Explore 3 Map 4 Reflect 5 Make 6 Ask 7 Show 8 Collaborate

Prior to the fifth and final cycle (November 2013- May 2014), a number of scenarios were created at national level using the Future Classroom Scenario development process. Coordinators attended a training workshop in January 2013, received the final version of the process in March 2013, were offered a further training webinar in April 2013, and were asked to develop one scenario per country by the end of the school year. The list of those developed is in Table 4 below. Those which are highlighted were included in the top 15 scenarios reviewed by the Integration Committee (which also included five prepared by an expert group).

National coordinators attended a training workshop on the learning activity development process in June 2013. National coordinators were then asked to develop Learning Stories supported by at least five Learning Activities using the learning activity design process by December 2013. In many cases, teachers developed stories involving existing Learning Activities, although coordinators were asked to ensure that at least three new learning activities per country were created. They were quality assured by a member of the iTEC project team.

Table 4: Scenarios created in Cycle 5

Country	Scenarios submitted
Austria	1. Quadcopter with 3D printed parts
Belgium	1. Create collaboratively a class quiz
Estonia	1. Gamification of the course
France	1. Personalised learning paths
Hungary	1. Message in a bottle
Norway	1. Coding to learn
Portugal	1. Students as creators of digital learning resources.
Promethean	1. Flipping the teacher 2. Students design their own demonstrations of understanding
SMART	1. Virtual museum 2. Touch the future 3. Food challenge 4. Solving maths operations 5. Self portrait 6. Pollution everywhere 7. Link to reality 8. Flipping the class 9. Inspire you with collaboration 10. History in my community 11. Collaboration
Turkey	1. Using Mind Mapping in Analyzing, Creative Writing and Critical Thinking 2. Using interdisciplinary school subjects and technology to enrich teaching and learning

Appendix C: Evaluation methodology

Table 5: Overview of data collection from pilots

Cycle	No. pilots	No. teachers responding to survey	No. case studies
1	341	231	36
2	421	261	39
3	578	334	47
4	874	342	13
5	439	260	8

Teacher and student survey

The teacher survey was administered to all participating teachers in all five cycles. In the first three cycles, the main body of questions concerned the impact of the implementation on teachers' classroom practices. In addition, they were asked about the potential of the Learning Story for innovation and wide scale uptake. In the final two cycles, the focus of questions changed to pedagogical and technological differences and the potential of iTEC technologies, as well as impact on student learning outcomes. In addition, in cycle 5 students' perceptions of impact on their learning outcomes were also gathered through a short survey.

The teacher survey was delivered online using SurveyMonkey. In C1-C3 teachers' responses were only included if they had completed most of the survey; in C4-C5 teachers' responses were included if they had answered beyond the demographic questions. Some of these teachers did not complete the survey, resulting in slightly different sample sizes for individual questions.

The data elicited through the teacher survey has been dealt with in two ways. The closed questions were analysed using SPSS, while open-ended questions were analysed by Excel. As teachers responded to the survey in their national language, open-ended responses were translated into English using Google Translate. Where it was not possible to make sense of the response in this way, NPCs' help was sought, but it is possible that some responses do not translate into English accurately and thus occasional errors in understanding may result.

In the main report, analyses have included descriptive summaries of aggregated data from survey questions, acknowledging that there may be bias in the data at the country level due to differing numbers of teachers participating in each country. However, it is likely that the variation within a country in terms of teacher practices is large, although of course at the country level (and in some cases regional level) policies and the curriculum will influence teachers. It was not possible to provide a statistical comparison based on the country samples available.

Implementation case studies

The case studies were purposively selected by the NPCs each cycle according to specified criteria, detailed in the evaluation handbook for each cycle (for example, from schools that were representative of those participating in iTEC, from schools with adequate technology provision, from a range of subject areas). The case studies are, therefore, not intended to be representative of the country in which they were conducted.

Implementation case studies were conducted in all five cycles. Qualitative data collection was semi-structured through the use of semi-structured interview schedules and templates for case study reporting. Each case study included a lesson observation and interviews with the teacher, a group of 6-8 students, the head teacher and, if applicable, the ICT coordinator. In cycles 1-3, each participating country was asked to conduct 3 case studies (2 case study reports based on a template, 1 set of raw data – translated interview transcripts, completed lesson observation template, lesson plan). In cycles 3 and 4 each participating country conducted 1 case study (1 set of raw data).

In cycles 4 and 5, teacher focus groups were introduced to gather teachers' perceptions on iTEC technologies.

Qualitative data from the case study interviews and case study reports were coded thematically in Nvivo using a conceptual framework adapted from the SITES2 study (Kozma, 2003, p13). Selected quotations are used to exemplify the reported findings. In cycle 1 and cycle 2, only a selection of case studies were coded rather than the entire set. In addition, they were coded by a different member of the team and analysed more generally in relation to themes emerging as common in qualitative research. In cycles 3 to 5, coding was applied systematically to all data, enabling the exact number of references to be identified. As a result, relative frequencies of themes arising are only reported in relation to cycles 3 to 5. However, case study interviews and teacher focus groups were designed to be semi-structured in nature and NPCs were free to make minor adaptations as appropriate, for example, including their own prompts. Therefore, whilst numbers of case study reports or interviewees mentioning various themes are provided throughout this report to allow a comparison of the relative frequency with which they were mentioned, the diversity in the conduct of the case studies, means these should be interpreted as illustrative, rather than statistical figures.

National case studies

Interviews were conducted with stakeholders from 16 countries (AT, BE, CZ, EE, ES, FI, FR, HU, IL, IT, LT, NO, PT, SK, TR, UK) by members of the project team. Where possible interviews were arranged as group discussions. Where it was not possible to schedule a time suitable for all the interviewees, individual interviews were conducted. Interviews were conducted online using Flashmeeting or Skype, or by telephone. A total of 41 individuals were interviewed.

Table 6: National case study interviewees

Country	Interviewees
Austria	1. Head of Dep., Bundesministerium für Unterricht, Kunst und Kultur (iTEC Partner lead contact). 2. Founder of ENIS Austria (iTEC NPC). 3. Representative from Bundesministerium für Unterricht, Kunst und Kultur. 4. iTEC Teacher
Belgium	1. EUN Steering Committee member for the MoE in Flanders. 2. NPC/NTC
Czech Republic	1. NPC and EUN steering committee member 2. Assistant NPC
Estonia	1. University researcher
Finland	1. NPC 2. NTC 3. EUN Steering Committee member since EUN was set up Representative from FNBE responsible for iTEC (Spring 2013 onwards)
France	1. General inspector at the MoE 2. NPC 3. MoE representative, EUN steering committee member, member of national steering committee for iTEC
Hungary	1. Head of Development, Educatio (managerial responsibility for iTEC). 2. Researcher, National Institute for Public Education (OFI). 3. NPC
Israel	1. NPC/NTC 2. Teacher trainer in MoE (previously an iTEC teacher) Written feedback also obtained from MoE representatives with responsibility for collaborative learning and ICT
Italy	1. ICT Manager, INDIRE 2. NPC
Lithuania	1. iTEC MoE rep 2. Director of Centre for ICT in Education, CITE 3. Deputy Director of CITE
Norway	1. NPC 2. Director of the Centre for ICT in Education, EUN steering committee member
Portugal	1. NPC 2. Co-ordinator of Educational Resources and Technology, MoE
Slovak Republic	1. Project Manager, ELFA S.R.O.
Spain	1. Secretary General de Education for Extramadura 2. iTEC coordinator for Extramadura 3. NPC (SMART)
Turkey	1. NPC 2. iTEC teacher 3. iTEC teacher 4. iTEC teacher
UK	1. NPC (Promethean) 2. External expert and ESSIE national co-ordinator 3. MoE representative 4. Futurelab at NFER representative

The majority of interviews were recorded (where this was not possible, notes were taken), but were not transcribed verbatim. The interview schedule was designed to be semi-structured, with interviewers being free to respond to interviewees' comments and to adjust questions or provide prompts as they saw fit. Summary reports were drafted by each of the interviewers using a common template. Some interviewers prepared one report per country, while others chose to prepare one report per interview if more than one had been conducted. The quotes included in this report are therefore taken from the national case study reports and are not direct quotations from the interviewees (unless indicated by speech marks).

In total, 18 reports were analysed using Nvivo. A deductive approach was taken, basing the coding on the themes of the report template. In this resulting report, lists of the countries in which a theme was mentioned during the interviews are provided to allow comparison and to indicate the relative frequency with which particular comments appear. However, as the interviews were semi-structured, the precise issues discussed in each interview varied and this needs to be taken into account when interpreting this data.

Data were also collected from a pre-interview survey prior to the online interview. Twelve surveys were returned from interviewees in ten countries (BE, CZ, FI, FR, HU, IL, LT, NO, PT, UK).

Table 7: Sources of evidence: how did the iTEC approach impact on learners and learning

Date	Evaluation focus	Data
Sep 11-Jun 14	Learning experience, learning outcome	Teacher surveys (n=1399), student survey (n=1488), national case studies (n=16), implementation case studies (n=68), teacher focus groups (C4, n=10)
Sep 11-Jun 14	Student motivation	Teacher surveys (n=1399), student survey (n=1488), implementation case studies (n=68)

Table 8: Sources of evidence: how did the iTEC approach impact on teachers and teaching

Date	Evaluation focus	Data
Jan 13-Aug 13	Scenario development workshops	16 national case studies (41 interviews), teacher survey (n=17), stakeholder survey (n=2), NPC focus group, NPC survey (n=11), Estonian leaning design case study, scenario selection committee members (n=5)
Sep 13-Feb 14	Learning Activity development workshops	5 case studies, post-workshop group interviews (n=2), follow-up teacher interviews (n=14), workshop facilitator survey (n=9), NPC follow-up survey (n=11), Estonian learning design case study, interview with MOOC facilitator
Sep 11-Jun 14	Teacher digital competences and pedagogy	Teacher surveys (n=1399), implementation case studies (n=68), teacher focus groups (C4, n=10)
Sep 11-Jun 14	Scaling up technology use	Teacher surveys (n=1399), implementation case studies (n=68), teacher focus groups (C5, n=9)
Sep 11-Jun 14	Experimenting with innovative digital tools	Teacher surveys (n=1399), implementation case studies (n=68), teacher focus groups (C5, n=9), people and event directory survey (n=132)
Mar 14-Apr 14	Pilot MOOC for all teachers, based on iTEC professional development package	Interview with MOOC facilitator, facilitator's evaluation data: teacher survey (n=295)
Sep 11-Jun 14	Teacher motivation	Teacher surveys (n=1399), implementation case studies (n=68), teacher focus groups (C4, n=10)

Table 9: Sources of evidence: what is the potential of the iTEC approach for system-wide adoption in schools

Date	Evaluation focus	Data
Sep 11-Jun 14	Potential of iTEC outputs	Teacher surveys (n=1399), 16 national case studies (41 interviews), implementation case studies (n=68)
Sep 11-Jun 14	Impact to date	Teacher surveys (n=1399), implementation case studies (n=68), teacher focus groups (C4/5, n=19), national case studies (n=16),
Sep 11-Jun 14	Conditions for success	Teacher surveys (n=1399), implementation case studies (n=68),

Appendix D: Exemplar scenario, Learning Activities and Learning Story

Cycle 4 scenario: Digital Producers

Core purpose:

Using digital media to create "broadcasts" of curricular work: presentations, classroom discussions and other school activities are captured and recorded through various means, they are then edited and uploaded to the web or to the VLE.

Trend/s:

- Ability to capture the moment. Focus on new literacies for a new media age. Modern devices are "mobile media production studios"
- Young people are always connected and make heavy use of digital media, this is posing challenges to teachers and education systems
- The challenges of supporting SMT subjects in the classroom

Innovative feature:

The materials being used on a large scale, in this case in over 1000 classrooms

Narrative overview:

Mrs Clay and Mr Hague are science teachers. They have heard about the iTEC 'Broadcasting STEM Learning' initiative and competition (the initiative is a new idea, yet to be established). They think this is a way of deepening their students' subject knowledge through **using technology tools and resources** in digital production. Through this initiative the iTEC project aims to engage pupils from 1000 classrooms across Europe in producing podcasts or short movies/animations about an aspect of the STEM curriculum. These learning broadcasts will be collated on the iTEC platform and tagged (for age group and subject etc), eventually providing a multi-lingual, searchable database of STEM learning broadcasts for students around the world offering **a variety of routes to** use for learning and revision purposes. Students and teachers can comment on and rate the uploaded broadcasts according to a set of criteria which are defined by students with the help of their teachers at the start of the initiative and reviewed at the stage of each round of the competition. The creators of the highest rated broadcasts in each age group will be showcased on the iTEC website.

Mrs Clay and Mr Hague want to involve their students in making broadcasts about their current topics in science as they know that in order to make a learning broadcast for others, the students will need to have a deep conceptual understanding of the material themselves. At the start of their new topics of learning, the teachers make the students aware that they will be making broadcasts aimed at their peers (and themselves for exam revision purposes later in the year). In groups, students will choose the area of the curriculum they wish to cover, research the subject and decide whether to make a choice of making a podcast or a short film/animation. For this reason, the teachers use both podcasts and videos during their teaching – to inspire the students – and ask the students to discuss the potential of each method of communication, thus developing their digital media literacy at the same time as their science understanding. Students work with their teachers to develop criteria/rubrics through which to peer-assess the outputs and feed these through to the 'Broadcasting STEM Learning' initiative organisers to help develop selection criteria.

Whilst teachers ensuring that the students have a secure understanding of the area of science they have chosen, they support their students to plan the content of their broadcasts – possibly drawing on the expertise of media studies staff and students – including what key content to include and considering how to communicate it to their audience. Students create their broadcasts using cameras/digital recorders, free web-based software and a variety of differentiated source material for use by students with different levels of understanding.

Once the broadcasts have been created students watch/listen to each other's broadcasts and provide feedback to each other using the same criteria/rubrics provided by the 'iTEC Broadcasting STEM Learning' initiative. The teachers also provide feedback on accuracy of content. The students address the feedback and the broadcasts are then submitted to the 'iTEC Broadcasting STEM Learning' competition as well as being uploaded to the school website/VLE as a means of sharing with the wider school community and parents/carers. Students also spend some time, with their teachers, rating other broadcasts uploaded to the 'iTEC Broadcasting STEM Learning' initiative as part of the competition. Throughout the year the teachers and students refer to the database of learning broadcasts and use the films and podcasts available to support learning discussions in class and revision.

If these trends continue, in five years we might see the following changes in:

Use the following boxes as guidance. Not all of the categories might apply or there might not be enough time to consider them all – focus on the aspects of the trends or the categories that you, as a group, think are more relevant or interesting. Add further categories if felt relevant.

The role of teachers

Teachers will continue to provide guidance and instruction in relation to subject knowledge, but their role will also involve the facilitation of activities in which students may be the experts. Teachers' authority may be challenged and teachers will need to be flexible and open minded.

Teachers' professional development

Keeping abreast of developments in subject knowledge and pedagogy will still be important, but teachers will also be able to support students in digital media production. A basic understanding of tools and practices will be important, but more important will be the ability to devolve responsibilities to students (see "the role of teachers"). Teachers will know how to recognise and reward student expertise, but they will still be able to control and coordinate what happens in the classroom, ensuring that curricular requirements are always accounted for.

The role of students

Students will become self-directed learners and develop collaboration skills through peer activities. The integration of formal education and informal practices of digital media production will cause changes in the expectations surrounding students. While they will still be expected to act as "students" and to develop subject knowledge, other roles and skills will be just as important - for instance, digital production skills and the ability to take different roles in production (i.e. performer, scriptwriter, director, camera person) and assessment criteria.

Skills

A number of skills that used to be informal will be recognised also at school. The need to teach and support "digital media literacy" will be just as important as teaching science or mathematics.

School management

Technology

Technology will allow schools to easily and safely connect with other schools involved in similar activities and projects. This will be an important development which will provide students with audiences of other students and teachers to whom they can show off their media productions and achievements. Schools will not compete with traditional platforms like YouTube, but will complement them by fulfilling their traditional mission of educating and teaching. For instance, it will be possible to involve up to 1000 classrooms around Europe in sharing and peer-assessing digital media outputs (e.g. short movies and animations) based on important subjects like MST (Mathematics, Science and Technology).

Technology will allow schools in different countries to collate and tag (for age group and subject etc) the student outputs, eventually providing a multi-lingual, searchable database of MST learning broadcasts for students around Europe, to use for learning and revision purposes.

Parents & Carers

Assessment

Students will take a greater role in developing criteria for assessment and peer-assessment will be required

Accreditation

School subjects and curriculum

Digital media are used to create "broadcasts" of curricular work: presentations, classroom discussions and other school activities are captured and recorded through various means; they are then edited and uploaded to the web or to the VLE.

Where and when (physical spaces and times in the school and beyond)

Reallocate some of the technology kit across the school, thus ensuring that each classroom has access to media production materials at all times as well as having a dedicated resource that teachers could book

Future employers

Budget

The Local Community

Cycle 4 Learning Activities and Learning Story derived from Digital Producer scenario

Learning Activities

Learning Activity	Brief Description	Recommended Tools
Dream	Introducing, understanding and questioning a design brief	Functionalities: 1. reflection. 2. team formation, collaborative editing, publishing. 3. blogging Tools: TeamUp, ReFlex, Google Sites, Blogger, Corkboard.me
Explore	Collecting information in relation to the design brief	Functionalities: 1. web browser. 2. bookmarking, collaborative editing. 3. media recorder, camera, note taking equipment. 4. collaborative editing Tools: TeamUp, ReFlex, iTEC Widget Store
Map	Creating a mindmap to understand relations between the collected information	Functionalities: 1. mind mapping Tools: post-it notes, Bubbl.us, CmapTools, Popplet, Mindmeister, Freemind, TeamUp, ReFlex
Reflect	Recording audio-visual reflections and feedback	Functionalities: 1. audio/video reflection. Tools: TeamUp, ReFlex, Redpentool, Voicethread
Make	Creating a design	Functionalities: 2. media editing, diy kit, programming environment, construction kit, 3d editing, 3d printing Tools: Prezi, Sketchup, Scratch, TeamUp, ReFlex, iTEC Widget Store
Ask	Performing workshops with people who may represent future users of the design	Functionalities: 1. media recorder, note taking Tools: audio recorder, video recorder, post-it notes
Show	Publishing and presenting designs to an audience	Functionalities: 1. video editing, media recording, video publication 2. media sharing Tools: iTEC Widget Store
Collaborate	Forming ad-hoc collaborations with learners of other schools	Functionalities: 1. online discussion, media publication, publication. 2. blogging Tools: iTEC students collaborate facebook group, iTEC teacher community

Learning Story: Tell a Story

This story's unique quality is its focus on narration and digital storytelling. Learning how to tell a story, to eloquently convey a point or to convince an audience, for example parents or other adults, can be considered a general expert skill, relevant to all areas of interest. This learning story will convey storytelling as a meaningful learning experience and answers the question of how storytelling and narrative relate to all subject areas. Using digital storytelling may motivate students and allow for non-traditional tasks and activities.

Storytelling design brief – Create an engaging short video story that relates a scientific phenomena to a personal experience and is no longer than 5 minutes. Select an audience and be sure to tell the story in an engaging, factually correct, yet understandable way for your audience.

DREAM – I am a science teacher and with the media studies teacher, I am challenging my students to create engaging short video stories about the concept of friction. I give them the design brief and suggest they think of their peers as the target audience. I show a few inspiring video stories to them and we proceed with discussing the potential of each method of communication, thus developing their digital media literacy at the same time as their science understanding. The media studies teacher and I agree that this will support the students' ability to narrate and to deeply engage with a scientific concept. In the first lesson, I ask my students to dream up what their video stories could be about. *REFLECT* – Each student uses ReFlex to record their first reflection as well as their dreamed achievement as a time capsule, dated at the end of the course.

EXPLORE – I ask the students to find, view and review engaging science videos to gain inspiration for their own videos as home work, for example at home, after school clubs or public libraries. They will also deeply engage with their science story, trying to figure out the mechanics involved, how to experiment with them and how to explain them in their story. REFLECT – Students reflect on what they've found and what their initial ideas for their stories are.

MAP – Back in school, all students create mind maps of their findings and start creating storyboards for their video stories. Pairs of students comment each others' plans. The storyboards show sketches of scenes and video transitions, and describe shooting locations, sound information and descriptions of the actors dialogue, expression and movement. After the storyboards are completed, the students, the media teacher and I develop criteria based on which the video stories will be evaluated. *REFLECT* – Teams reflect on the activity, their challenged and their plans for the upcoming make activity.

MAKE – The students start their video production using their mobile phones and digital cameras. They share tips, ideas and media files. To edit their stories, they are using free web-based software. Some of the clips have to be filmed outside of the school. The media teacher is providing tips about the narrative structure of the videos, while I am mainly mindful about the scientific accuracy of the content. I remind the students to prepare for participatory design (PD) workshops with media professionals. *REFLECT* – Students reflect on their data gathering progress and their plans for the upcoming PD workshop.

ASK and COLLABORATE – One student showed his reflections to his mother, who works for a children's television programme and offered that she and her colleagues could tour the students around the television studio and comment on the first draft of the student videos. Although I planned on using the iTEC people and events network to locate a screenplay writer or fiction author who might be interested in supporting the students, this seems to be a much more interesting connection. During the workshop with the television staff, the students are filled with exciting ideas and are energized to add the received suggestions to their video stories, although this means for some of the students to put in a few more hours than expected. *REFLECT* – PD workshop participants comment on the reflection and development of the students work.

SHOW – At the end of the course, the students upload their video stories to an online video sharing platform, such as YouTube and Vimeo, and link to them through the iTEC facebook group. For this, each student has to collect permission of their parents. The students view and comment the videos created by other iTEC students across Europe. As all videos include subtitles, the videos communicate easily across the language borders of European countries. We are also asking parents to view the videos and comment on them. Some of the videos are really interesting, so I decide to bookmark and use them in my teaching in the future. *REFLECT* – I am using the accumulation of comments, the reflection recordings of my students, their documentation as well as the feedback I recorded throughout the Learning Story to assess their work. We discuss my assessment in the following lesson. Throughout the discussion, students get the chance to argue for or against my assessment. Some of them bring up strong grounds that make me re-evaluate their work.

Exciting examples – MIT Blossoms videos: http://blossoms.mit.edu/

Support material – UNESCO Young Digital Creators is a guidebook for digital production at school.

Appendix E: Exemplar implementation case study (cycle 5)

In the Norwegian case study, the observed session was based on the scenario Teaching by Programming and an associated Learning Story Code to Learn. It involved a group of 16 – 18 years old students working in groups of four. The teacher used the game creation programme Construct 2 to teach the principles of programming, and to work with the creation of learning games. A range of technologies were used in this activity. iTEC technologies Composer, People and Events Directory, SDE, were used alongside WordPress (blog), Google Drive (joint writing), Facebook (group work), Mindomo (mind maps), and MS Photo Story.

The teacher described how learners developed both increased autonomy and an enhanced capacity for meaningful collaboration as a result of their participation in the iTEC experience. Also, through blogging in English they were able to tap into supportive peer and staff communities and have "some contact with ... in a mentor-like fashion, other teachers in the subjects which they are creating games for". Equally, the teacher felt benefit from peer support networks established as part of the iTEC experience, having taking part in a teachers' workshop in Oslo: " It was great to get some information and meet other teachers…since I used to be the only one who was involved with programming and games… Yes, so it was really great". Interestingly, the teacher identified the supportive scope of iTEC, saying it "really is a European project" that has introduced extensive innovations:

> *Yes, it is innovative in many ways, to a very large extent, both in relation to here and more generally. I have the impression that a lot of traditional teaching still goes on, and this is a long, long way from that. Think about the fact that we have writing on shared documents, blogging, social media, Facebook groups and contacts and things like that. I also use some of these tools in mainstream teaching, but not so .... in [the same] a way.. Not in a way that produces synergy effects that combine so many different tools.*

Students welcomed the change from "classroom-based lessons" which were regarded as "not very exciting". Supported by the collaborative forum available to them, they developed a repertoire of skills with an extensive range of ICT tools which they were able to deploy in interrelated ways. The iTEC experience led to "more fun group work", satisfaction in working to self-imposed deadlines and learning both by getting things right and wrong: "It's really satisfying working for half an hour and then trying out the game and seeing that everything works…It's also kind of fun when things don't work as they should either".

Students could clearly see the real world applicability of the ICT skills that they were learning: "…there's Construct, which even if there isn't coding like this in the real world or in working life, then it's [still useful]... You mostly learn about what you can do, even if it is very simplified". They were also enthusiastic about applying such skills in their working lives.

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